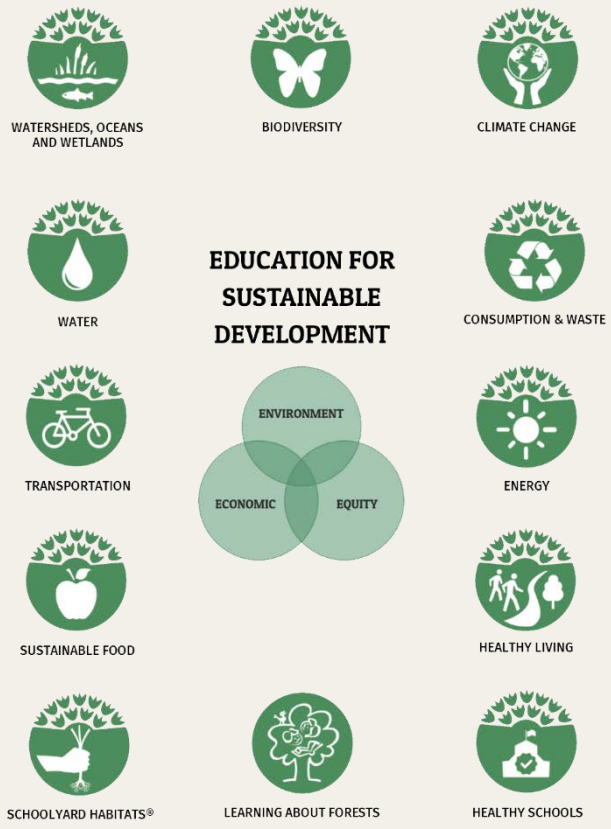
Pathways to Sustainability

Alignment to NGSS – MS: Earth Science

Students in middle school develop understanding of a wide range of topics in Earth and space science (ESS) that build upon science concepts from elementary school through more advanced content, practice, and crosscutting themes. There are six ESS standard topics in middle school: Space Systems, History of Earth, Earth's Interior Systems, Earth's Surface Systems, Weather and Climate, and Human Impacts. The content of the performance expectations are based on current community-based geoscience literacy efforts such as the Earth Science Literacy Principles (Wysession et al., 2012), and is presented with a greater emphasis on an Earth Systems Science approach. The performance expectations strongly reflect the many societally relevant aspects of ESS (resources, hazards, environmental impacts) as well as related connections to engineering and technology.

The National Wildlife Federation's Eco-Schools USA programs has aligned three of the six middle school earth and space science topics that meet our learning objectives and outcomes, **Earth's Systems, Weather and Climate** and **Human Impacts**.



Earth's Systems: Students understand how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students can investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data. Of special importance in both topics are the ways that geoscience processes provide resources needed by society but also cause natural hazards that present risks to society; both involve technological challenges, for the identification and development of resources and for the mitigation of hazards.

Weather and Climate: Students can analyze data, including maps, and construct and use models to develop understanding of the factors that control weather and climate.

A systems approach is also important here, examining the feedbacks between systems as energy from the sun is transferred between systems and circulates though the ocean and atmosphere.

Human Impacts: Students understand the ways that human activities impacts Earth's other systems. Students can use many different practices to understand the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts of their development.
The National Wildlife Federation's Eco-Schools USA program has aligned their program Pathways of Sustainability to the Next Generation Science Standards, NGSS. As a part of the Eco-Schools Seven Step Framework, linking to the curriculum is a priority. This alignment is designed to highlight the natural connections between the NGSS and the Eco-Schools USA program.

Our program icons are used to denote pathway connections to the NGSS Performance Expectations and alignment to the Common Core State Standards, CCSS, English Language Arts, ELA and Mathematics.

Green STEM is an initiative of NWF's Eco-Schools USA program and is focused on identifying best practice in the STEM fields as it relates to environment-based learning. These elements include:

- Project, problem and place-based learning
- Utilizing the school, both inside and outside, as a learning laboratory
- Interdisciplinary approach
- Innovation space
- A commitment to stewardship
- An inclusive culture, where all students can learn, participate and take action

EARTH'S SYSTEMS

Students who demonstrate understanding can:

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy and groundwater resources are the result of past and current geoscience processes.


CLIMATE CHANGE


HEALTHY LIVING


LEAF


SCHOOLYARD HABITATS®


WOW

Each Performance Expectation is more successfully accomplished by students who have numerous opportunities to engage in inquiry based learning experiences and using the school as a learning laboratory, provides students with these opportunities. Students will be able to develop and use models with greater precision and understanding and have the ability to communicate understanding with fact-based evidence.

Students who have played an integral role in making meaningful changes on their campus have the conceptual understanding needed to build new learning around these performance expectation's overarching concepts, cause and effect relationships and the flow of energy into and out of systems.

Driving Questions – Examples

- How can we, as landscape architects, design and construct a schoolyard habitat, which will provide opportunities for students to learn and study Earth's systems?
- How can we, as climate scientists, demonstrate to our school that our resources are unevenly distributed, some finite and some infinite and how they were and are shaped by Earth's processes?

EARTH'S SYSTEMS - CONTINUED

SCIENCE AND ENGINEERING PRACTICES

- Developing and Using Models
- Constructing Explanations and Designing Solutions

DISCIPLINARY CORE IDEAS

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

ESS3.A. Natural Resources

CROSSCUTTING CONCEPTS

- Cause and Effect
- Energy and Matter

CONNECTIONS TO ENGINEERING, TECHNOLOGY AND APPLICATIONS OF SCIENCE

- Connections to Engineering And Technology On Society and the Natural World

Connections to other DCIs to this grade band: **MS.PS1.A** (MS-ESS2-4) (MS-ESS3-1); **MS.PS1.B** (MS-ESS3-1); **MS.PS2.B** (MS-ESS2-4); **MS.PS3.A** (MS- ESS2-4); **MS.PS3.D** (MS-ESS2-4); **MS.PS4.B** (MS-ESS2-4); **MS.LS1.C** (MS-ESS3-1); **MS.ESS2.D** (MS-ESS3-1)

Articulation of DCIs across grade-bands: **3.PS2.A** (MS-ESS2-4); **4.PS3.B** (MS-ESS2-1) (MS-ESS2-4); **4.PS3.D** (MS-ESS3-1); **4.ESS2.A** (MS-ESS2-1); **4.ESS3.A** (MS-ESS3-1); **5.PS2.B;** (MS-ESS2-4); **5.PS3.D** (MS-ESS3-1); **5.LS2.B** (MS-ESS2-1); **5.ESS1.B** (MS-ESS2-4); **5.ESS2.A** (MS-ESS2-1); **5.ESS2.C** (MS-ESS2-4); **HS.PS1.B** (MS-ESS2-1); **HS.PS2.B** (MS-ESS2-4); **HS.PS3.B** (MS-ESS2-1) (MS-ESS2-4) (MS-ESS3-1); **HS.PS4.B** (MS-ESS2-4); **HS.LS1.C** (MS-ESS2-1) (MS-ESS3-1); **HS.LS2.B** (MS-ESS2-1); **HS.ESS2.A** (MS-ESS2-1) (MS-ESS2-4) (MS-ESS3-1**);** **HS.ESS2.B** (MS-ESS3-1); **HS.ESS2.C** (MS-ESS2-1) (MS-ESS2-4) (MS-ESS3-1); **HS.ESS2.D** (MS-ESS2-4); **HS.ESS2.E** (MS-ESS2-1); **HS.ESS3.A** (MS-ESS3-1)

Common Core State Standards Connections

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1)

SL.8.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-1)

Mathematics

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1)

7EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1)

WEATHER AND CLIMATE

Students who demonstrate understanding can:

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

CLIMATE CHANGE

ENERGY

Each Performance Expectation is more successfully accomplished by students who have numerous opportunities to engage in inquiry based learning experiences and using the school as a learning laboratory, provides students with these opportunities. Students will be able to develop and use models with greater precision and understanding and have the ability to communicate understanding with fact-based evidence.

Students who have played an integral role in making meaningful changes on their campus have the conceptual understanding needed to build new learning around these performance expectation's overarching concept, stability and change.

Driving Questions – Examples

- How can we, as city health officials, monitor our air temperature and quality, and increase understanding about why global temperatures have risen, what that means for the community and ways we can work together to stay healthy and safe?
- How can we, as geoscientists, better understand the benefits of renewable resources for use in our community and work with the city council on plans to include affordable access to those sources of energy, via residential and commercial mechanisms to collect, store, and use solar, wind, hydro, and/or geothermal energy?

WEATHER AND CLIMATE - CONTINUED

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
• Asking Questions and Defining Problems	**ESS3.D** Global Climate Change	• Stability and Change

Connections to other DCIs in this grade band: **MS.PS3.A** (MS-ESS3-5)

Articulation of DCIs across grade-bands: HS.PS3.B (MS-ESS3-5); HS.PS4.B (MS-ESS3-5); HS.ESS2.A (MS-ESS3-5); HS.ESS2.D (MS- ESS3-5); HS.ESS3.C (MS-ESS3-5); HS.ESS3.D (MS-ESS3-5)

Common Core State Standards

ELA/Literacy
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-5)

Mathematics
MP.2 Reason abstractly and quantitatively. (MS-ESS2-5),(MS-ESS3-5)
6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-5)
7EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-5)

HUMAN IMPACTS

Students who demonstrate understanding can:

MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Each Performance Expectation is more successfully accomplished by students who have numerous opportunities to engage in inquiry-based learning experiences and using the school as a learning laboratory, provides students with these opportunities. Students will be able to develop and use models with greater precision and understanding and have the ability to communicate understanding with fact-based evidence.

Students who have played an integral role in making meaningful changes on their campus have the conceptual understanding needed to build new learning around these performance expectation's overarching concepts, of understanding patterns and cause and effect relationships.

Driving Questions – Examples

- How can we, as waste managers, raise awareness around the life cycle of products at our school and how they impact our environment and the local economy?
- How can we, as local farmers, work with soil scientists and engineers to develop space saving food systems to address current and future access to quality food for our growing community?

HUMAN IMPACTS- CONTINUED

SCIENCE AND ENGINEERING PRACTICES

- Analyzing and Interpreting Data
- Constructing Explanations and Desigining Solutions
- Engaging in Argument from Evidence

DISCIPLINARY CORE IDEAS

ESS3.B Natural Hazards

ESS3.C Human Impacts on Earth Systems

CROSSCUTTING CONCEPTS

- Patterns
- Cause and Effect

CONECTIONS TO ENGINEERING, TECHNOLOGY AND APPLICATIONS TO SCIENCE

- Influence of Science, Engineering and Technology on Society and the Natural World

CONNECTIONS TO NATURE OF SCIENCE

- Science Addresses Questions About the Natural and Material World

Connections to other DCIs in this grade band: **MS.PS3.C** (MS-ESS3-2); **MS.LS2.A** (MS-ESS3-3) (MS-ESS3-4); **MS.LS2.C** (MS-ESS3-3) (MS-ESS3-4); **MS.LS4.D** (MS-ESS3-3) (MS-ESS3-4)

Articulation of DCIs across grade-bands: **3.LS2.C** (MS-ESS3-3) (MS-ESS3-4); **3.LS4.D** (MS-ESS3-3) (MS-ESS3-4); **3.ESS3.B** (MS-ESS3-2); **4.ESS3.B** (MS-ESS3-2); **5.LS2.A** (MS-ESS3-3) (MS-ESS3-4); **5.ESS3.C** (MS-ESS3-3) (MS-ESS3-4); **HS.LS2.A** (MS-ESS3-4); **HS.LS2.C** (MS-ESS3-3),(MS-ESS3-4); **HS.LS4.C** (MS-ESS3-3) (MS-ESS3-4); **HS.LS4.D** (MS-ESS3-3) (MSESS3-4); HS.ESS2.B (MS-ESS3-2); **HS.ESS2.C** (MS-ESS3-3); **HS.ESS2.D** (MS-ESS3-2) (MS-ESS3-3); **HS.ESS2.E** (MS-ESS3-3) (MS-ESS3-4); **HS.ESS3.A** (MS-ESS3-4); **HS.ESS3.B** (MSESS3-2); **HS.ESS3.C** (MS-ESS3-3) (MS-ESS3-4); **HS.ESS3.D** (MS-ESS3-2) (MS-ESS3-3)

HUMAN IMPACTS- CONTINUED

Common Core State Standards

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-2),(MS-ESS3-4)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-2)

WHST.6-8.1 Write arguments focused on discipline content. (MS-ESS3-4)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focusedquestions that allow for multiple avenues of exploration. (MS-ESS3-3)

WHST.6-8.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. (MS-ESS3-3)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-4)

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-ESS3-2)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS3-3),(MS-ESS3-4)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-ESS3-3),(MS-ESS3-4)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4)

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-2),(MS-ESS3-3),(MS-ESS3-4)