Earth and Space Science Objectives

(1) Earth and Space Science (ESS) is a capstone course designed to build on students' prior scientific and academic knowledge and skills to develop understanding of the Earth System in space and time.

(2) NATURE OF SCIENCE

Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.

(3) SCIENTIFIC INQUIRY

Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) SCIENCE AND SOCIAL ETHICS

Scientific decision-making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information.

(5) EARTH AND SPACE SCIENCE THEMES

An Earth systems approach to the themes of Earth in Space and Time, Solid Earth, and Fluid Earth defined the selection and development of the concepts discussed below.

(A) **Earth in Space and Time.** Earth has a long, complex, and dynamic history. Advances in technologies continue to further our understanding of the origin, evolution, and properties of the Earth and planetary systems within a chronological framework. The origin and distribution of resources that sustain life on Earth are the result of interactions among Earth's subsystems over billions of years.

(B) **Solid Earth.** The geosphere is a collection of complex, interacting, dynamic subsystems linking Earth's interior to its surface. The geosphere is composed of materials that move between subsystems at various rates driven by the uneven distribution of thermal energy. These dynamic processes are responsible for the origin and distribution of resources as well as geologic hazards that impact society.

(C) **Fluid Earth.** The fluid Earth consists of the hydrosphere, cryosphere, and atmosphere subsystems. These subsystems interact with the biosphere and geosphere resulting in complex biogeochemical and geochemical cycles. The global ocean is the thermal energy reservoir for surface processes and, through interactions with the atmosphere, influences climate. Understanding these interactions and cycles over time has implications for life on Earth.

(6) EARTH AND SPACE SCIENCE STRANDS

The course has three strands used throughout each of the three themes: systems, energy, and relevance.

(A) **Systems.** A system is a collection of interacting physical, chemical and biological processes that involves the flow of matter and energy on different temporal and spatial scales. The Earth system is composed of interdependent and interacting subsystems of the geosphere, hydrosphere, atmosphere, cryosphere, and biosphere within a larger planetary and stellar system. Change and constancy occur in Earth's system and can be observed, measured as patterns and cycles, and described or presented in models used to predict how the Earth system changes over time.

(B) **Energy.** The uneven distribution of Earth's internal and external thermal energy is the driving force for complex, dynamic and continuous interactions and cycles in Earth subsystems. These interactions are responsible for the

movement of matter within and between the subsystems resulting in, for example, plate motions and ocean-atmosphere circulation.

(C) **Relevance**. The interacting components of the Earth system change by both natural and human-influenced processes. Natural processes include hazards such as flooding, earthquakes, volcanoes, hurricanes, meteorite impacts, and climate change. Some human-influenced processes, such as pollution and nonsustainable use of Earth's natural resources, may damage the Earth system. Examples include climate change, soil erosion, air and water pollution, and biodiversity loss. The time scale of these changes and their impact on human society must be understood to make wise decisions concerning the use of the land, water, air, and natural resources. Proper stewardship of Earth will prevent unnecessary degradation and destruction of Earth's subsystems and diminish detrimental impacts to individuals and society.