

Earth Science Pathway Endorsement Specs

Purpose

This document describes the specifications associated with the Earth Science Pathway Science Endorsements. There are three endorsements in the Biology Pathway: Science Core, Earth Science 1, and Earth Science 2.

The **Science Core Endorsement**, when attached to a current Education License, verifies that the individual has the skills and knowledge necessary to teach students three-dimensionally in a secondary science classroom and is required to teach Middle School Science Courses in Grades 6, 7, or 8. Additionally, this endorsement is required as a prerequisite to earn any high school Level-1 or Level-2 content specific science endorsement.

The **Earth Science 1 Endorsement**, when attached to a current Education License, verifies that the individual has the skills and knowledge necessary to teach students in a secondary earth science classroom and is required to teach High School (9-12) General Earth and Space Science Course and High School Astronomy, Environmental Science, Geology, and Meteorology Elective Courses. This endorsement is required as a prerequisite to the Secondary Earth Science 2 Endorsement.

This **Earth Science 2 Endorsement**, when attached to a current Secondary Education License, verifies that the individual has the skills and knowledge necessary to teach students in an advanced secondary earth science classroom and is required to teach Advanced Earth/Environmental (AP, CE, and IB) and other high school earth science elective courses. Those with this endorsement can also teach all the courses a Earth Science 1 endorsed educator can teach. NOTE: Advanced Earth/Environmental Science (AP, CE, and IB) courses may also include additional requirements in order to be approved by the university or college board to teach.

Endorsement Requirement Areas

The Science Core endorsement is a prerequisite for the Earth Science 1 and Earth Science 2 Endorsements and has 7 requirement areas:

1. Earth Science Content Knowledge
2. Life Science Content Knowledge
3. Chemistry Content Knowledge
4. Physics Content Knowledge
5. Three-Dimensional Science & Engineering Pedagogical Knowledge
6. Science Education Teaching & Dispositions Knowledge
7. Science Classroom Lab Safety Knowledge

The Earth Science 1 Endorsement is a prerequisite for the Earth Science 2 Endorsement has 5 requirement areas:

8. Earth's Place in the Universe Content Knowledge
9. Geologic Systems & Processes Content Knowledge
10. Weather & Climate Content Knowledge
11. Biogeology Content Knowledge
12. Earth & Human Activity Content Knowledge

The Earth Science 2 Endorsement has the following 2 requirement areas:

13. Advanced Data Analysis Content Knowledge
14. Advanced Earth Science Knowledge

Endorsement Type

A professional endorsement will be awarded when all of the prerequisite and endorsement requirement areas have been met. An associate Science Core Endorsement will be awarded if the applicant has completed at least 3 of the 7 requirement areas. An associate Earth Science 1 Endorsement will be awarded if the applicant holds a Professional Science Core endorsement, has college a major or minor in Earth Science, **OR** has completed at least 5 of the 12 requirement areas. An associate Earth Science 2 Endorsement will be awarded if the applicant holds Professional Science Core and Earth Science 1 endorsements, has a college major in Earth Science, OR has completed at least 6 of the 14 requirement areas.

Requirement Area Options

The different options available to complete requirement areas 8-14 for the Earth Science 1 and Earth Science 2 Endorsements are described below. The options for requirement areas 1-7 associated with the Science Core Endorsement can be found in the [Science Core Endorsement Specs](#). Quick links to the requirement area competencies are linked in parentheses.

Requirement Area 8: Earth's Place in the Universe Content Knowledge ([ES1.1](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Astronomy (e.g., General Astronomy, The Solar System, The Universe, Astrophysics)
 - Lab course is not required but recommended

College Major or Minor (Meets Requirement Areas 1-5 for the Earth Science 1 endorsement)

- College Major or Minor in Earth Science, Earth Science Education, Physical Science Education, or an Earth Science Variation (e.g., Environmental Science, Geology, Meteorology, Astronomy)
- Other College Majors or Minors may be approved for this endorsement with approval of USBE Science Specialist based on a transcript review

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- **Praxis Exam** (Meets Requirement Areas 8-12 for this endorsement)
 - [Earth and Space Sciences PRAXIS \(5572\)](#) with score of 148 or higher
- **NES Test**
 - [Earth and Space Science NES Test \(322\)](#) with score of 220 or higher
- Other equivalent state or national exams that meet competencies and approved by USBE

Requirement Area 9: Geologic Systems & Processes Content Knowledge ([ES1.2.A-C](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Geology (e.g., General Geology, Physical Geology, Historical Geology, Mineralogy, Dynamic Earth)
 - Lab course is not required but recommended

College Major or Minor (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 10: Weather & Climate Content Knowledge ([ES1.2.D](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Meteorology (e.g., General Meteorology, Weather, Climate, Climate Change, Severe and Hazardous Weather)
 - o Lab course is not required but recommended

College Major or Minor (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 11: Biogeology Content Knowledge ([ES1.2.E](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Ecology (e.g., General Ecology, Field Ecology, Marine Ecology, Stream Ecology, or Wildlife Biology)
 - o Lab course is not required but recommended
 - o A course in Environmental Science does not meet this requirement

College Major or Minor (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 12: Earth & Human Activity Content Knowledge ([ES1.3.A-D](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Environmental Science (e.g., Environmental Science, Conservation Biology, Natural Resources, Natural Energy)
 - o Lab course is not required but recommended

College Major or Minor (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Earth Science 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 13: Advanced Data Analysis Content Knowledge ([ES2.1](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Statistics (e.g., General Statistics, Applied Statistics, Probability and Statistics, Statistics for Scientists)

College Major (Meets Requirement Areas 13-14 for the Earth Science 2 endorsement)

- College Major in Earth Science, Earth Science Education, or an Earth Science Variation (e.g., Environmental Science, Geology, Meteorology, Astronomy)
- Other College Majors may be approved for this endorsement with approval of USBE Science Specialist based on a transcript review

Teaching Experience and Professional Learning (Meets Requirement Areas 13-14 for the Earth Science 2 endorsement)

- Teach either AP Environmental Science or IB Environmental Systems and Societies for 3 years.
- Attend the relevant Professional Learning for the course being taught.
 - AP Summer Institute for AP Biology.
 - Diploma Program Environmental Systems and Societies Workshop for IB Environmental Systems and Societies.
- Apply principles acquired in professional learning into teaching for 2 years.

Requirement Area 14: Advanced Earth Science Content Knowledge (ES2.2)

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Complete **TWO** 3+ credit university courses (passed with a grade of C or higher) any of the following Advanced/Applied Earth Science in addition to the courses taken to meet Earth Science 1 Endorsement requirements (if applicable).
 - Atmospheric Science
 - Environmental Management
 - Geologic/Natural Hazards
 - Historical or Physical Geology
 - Intro to GIS, Soil Science
 - Other upper division (3000+) earth science course

College Major (Meets Requirement Areas 13-14 for the Earth Science 2 endorsement)

- As described in Requirement Area 13 description

Teaching Experience and Professional Learning (Meets Requirement Areas 13-14 for the Earth Science 2 endorsement)

- As described in Requirement Area 13 description

Requirement Area Competencies

The Secondary Earth Science 1 competencies are organized into 1 section:

- 1. Earth Science 1 Core Ideas** – The Utah Secondary Earth Science 1 qualifies teachers to teach the core High School (9-12) General Earth and Space Science course focused specifically in the High School Earth and Space Science disciplinary core ideas:

ES1.1 Earth's Place in the Universe

ES1.2 Earth's Systems

ES1.3 Earth and Human Activity

The Secondary Earth Science 2 competencies are organized into 1 section:

- 1. Earth Science 2 Core Ideas** – This endorsement is required to teach Advanced Earth/Environmental Science (AP, CE, and IB) and high school Earth Science elective courses. These competencies and requirements go above that of the core ideas found in the SEEd Earth Science Standards.

ES2.1 Advanced Data Analysis

ES2.2 Advanced Earth Science Content Knowledge

Each of the requirement area competencies are described below. Quick links to each requirement area options are provided in the parentheses.

Requirement Area 8 - Earth's Place in the Universe Content Knowledge (Options)

Requirement Area ES1.1: Earth's Place in the Universe

Area ES1.1.A: The Universe and its stars

- ES1.1.A.a The star called the Sun is changing and will burn out over 10 billion years.
- ES1.1.A.b The Sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky way is just one of hundreds of billions of galaxies in the Universe.
- ES1.1.A.c The study of star's light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.

Area ES1.1.B: Earth and the Solar System

- ES1.1.B.a Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.
- ES1.1.B.b Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the orientation of the planet's axis of rotation, both occurring over tens to hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause cycles of ice ages and other gradual climate changes

Area ES1.1.C: History of Planet Earth

- ES1.1.C.a Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time.
- ES1.1.C.b Continental rocks, which can be older than 4 billion years, are generally much older than rocks on the ocean floor, which are less than 200 million years old. Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches.
- ES1.1.C.c Although active geological processes, such as plate tectonics, and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects and provide information about Earth's formation and early history

Requirement Area 9 - Geologic Systems & Processes Content Knowledge (Options)

Requirement Area ES1.2: Earth's Systems

Area ES1.2.A: Earth Materials and Systems

- ES1.2.A.a Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts.
- ES1.2.A.b Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. The top part of the mantle, along with the crust, forms

structures known as tectonic plates.

- ES1.2.A.c Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the gravitational movement of denser materials toward the interior.
- ES1.2.A.d The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

Area ES1.2.B: Plate Tectonics and Large-Scale System Interactions

- ES1.2.B.a The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle providing the primary source of the heat that drives mantle convection.
- ES1.2.B.b Plate tectonics can be viewed as the surface expression of mantle convection.

Area ES1.2.C: The Roles of Water in Earth's Surface Processes

- ES1.2.C.a The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks.

Requirement Area 10 - Weather & Climate Content Knowledge ([Options](#))

Requirement Area ES1.2: Earth's Systems

Area ES1.2.D: Weather and Climate

- ES1.2.D.a The foundation for Earth's global climate system is the electromagnetic radiation from the sun as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems and this energy's re-radiation into space.
- ES1.2.D.b Climate change can occur when certain parts of Earth's systems are altered. Geological evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere; longer term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis; or even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years.
- ES1.2.D.c Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

Requirement Area 11 - Biogeology Content Knowledge ([Options](#))

Requirement Area ES1.2: Earth's Systems

Area ES1.2.E: Biogeology

- ES1.2.E.a The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

Requirement Area 12 - Earth & Human Activity Content Knowledge ([Options](#))

Requirement Area ES1.3: Earth and Human Activity

Area ES1.3.A: Natural Resources

- ES1.3.A.a Resource availability has guided the development of human society. All forms of

energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks, as well as benefits.

- ES1.3.A.b New technologies and regulations can change the balance of these factors

Area ES1.3.B: Natural Hazards

- ES1.3.B.a Natural hazards and other geological events have shaped the course of human history by destroying buildings and cities, eroding land, changing the course of rivers, and reducing the amount of arable land. These events have significantly altered the sizes of human populations and have driven human migrations.
- ES1.3.B.b Natural hazards can be local, regional, or global in origin, and their risks increase as populations grow. Human activities can contribute to the frequency and intensity of some natural hazards.

Area ES1.3.C: Human Impacts on Earth Systems

- ES1.3.C.a The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Scientists and engineers can make major contributions— for example, by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
- ES1.3.C.b When the source of an environmental problem is understood and international agreement can be reached, human activities can be regulated to mitigate global impacts (e.g., acid rain and the ozone hole near Antarctica).

Area ES1.3.D: Global Climate Change

- ES1.3.D.a Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history.
- ES1.3.D.b Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts.
- ES1.3.D.c Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities, as well as to changes in human activities. Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences—for humanity as well as for the rest of the planet.

Requirement Area 13 - Advanced Data Analysis Content Knowledge (Options)

Requirement Area ES2.1: Advanced Data Analysis

Area ES2.1.A: Representing and Describing Data

- ES2.1.A.a Construct a graph, plot, or chart (X,Y; Log Y; Bar; Histogram; Line, Dual Y; Box and Whisker; Pie) showing correct: a) Orientation, b) Labeling, c) Units, d) Scaling, e) Plotting, f) Type, g) Trend line
- ES2.1.A.b Describe data from a table or graph, including: a) Identifying specific data points, b) Describing trends and/or patterns in the data, c) Describing relationships between variables

Area ES2.1.B: Statistical Tests and Data Analysis

- ES2.1.B.a Perform mathematical calculations, including: a) Mathematical equations, b) Means, c) rates, d) ratios, e) percentages.
- ES2.1.B.b Use confidence intervals and/or error bars (both determined using standard errors) to determine whether sample means are statistically different.
- ES2.1.B.c Perform chi-square hypothesis testing
- ES2.1.B.d Use data to evaluate a hypothesis (or prediction), including a) Rejecting or failing to reject the null hypothesis, b) Supporting or refuting the alternative hypothesis.



Requirement Area 14 - Advanced Life Science Content Knowledge (Options)**Requirement Area ES2.2: Advanced Earth Science Content Knowledge****Area ES2.2.A: The Living World and Populations**

- ES2.2.A.a Describe the global distribution and principal environmental aspects of terrestrial biomes.
- ES2.2.A.b Explain how solar energy is acquired and transferred by living organisms.
- ES2.2.A.c Describe ecosystem service and human disruptions to them.
- ES2.2.A.d Describe island biogeography and its role in evolution.
- ES2.2.A.e Describe ecological tolerance.
- ES2.2.A.f Explain how natural disruptions, both short and long-term, impact an ecosystem.
- ES2.2.A.g Describe ecological succession and its effect on ecosystems.
- ES2.2.A.h Identify differences between generalist and specialist species.
- ES2.2.A.h Identify differences between K- and r-selected species.
- ES2.2.A.i Explain survivorship curves.
- ES2.2.A.j Explain age structure diagrams.
- ES2.2.A.k Explain factors that affect total fertility rate in human populations.
- ES2.2.A.l Explain how human populations experience growth and decline.

Area ES2.2.B: Earth Systems and Resources

- ES2.2.B.a Describe the characteristics and formation of soil including similarities and differences between properties of different soil types.
- ES2.2.B.b Describe the structure and composition of the Earth's atmosphere including how environmental factors can result in atmospheric circulation.
- ES2.2.B.c Describe the characteristics of a watershed.
- ES2.2.B.d Describe how the Earth's geography affects weather and climate.
- ES2.2.B.e Describe the environmental changes and effects that result from El Niño or La Niña events (El Niño–Southern Oscillation).
- ES2.2.B.f Explain the concept of the tragedy of the commons.
- ES2.2.B.g Describe the effect of clearcutting on forests.
- ES2.2.B.h Describe agricultural practices that cause environmental damage.
- ES2.2.B.i Describe different methods of irrigation including their benefits and drawbacks.
- ES2.2.B.j Describe the benefits and drawbacks of different methods of pest control.
- ES2.2.B.k Identify different methods of meat production including the benefits and drawbacks.
- ES2.2.B.l Describe causes of and problems related to overfishing.
- ES2.2.B.m Describe natural resource extraction through mining including ecological and economical impacts of natural resource extraction through mining.
- ES2.2.B.n Describe the effects of urbanization on the environment.
- ES2.2.B.o Explain the variables measured in an ecological footprint.
- ES2.2.B.p Explain the concept of sustainability.
- ES2.2.B.q Describe methods for mitigating problems related to urban runoff.
- ES2.2.B.r Describe sustainable agricultural and food production practices.
- ES2.2.B.s Describe the benefits and drawbacks of aquaculture.
- ES2.2.B.t Describe methods for mitigating human impact on forests.

Area ES2.2.C: Energy Resources and Consumption

- ES2.2.C.a Identify differences between nonrenewable and renewable energy sources.
- ES2.2.C.b Describe trends in energy consumption.



- ES2.2.C.c Identify types of fuels and their uses.
- ES2.2.C.d Identify where natural energy resources occur.
- ES2.2.C.e Describe the use and methods of fossil fuels in power generation and the effects of fossil fuels on the environment.
- ES2.2.C.f Describe the use of nuclear energy in power generation and the effects of the use of nuclear energy on the environment.
- ES2.2.C.g Describe the effects of the use of biomass in power generation on the environment.
- ES2.2.C.h Describe the use of solar energy in power generation and the effects of solar energy power generation on the environment.
- ES2.2.C.i Describe the use of hydroelectricity in power generation and the effects of the use of hydroelectricity power generation on the environment.
- ES2.2.C.j Describe the use of geothermal energy in power generation and the effects of geothermal energy power generation on the environment.
- ES2.2.C.k Describe the use of hydrogen fuel cells in power generation and the effects of hydrogen fuel cell power generation on the environment.
- ES2.2.C.l Describe the use of wind energy in power generation and the effects of wind energy power generation on the environment.
- ES2.2.C.m Describe methods for conserving energy.

Area ES2.2.D: Atmospheric, Aquatic, and Terrestrial Pollution

- ES2.2.C.n ES2.2.D.a Identify the sources and effects of air pollutants
- ES2.2.C.o Explain the causes and effects of photochemical smog and methods to reduce it.
- ES2.2.C.p Describe thermal inversion and its relationship with pollution.
- ES2.2.C.q Describe natural sources of CO₂ and particulates.
- ES2.2.C.r Identify indoor air pollutants.
- ES2.2.C.s Explain how air pollutants can be reduced at the source.
- ES2.2.C.t Describe the effects of acid deposition on the environment.
- ES2.2.C.u Describe human activities that result in noise pollution and its effects.
- ES2.2.C.v Identify differences between point and nonpoint sources of pollution.
- ES2.2.C.w Describe the impacts of human activities on aquatic ecosystems.
- ES2.2.C.x Describe the causes and effects of endocrine disruptors on ecosystems.
- ES2.2.C.y Describe the impacts of human activity on wetlands and mangroves.
- ES2.2.C.z Explain the environmental effects of excessive use of fertilizers and detergents on aquatic ecosystems.
- ES2.2.C.aa Describe the effects of thermal pollution on aquatic ecosystems.
- ES2.2.C.bb Describe the effect of persistent organic pollutants (POPs) on ecosystems.
- ES2.2.C.cc Describe the effects of bioaccumulation and biomagnification.
- ES2.2.C.dd Describe the effects of solid waste disposal methods.
- ES2.2.C.ee Describe changes to current practices that could reduce the amount of generated waste and their associated benefits and drawbacks.
- ES2.2.C.ff Define lethal dose 50% (LD₅₀) and evaluate dose response curves.

Area ES2.2.E: Global Change

- ES2.2.E.a Explain the importance of stratospheric ozone to life on Earth and chemicals used to substitute for chlorofluorocarbons (CFCs).
- ES2.2.E.b Identify Greenhouse Gases and the sources and potency of the greenhouse gases.
- ES2.2.E.c Identify the threats to human health and the environment posed by an increase in greenhouse gases

- ES2.2.E.d Explain how changes in climate, both short- and long-term, impact ecosystems.
- ES2.2.E.e Explain the causes and effects of ocean warming and ocean acidification.
- ES2.2.E.f Explain the environmental problems associated with invasive species and strategies to control them.
- ES2.2.E.g Explain how species become endangered and strategies to combat the problem.
- ES2.2.E.g Explain how human activities affect biodiversity and strategies to combat the problem.