Unit Overview	
Content Area: Earth and Space Science	
Unit Title: Earth's Surface Processes	**Unit:** 1 & 2
Target Course/Grade Level: 4	**Timeline:** 30 Days

Unit Summary:

Is it possible to engineer ways to protect humans from natural Earth?

In this unit of study, students apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. In order to describe patterns of Earth's features, students analyze and interpret data from maps. The crosscutting concepts of *patterns*, *cause and effect*, and the influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in planning and carrying out investigations, analyzing and interpreting data, and constructing explanations and designing solutions. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 4-ESS2-2, 4-ESS3-2, 3-5-ETS1-2, and 3-5-ETS1-3.

What do the shapes of landforms and rock formations tell us about the past?

In this unit of study, students develop understandings of the effects of weathering and the rate of erosion by water, ice, wind, or vegetation. The crosscutting concepts of patterns and cause and effect are called out as organizing concepts. Students demonstrate grade-appropriate proficiency in planning and carrying out investigations and constructing explanations. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 4-ESS2-1 and 4-ESS1-1.

Learning Targets

NJSLS-Science

4-ESS2-1.	Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
4-ESS1-1.	Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. [
4-ESS2-2.	Analyze and interpret data from maps to describe patterns of Earth's features.
4-ESS3-2.	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*

3-5-ETS1- 2.	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
K-2- ETS1-3.	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems
- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

ESS2.E: Biogeology
- Living things affect the physical characteristics of their regions.

ESS1.C: The History of Planet Earth
- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.

ESS2.B: Plate Tectonics and Large Scale System Interactions
- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.

ESS3.B: Natural Hazards
- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.

ETS1.B: Designing Solutions to Engineering Problems
- Testing a solution involves investigating how well it performs under a range of likely conditions.

ETS1.B: Developing Possible Solutions
- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.

ETS1.C: Optimizing the Design Solution
- Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Science and Engineering Practices

Planning and Carrying Out Investigations
- Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.

Constructing Explanations and Designing Solutions
- Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Identify the evidence that supports particular points in an explanation.

Analyzing and Interpreting Data

- Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning.

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Analyzing and Interpreting Data

- Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Analyze data from tests of an object or tool to determine if it works as intended.

NJSLS Connections

Primary Interdisciplinary Connections:

English Language Arts/Literacy:

To support integration of the language arts standards in this unit, students can read content-specific texts to deepen their understanding of the cause-and-effect relationships within earth systems. As they read, students should take notes, which can be used to help them understand and explain how earth processes affect the world around them. They should ask questions, such as,

- ✓ What types of soil erode faster?
- ✓ Why do some rocks weather more easily or more quickly than others?
- ✓ What patterns of change can be observed using models?

As they attempt to answer these questions, students can cite evidence from observations and from texts to support their thinking. In addition, students can conduct short research projects that will help them gather additional evidence to support explanations. Throughout this unit, students should collect and record data in science journals and analyze the data to identify patterns of change.

To support integration of the CCSS for English Language Arts in this unit, students should have access to multiple sources of information about Earth's features and earth processes. Students should have opportunities to read, analyze, and interpret information from nonfiction text, charts, graphs, diagrams, timelines, and interactive elements on the Internet. Students use this information, along with data they collect during investigations, to help explain, both orally and in writing, the patterns they observe in the features of the Earth and in the natural hazards that occur on the Earth.

As students engage in the engineering design process, they need opportunities to conduct research to build their understanding of how earth processes affect humans and to find examples of ways in which engineers reduce the effect of volcanic eruptions, earthquakes, floods, and tsunamis. Students should take notes as they read and summarize or paraphrase their notes to support their work throughout the engineering design process.

In addition, students should provide a list of sources when using this type of information.

Mathematics:

To support integration of the Mathematics standards into this unit, students are expected to use mathematics when analyzing quantitative data to identify patterns, explain cause-and-effect relationships, and make predictions. Students need opportunities to measure earth materials using tools, such as balances and graduated cylinders, and to measure distances and heights using rulers or tape measures. Students should also be required to solve problems involving measurement and data.

- Use measurements to determine how far earthquakes and volcanoes tend to occur from continental boundaries.
- Analyze data to determine patterns of change that occur in areas where volcanoes erupt, earthquakes occur, and in flood zones.
- Reason abstractly and quantitatively to draw diagrams to build scale models.
- Analyze timelines, charts, and graphs to determine patterns in Earth's features and patterns of change caused by earth processes.
- Reason abstractly and quantitatively when discussing the effects of an earth process on humans. For example, on average, 3,000 lives are lost every year due to tsunamis. When early warning systems are in place, fewer than 1,000 lives are lost annually.
- Analyze constraints on materials, time, or cost to in order to determine criteria for design solutions.

Unit Essential Questions

1. How can evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation be observed or measured?
2. What can rock formations tells us about the past?
3. What can maps tell us about the features of the world?
4. In what ways can the impacts of natural Earth processes on humans be reduced?

Unit Understandings

Cause-and-effect relationships are routinely identified, tested, and used to explain change.

- Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.
- Rainfall helps to shape the land and affects the types of living things found in a region.
- Living things affect the physical characteristics of their regions.
- Science assumes consistent patterns in natural systems.
- Patterns can be used as evidence to support an explanation.
- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes.
- The presence and location of certain fossil types indicate the order in which rock layers were formed.
- Patterns can be used as evidence to support an explanation.
- Maps can help locate the different land and water features of Earth.
- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns.
- Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans.
- Major mountain chains form inside continents or near their edges.

	• Cause-and-effect relationships are routinely identified, tested, and used to explain change. • Engineers improve existing technologies or develop new ones to increase benefits, decrease known risks, and meet societal demands. • A variety of hazards result from natural processes (e.g., earthquakes, floods, tsunamis, volcanic eruptions). • Humans cannot eliminate the hazards, but they can take steps to reduce their impacts. • Research on a problem should be carried out before beginning to design a solution. • Testing a solution involves investigating how well it performs under a range of likely conditions. • At whatever stage, communicating with peers about proposed solutions to a problem is an important part of the design process, and shared ideas can lead to improved designs. • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.
Unit Learning Targets (Outcomes) – Formative Assessment *Students who understand the concepts are able to …*	
· Support explanations using patterns as evidence.	
· Identify the evidence that supports particular points in an explanation.	
· Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. Examples of evidence from patterns could include: ✓ Rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time. ✓ A canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.	
· Identify and test cause-and-effect relationships in order to explain change.	
· Generate multiple solutions to a problem and compare them based on how well they meet the criteria and constraints of the design solution.	
· Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. Examples of solutions could include: ✓ Designing an earthquake-resistant building ✓ Improving monitoring of volcanic activity.	

· Generate multiple possible solutions to a problem and compare them based on how well each is likely to meet the criteria and constraints of the problem.

· Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

· Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Cross Cutting Concepts:

Cause and Effect

- Relationships are routinely identified, tested, and used to explain change. (4-ESS3-2)

Patterns

- Patterns can be used as evidence to support an explanation. (4-ESS2-2)

Integration of Technology: Web-based textbook, interactive whiteboard, interactive texts, videos, digital board builder

Technology Resources:

http://www.learner.org/interactives/dynamicearth/
http://video.mit.edu/watch/layers-of-the-earth-12670/
www.sciencemonster.com/earth-science/layers-of-the-earth.html/

Opportunities for Differentiation: Differentiation and support tips, which includes suggestions for ELL, struggling students, and accelerated students, are available below the instructional practice section of each model lesson.

Teacher Notes:

Career Ready Practices: *In this unit the following career ready practices are addressed*

CRP1: Act as a reasonable and contributing citizen and employee
CRP2: Apply appropriate academic and technical skills
CRP3: Attend to personal health and financial well-being
CRP4: Communicate clearly and effectively and with reason
CRP5: Consider the environmental, social and economic impacts of decisions
CRP6: Demonstrate creativity and innovation
CRP7: Employ valid and reliable research strategies
CRP8: Utilize critical thinking to make sense of problems and persevere in solving them
CRP9: Model integrity, ethical leadership and effective management
CRP10: Plan education and career paths aligned to personal goals
CRP11: Use technology to enhance productivity
CRP12: Work productively in teams while using cultural global competence

Prior Learning- by the end of Grade 2 , students understand that:

Grade 2 Unit 4: The Earth's Land and Water

- Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.

- Maps show where things are located. One can map the shapes and kinds of land and water in any area.

Grade 2 Unit 5: Changes to Earth's Land

- Wind and water can change the shape of the land.

Grade 2 Unit 4: The Earth's Land and Water

- Maps show where things are located. One can map the shapes and kinds of land and water in any area.
- Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.

Evidence of Learning
Summative Assessment
Natural Disaster Research, p. 137, Knowing Science, project may be used as a summative assessment. Rubric, p.137, Knowing Science
Equipment needed: Whiteboard, laptops, headphones, and hands-on materials for lessons
Teacher Instructional Resources (Hyperlinks): **Glaciers, Water, and Wind, Oh My!** This hands-on activity allows students to explore five earth forces that may cause erosion as they model, observe, and record the effects of erosion on earth surfaces. Stations include demonstrations of chemical, wind, water, ice and heat forces as they affect weathering. **Bill Nye Video-Erosion:** Bill Nye, "The Science Guy", presents a video describing the effects of weathering (wind, water, ice) on landforms. Bryce Canyon is used as an example of the ways in which freezing water, plant roots, and wind weather the earth's surface creating the means for erosion. Students in video simulate effects of weathering which can be duplicated in a classroom setting. Nye also emphasizes the passage of time in millions of years as he explains the slower erosive effects of certain types of weathering. **Gary's Sand Journal:** This book allows students to observe illustrations of magnified sand particles with guided dialogue from an earth scientist who discusses sand origins. This book can be used to introduce students to types of sand, explain how earth processes were responsible for their creation, and discuss the work of earth scientists. After reading this book, students may use it as a resource when examining their own sand samples. They could list properties, discuss sand origins, and illustrate samples in a science journal. **Explaining Glaciers, Accurately:** Fourth grade lessons on glacial erosion demonstrate and explain the manner in which glaciers erode the earth. The mechanisms of plucking and abrasion are discussed. Activities (either whole-class or small group) include a teacher creation of a glacier model (using dirt and rocks to simulate a mountain, ice cubes and a small amount of water for glacier), then teacher demonstration of glacier "plucking" earth as it travels in a simulation activity. Students then experiment with rock samples, wood, sandpaper, and ice as they rub materials against each other to explore how glacial striations form and abrade other surfaces. In each simulation, students are asked to predict what would happen when glacial model water freezes, as they draw before and after pictures of the model. Students are also asked to predict how glacial striations were formed as they view photos,

then record results of their abrasive materials activity. Students could benefit from the expertise of a mentoring geologist who shares illustrations and information with students and teachers.

Coastal Erosion: This engineering design lesson focuses on the effects of erosion on Florida's coastline. It is one lesson offered within a larger weathering and erosion unit. Students groups work to create and use a model able to slow erosion, without damaging the coastal ecosystem. Students are responsible for developing scale diagram of their coastline erosion solution before building and testing their models in a pan to simulate the coastline. Students then complete a redesign cycle. Similar lessons from the developer can be used in conjunction with this lesson to incorporate the effects of erosion on humans and wildlife.

Engineering for the Three Little Pigs: This activity helps to demonstrate the importance of rocks, soils, and minerals in engineering and how using the right material for the right job is important. The students build 3 different sand castles composed of varying amounts of sand, water, and glue. The 'buildings' in this lesson are made of sand and glue, sand being a soil and glue being composed of different minerals. They then test them for strength (load bearing), and resistance to weathering. The students will then compare possible solutions and discuss how well each is likely to work while meeting the criteria and constraints of the problem. The students will be the engineers who figure out which materials are best for the buildings they are making, taking into consideration all the properties of materials that are discussed in the lesson.

Building for the Big One: This lesson plan details a Design Challenge in which students build and test structures while learning about the earthquakes that shake them. It is designed as a review or culmination of an Earthquake unit of study. The lesson plan allows teachers to connect back to previous lessons. The Tech Museum of Innovation also suggests that the lesson might be used as a form of introduction to a unit about earthquakes. The lesson would then be used to determine students' prior knowledge to set the stage for the design challenge. This resource often mentions the effects of tectonic plates on earthquake location. Grade 4 curriculum does not include tectonic plates in their earth science curriculum. Tectonic plate information is included in the lesson as a resource for the teacher.

Earthquakes in the Classroom: Students investigate which building types are structured to withstand earthquake damage. They take on the role of engineers as they design their own earthquake resistant buildings, then test them in a simulated earthquake activity. Students also develop an appreciation for the job of engineers who need to know about earthquakes and their causes in order to design resistant buildings. This lesson is one of several in the "Earthquakes Rock" unit provided by the Teach Engineering site. The unit "URL" listed here is not being reviewed for the Performance Expectation listed. It is offered as a supplemental concept and lesson background aid for teachers. https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_natdis/cub_natdis_lesson03.xml

Getting the Right Angle on the Story: This informational text shows students how tsunamis form and behave. It also describes how scientists are collecting data to create models that can be used to predict tsunamis. Animations/computer models are also included to enhance student knowledge of how tsunami warnings work. Models integrate new, unfamiliar vocabulary. Students could use the resource as a starting point for an earth systems unit; teachers could assign the site as a form of research where students gather data, take notes, and draw inferences from text. As students begin their study, they could generate a list of the earth's natural disasters and define their impact on human life and the environment. Their possible solutions for lessening that impact could also be incorporated as an informal formative assessment to determine student prior knowledge.

DLESE Earth Science Literacy Maps are a tool for teachers and students to find resources that relate to specific Earth science concepts. These maps illustrate connections between concepts and how they build upon one another across grade levels. Clicking on a concept within the maps will show DLESE

resources related to the concept, as well as information about related AAAS Project 2061 Benchmarks and National Science Education Standards.

Modifications for ELL's, Special Education, 504, and Gifted and Talented Students:

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

· Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

· Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

· Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).

· Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

· Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.

· Use project-based science learning to connect science with observable phenomena.

· Structure the learning around explaining or solving a social or community-based issue.

· Provide ELL students with multiple literacy strategies.

· Collaborate with after-school programs or clubs to extend learning opportunities.

· Restructure lesson using UDL principles (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

ACTIVITIES	**MATERIALS**
1.1: Beneath our Feet Identify Earth's layers and the characteristics of each Session 1	Create an informal learning center or discovery area. Provide books on rocks and minerals and invite students to bring in their own samples to share and identify.Create an informal learning center or discovery area. Provide books on rocks and minerals and invite students to bring in their own samples to share and identify.
1.1: Beneath our Feet Create models of Earth's internal structure Session 2	Provide the opportunity for a "home project" to create additional models of Earth layers.

1.2: Fossils Tell a Story Introduce to Pangea. Session 1	Provide the opportunity for a "home project" to create Pangea models.
1.2: Fossils Tell a Story **Session 2** Recognize that fossils provide evidence about organisms that lived long ago Explain how fossils provide evidence about the nature of the environment at any time in history Create models to better understand plate tectonics and fossil records	Find a local geologist or fossil collector to come in and talk about their work.
1.2: Fossils Tell a Story Session 3 Introduce to main types of fossils	Visit a local museum or science center to learn more about local geologic history.
1.2: Fossils Tell a Story Session 4 Make models of fossils	
1.2: Fossils Tell a Story Session 5 Make models of fossils	
1.2: Fossils Tell a Story Session 6 Understand how Earth's history is represented through geologic time	Students may further research fossils or an era of geologic time that interests them.
1.3: What is Soil? Session 1 Identify and describe soil layers	Encourage students to bring in soil samples from around their homes or collect samples from the area around the school.
1.3: What is Soil? Session 2 Observe properties of soil samples	Invite a local farmer or cooperative extension representative to talk about soil and bring in local samples.
1.4: Weathering and Erosion Session 1 Introduce to weathering	Research the geology of your local area.
1.4: Weathering and Erosion	

Session 2 Create models to represent and understand various types of weathering	
1.4: Weathering and Erosion Session 3 Create models to represent and understand various types of weathering	
1.4: Weathering and Erosion Session 4 Introduce to erosion	Introduce to erosion
1.4: Weathering and Erosion Session 4 Introduce to erosion	If you live near a local waterway, take a field trip to find evidence of erosion or erosion prevention.
1.4: Weathering and Erosion Session 5 Create models to represent and understand various types of erosion	
1.4: Weathering and Erosion Session 6 Create models to represent and understand various types of erosion	
1.4: Weathering and Erosion Session 7 Create models to represent and understand various types of erosion Compare the processes of weathering and erosion Understand the impacts of weathering and erosion on humans	
1.5: Patterns in Earth's Features Session 1 Give examples of Earth's continental and oceanic landforms	
1.5: Patterns in Earth's Features Session 2 Explain the main mountains formation mechanisms	
1.5: Patterns in Earth's Features Session 3	Create a display of various types of maps brought in by students. Include local maps.

Compare types of maps that show Earth's features	
1.5: Patterns in Earth's Features Session 4 Explain how topographic maps represent contour and elevation	Invite a local Scout or 4-H leader to demonstrate orienteering.
1.6: Volcanoes, Tsunamis and Earthquakes – Oh My! Session 1 Understand the ways in which tectonic plates move Explain how volcanoes, earthquakes, and tsunamis form and describe their relationship to each other	
1.6: Volcanoes, Tsunamis and Earthquakes – Oh My! Session 2 Model natural disasters	
1.6: Volcanoes, Tsunamis and Earthquakes – Oh My! Session 3 Give examples of preventive measures humans take to reduce the impacts of these natural hazards	Contact school administrators to have them discuss with students emergency plans for the school in the event of a natural disaster.
1.6: Volcanoes, Tsunamis and Earthquakes – Oh My! Session 4 Give examples of preventive measures humans take to reduce the impacts of these natural hazards	Invite a representative from the local Red Cross to come talk about what the organization does to help people whose lives have been affected by a natural disaster.
1.6: Volcanoes, Tsunamis and Earthquakes – Oh My! Session 5+ Research examples of preventive measures humans take to reduce the impacts of these natural hazards	Have students interview a family member about natural disasters or extreme weather events they have experienced or remember hearing about.