*Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.

HS-ESS3-4

Students who demonstrate understanding can:

HS-ESS3-4. **Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

The performance expectation above was developed using the following elements from *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles and theories.

- Design or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*

Crosscutting Concepts

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.

Connections to Engineering, Technology, and Applications of Science

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

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Observable features of the student performance by the end of the course:

1	Using scientific knowledge to generate the design solution		
	a	Students use scientific information to generate a number of possible refinements to a given technological solution. Students:	
		i.	Describe* the system being impacted and how the human activity is affecting that system;
		ii.	Identify the scientific knowledge and reasoning on which the solution is based;
		iii.	Describe* how the technological solution functions and may be stabilizing or destabilizing the natural system;
		iv.	Refine a given technological solution that reduces human impacts on natural systems; and
		v.	Describe* that the solution being refined comes from scientists and engineers in the real world who develop technologies to solve problems of environmental degradation.
2	Describing criteria and constraints, including quantification when appropriate		
	a	Students describe* and quantify (when appropriate):	
		i.	Criteria and constraints for the solution to the problem; and
		ii.	The tradeoffs in the solution, considering priorities and other kinds of research-driven tradeoffs in explaining why this particular solution is or is not needed.
3	Evaluating potential refinements		

	a	In their evaluation, students describe* how the refinement will improve the solution to increase benefits and/or decrease costs or risks to people and the environment.
	b	Students evaluate the proposed refinements for:
		i. Their effects on the overall stability of and changes in natural systems; and
		ii. Cost, safety, aesthetics, and reliability, as well as cultural and environmental impacts.