



Agriculture, Food, and Natural Resources Frameworks

Natural Resources and Environmental Service Systems Pathway

Natural Resources and Environmental Service Systems Pathway

The Natural Resource and Environmental Service Systems (NRESS) Career Pathway is a combination of two overlapping pathways. The Natural Resource Systems (NRS) encompasses the study of the management, protection, enhancement and improvement of soil, water, wildlife, forests and air as natural resources. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of natural resource systems in AFNR settings. The Environmental Service Systems (ESS) Career Pathway encompasses the study of systems, instruments and technology used to monitor and minimize the impact of human activity on environmental systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application, and management of ESS in Agriculture, Food, and Natural Resource (AFNR) settings.

Experiential Learning

Experiential Learning consists of Supervised Agriculture Experience (SAE), Work-based Learning (WBL), Apprenticeship, Job Shadow, and Service Learning experiences. Experiential Learning is a required component of a total agricultural education program and intended for every student. Through their involvement in Experiential Learning activities, students are able to consider multiple careers and occupations, learn expected workplace behavior, develop specific skills within an industry, and are given opportunities to apply academic and occupational skills in the workplace or a simulated workplace environment. Through these strategies, students learn how to apply what they are learning in the classroom as they prepare to transition into the world of college and career opportunities. Table 1 contains example SAEs defined by the National Future Farmers of America (FFA) Organization.

Table 1. Supervised Agricultural Experiences

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| <ul style="list-style-type: none"> • Environmental Science • Forestry • Natural Resource Management | <ul style="list-style-type: none"> • Outdoor Recreation • Wildlife Management |
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National FFA Organization

The FFA Organization is dedicated to making a positive difference in the lives of students by developing their potential for premier leadership, personal growth, and career success through agricultural education. FFA award and degree programs recognize students for excellence in academics, career development, leadership, and community service. Career and leadership development activities encompass the entire AFNR Career Cluster and each AFNR Pathway and are available at the local chapter, regional, state, and national levels. See Table 2 for example Career and Leadership Development Events related to the Natural Resource and ESS Pathway.

Table 2. FFA Activities

Career Development Events (CDE's)	Leadership Development Events (LDE's)
<ul style="list-style-type: none"> • Fish and Wildlife CDE • Forestry CDE • Soils • Agriscience Fair 	<ul style="list-style-type: none"> • Agricultural Issues Forum • Marketing Plan • Ag Communications • Prepared Public Speaking • Extemporaneous Speaking

Recommended Courses

Introductory Courses Number and Name	Intermediate Courses Number and Name	Advanced Courses Number and Name
<ul style="list-style-type: none"> • 24 Agriculture Science 1 • 81 Natural Resources Management 1 • 83 Fish and Wildlife 1 	<ul style="list-style-type: none"> • 79 Forestry Science and Management • 82 Natural Resources Management II • 85 Soil and Water Management 	<ul style="list-style-type: none"> • 10 Natural Recourse Science II (Science) • 78 Biotech and Renewable Resources II • 72 Environmental Science II

Minnesota Natural Resource and Environmental Service Systems Standards

Minnesota Framework: MN.NRES.01. Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.

Performance Indicator: MN.NRES.01.01. Classify different types of natural resources in order to enable protection, conservation, enhancement and management in a particular geographical region.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.

MN.NRES.01.01 Intro Course Benchmarks	NRES.01.01 Intermediate Course Benchmarks	MN.NRES.01.01 Advanced Course Benchmarks
NRES.01.01.01.a.Research and examine the characteristics used to identify trees and woody plants.	NRES.01.01.01.b.Apply identification techniques to determine the species of a tree or woody plant.	NRES.01.01.01.c.Evaluate the species of trees present to assess the health of an ecosystem (e.g., presence of native versus invasive species, biodiversity, etc.).
NRES.01.01.02.a.Research and examine the characteristics used to identify herbaceous plants.	NRES.01.01.02.b.Apply identification techniques to determine the species of an herbaceous plant.	NRES.01.01.02.c.Evaluate the species of herbaceous plants present to assess the health of an ecosystem (e.g., presence of native versus invasive plants, biodiversity, etc.).
NRES.01.01.03.a.Research and examine the characteristics used to identify wildlife and insects.	NRES.01.01.03.b.Apply identification techniques to determine the species of wildlife or insect.	NRES.01.01.03.c.Evaluate the species of wildlife and insects present to assess the health of an ecosystem.
NRES.01.01.04.a.Research and examine the characteristics used to identify aquatic species.	NRES.01.01.04.b.Apply identification techniques to determine the species of an aquatic organism.	NRES.01.01.04.c.Evaluate the aquatic species present to assess the health of an ecosystem.
NRES.01.01.05.a.Research and examine the characteristics used to identify non-living resources (e.g., soil types, climate, geography, etc.)	NRES.01.01.05.b.Apply identification techniques to determine the types of non-living resources in an area.	NRES.01.01.05.c.Evaluate the non-living resources present in an area to determine the best practices for improving, enhancing and protecting an ecosystem.
NRES.01.01.06.a.Research the purpose and value of resource inventories and population studies.	NRES.01.01.06.b.Apply procedures for conducting resource inventories and population studies.	NRES.01.01.06.c.Conduct an assessment of the resource inventories or population in a given area.

Performance Indicator: MN.NRES.01.02. Apply ecological concepts and principles to atmospheric natural resource systems.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.1.3.1 Natural and designed systems are made up of components that act within a system and interact with other systems
 - 9.4.4.2 Personal and community health can be affected by the environment, body functions and human behavior.

MN.NRES.01.02 Intro Course Benchmarks	NRES.01.02 Intermediate Course Benchmarks	MN.NRES.01.02 Advanced Course Benchmarks
NRES.01.02.01.a. Classify different kinds of biogeochemical cycles and the role they play in natural resources systems.	NRES.01.02.01.b. Assess the role that the atmosphere plays in the regulation of biogeochemical cycles.	NRES.01.02.01.c. Evaluate and make recommendations to lessen the impact of human activity on the ability of the atmosphere to regulate biogeochemical cycles.
NRES.01.02.02.a. Research and summarize how climate factors influence natural resource systems.	NRES.01.02.02.b. Analyze the impact that climate has on natural resources and debate how this impact has changed due to human activity.	NRES.01.02.02.c. Assess the primary causes of climate change and design strategies to lessen its impact on natural resource systems.

Performance Indicator: MN.NRES.01.03. Apply ecological concepts and principles to aquatic natural resource systems.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.
 - 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.NRES.01.03 Intro Course Benchmarks	NRES.01.03 Intermediate Course Benchmarks	MN.NRES.01.03 Advanced Course Benchmarks
NRES.01.03.01.a. Summarize the roles and properties of watersheds.	NRES.01.03.01.b. Assess the function of watersheds and their effect on natural resources.	NRES.01.03.01.c. Evaluate and defend the importance of watersheds to ecosystem function.
NRES.01.03.02.a. Examine and describe the importance of groundwater and surface water to natural resources	NRES.01.03.02.b. Analyze how different classifications of ground and surface water affect ecosystem function.	NRES.01.03.02.c. Devise and apply strategies to manage, protect, enhance or improve sources of groundwater or surface water based on its properties.
NRES.01.03.03.a. Compare and contrast riparian zones and riparian buffers based on their function.	NRES.01.03.03.b. Assess techniques used in the creation, enhancement and management of riparian zones and riparian buffers.	NRES.01.03.03.c. Devise and apply strategies for the creation, enhancement and management of riparian zones and riparian buffers.

Performance Indicator: MN.NRES.01.04. Apply ecological concepts and principles to terrestrial natural resource systems.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.
 - 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.NRES.01.04 Intro Course Benchmarks	NRES.01.04 Intermediate Course Benchmarks	MN.NRES.01.04 Advanced Course Benchmarks
NRES.01.04.01.a. Research and describe the stages of ecological succession.	NRES.01.04.01.b. Analyze and summarize examples of stages of succession.	NRES.01.04.01.c. Evaluate the stages of succession present in an ecosystem and predict which species will become more prevalent through future stages of succession.
NRES.01.04.02.a. Compare and contrast the impact of habitat disturbances and habitat resilience.	NRES.01.04.02.b. Analyze and summarize examples of habitat disturbances and habitat resilience.	NRES.01.04.02.c. Interpret signs of habitat disturbances and resilience in an ecosystem and use these signs to assess the health of an ecosystem.
NRES.01.04.03.a. Compare and contrast techniques associated with sustainable forestry (e.g., timber stand improvement, diversity improvement, reforestation, etc.).	NRES.01.04.03.b. Analyze a forest in order to determine which forestry techniques would improve that habitat.	NRES.01.04.03.c. Devise a forest management plan that improves the habitat while sustainably maximizing the amount of timber that can be harvested.
NRES.01.04.04.a. Compare and contrast techniques associated with soil management (e.g., soil survey and interpretation, erosion control, etc.).	NRES.01.04.04.b. Analyze a plot of land in order to determine which soil management techniques would be most applicable.	NRES.01.04.04.c. Devise a soil management plan to minimize erosion and maximize biodiversity, plant productivity, and the formation of topsoil.

Performance Indicator: MN.RN.01.05. Apply ecological concepts and principles to living organisms in natural resource systems.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
 - 9.4.2.1 The interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.

MN.NRES.01.05 Intro Course Benchmarks	NRES.01.05 Intermediate Course Benchmarks	MN.NRES.01.05 Advanced Course Benchmarks
NRES.01.05.01.a.Differentiate between population ecology, population density and population dispersion and describe the importance of these concepts to natural resource systems.	NRES.01.05.01.b.Analyze the factors that influence population density and population dispersion in natural resource systems.	NRES.01.05.01.c.Create a management plan for a population of a species in an ecosystem given its population ecology, population density and population dispersion in natural resource systems.
NRES.01.05.02.a.Research and summarize examples of invasive species.	NRES.01.05.02.b.Analyze factors that influence the establishment and spread of invasive species and determine the appropriate steps to prevent or minimize the impact of invasive species.	NRES.01.05.02.c.Evaluate the presence and impact of invasive species on natural resources in a given area and devise a plan to prevent, control or eliminate invasive species from that habitat.

Minnesota Framework: MN.NRES.02. Analyze the interrelationships between natural resources and humans.

Performance Indicator: MN.NRES.02.01. Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).

Minnesota Academic Science Standards

- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.4.4.2 Personal and community health can be affected by the environment, body functions and human behavior.

MN.NRES.02.01 Intro Course Benchmarks	NRES.02.01 Intermediate Course Benchmarks	MN.NRES.02.01 Advanced Course Benchmarks
NRES.02.01.01.a.Distinguish between the types of laws associated with natural resources systems.	NRES.02.01.01.b.Analyze the structure of laws associated with natural resources systems.	NRES.02.01.01.c.Evaluate the impact of laws associated with natural resources systems (e.g., mitigation, water regulations, carbon emissions, game limits, invasive species, etc.).
NRES.02.01.02.a.Distinguish between the types of agencies associated with natural resources systems.	NRES.02.01.02.b.Analyze the specific purpose of agencies associated with natural resources systems.	NRES.02.01.02.c.Evaluate the impact and effectiveness of agencies associated with natural resources systems (e.g., regulation of consumption, prevention of damage to natural resources systems, management of ecological interactions, etc.).

Performance Indicator: MN.NRES.02.02. Assess the impact of human activities on the availability of natural resources and or environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.4.3.3 Evolution by natural selection is a scientific explanation for the history and diversity of life on Earth.

MN.NRES.02.02 Intro Course Benchmarks	NRES.02.02 Intermediate Course Benchmarks	MN.NRES.02.02 Advanced Course Benchmarks
NRES.02.02.01.a.Summarize the relationship between natural resources, ecosystems and human activity.	NRES.02.02.01.b.Assess and explain how different kinds of human activity affect the use and availability of natural resources (i.e., agriculture, industry, transportation, etc.).	NRES.02.02.01.c.Evaluate how the availability of natural resources can be improved through changes to human activity.
NRES.02.02.02.a.Categorize the primary causes of extinction of living species due to human activity (e.g., overharvesting, habitat loss, invasive species, pollution, etc.).	NRES.02.02.02.b.Assess causes of extinction and describe how those causes related to loss of biodiversity.	NRES.02.02.02.c.Devise a strategy for preventing the loss of species and biodiversity that takes into account the primary causes of species extinction from human activity.
NRES.02.02.03.a.Examine and describe the manner in which modern lifestyles are related to the depletion of natural resources.	NRES.02.02.03.b.Identify solutions to improve the sustainability of modern lifestyles.	NRES.02.02.03.c.Evaluate how modern lifestyles affect resource consumption and energy use and devise a strategy to prevent the complete loss of a natural resource.

Performance Indicator: MN.NRES.02.03. Analyze how modern perceptions of environmental service systems and or natural resource management, protection, enhancement and improvement change and develop over time.

Minnesota Academic Science Standards

- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.4.4.2 Personal and community health can be affected by the environment, body functions and human behavior.

MN.NRES.02.03 Intro Course Benchmarks	NRES.02.03 Intermediate Course Benchmarks	MN.NRES.02.03 Advanced Course Benchmarks
NRES.02.03.01.a.Summarize and categorize the different social considerations in regards to the use of natural resources (e.g., public versus private, laws and regulations, economics, green technology, etc.).	NRES.02.03.01.b.Analyze how social considerations can affect the use and sustainability of natural resources.	NRES.02.03.01.c.Develop predictions for how the management, protection, enhancement and improvement of natural resources will evolve through social considerations (e.g., establishment of national parks, public opinion, and fishing, reduction of waste and energy consumption, etc.).
NRES.02.03.02.a.Research and assess how historical figures played a prominent role in shaping how natural resources are viewed and used today (e.g., Aldo Leopold, Teddy Roosevelt, John Muir, Rachel Carson, Gaylord Nelson, etc.).	NRES.02.03.02.b.Examine and describe the relationship between current trends in natural resource systems and historical figures that played a prominent role in shaping how natural resources are viewed and used today.	NRES.02.03.02.c.Anticipate and predict how society's views and use of natural resources will continue to change as a result of historical figures and trends in modern society.
NRES.02.03.03.a.Research how technology has affected the use and views of natural resources.	NRSE.02.03.03.b.Analyze and document how some technological advancements changed how natural resources were used and viewed (e.g., Industrial Revolution, fossil fuels, green technology, etc.).	NRES.02.03.03.c.Anticipate and predict how future technological advancements may affect the use and views of natural resources.

Performance Indicator: MN.NRES.02.04. Examine and explain how economics affects the use of natural resources and or environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.NRES.02.04 Intro Course Benchmarks	NRES.02.04 Intermediate Course Benchmarks	MN.NRES.02.04 Advanced Course Benchmarks
NRES.02.04.01.a. Compare and contrast how the economic value of a natural resource affects its availability.	NRES.02.04.01.b. Assess whether economic value increases or decreases the conservation, protection, improvement and enhancement of natural resources.	NRES.02.04.01.c. Devise a plan to improve the conservation, protection, improvement and enhancement of natural resources based on economic value and practices.
NRES.02.04.02.a. Research the impact of the use of natural resources on local, state and national economies (e.g., outdoor recreation, energy production, preservation, etc.).	NRES.02.04.02.b. Assess the importance of the use of natural resources on local, state and national economies.	NRES.02.04.02.c. Anticipate and predict how changes to the availability of natural resources because of human activity may impact a local, state and national economy.
NRES.02.04.03.a. Compare and contrast the economic impact of green technology and alternative energy.	NRES.02.04.03.b. Analyze and document how the adoption of green technology and/or alternative energy affected a local, state or national economy.	NRES.02.04.03.c. Anticipate and predict the economic impact green technology and alternative energy.

Performance Indicator: MN.NRES.02.05. Communicate information to the public regarding topics related to the management, protection, enhancement, and improvement of natural resources.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.

MN.NRES.02.05 Intro Course Benchmarks	NRES.02.05 Intermediate Course Benchmarks	MN.NRES.02.05 Advanced Course Benchmarks
NRES.02.05.01.a. Examine and describe ways in which a message regarding natural resources may be communicated to the public through standard media sources (e.g., press, radio, TV, public appearances, etc.).	NRES.02.05.01.b. Assess the effectiveness of different methods for communicating natural resource messages.	NRES.02.05.01.c. Devise and implement a strategy for communicating a natural resources message through media.
NRES.02.05.02.a. Research and summarize how social media and the Internet have changed how people perceive and utilize natural resources (e.g., greater awareness of conservation issues, calls to action, etc.).	NRES.02.05.02.b. Assess how to most effectively communicate a message about the conservation, management, enhancement and improvement of natural resources via social media and the Internet.	NRES.02.05.02.c. Anticipate and predict how messages about the conservation, management, enhancement and improvement of natural resources will change because of social media and the Internet.
NRES.02.05.03.a. Examine and describe how communication can be used to influence behavior, call people to action and instill a sense of civic behavior related to the conservation, management, enhancement and improvement of natural resources.	NRES.02.05.03.b. Analyze and summarize examples of how communication can be used to influence behavior, call people to action and instill a sense of civic behavior related to the conservation, management, enhancement and improvement of natural resources.	NRES.02.05.03.c. Create a communication plan to influence the behavior of people, call people to action and instill a sense of civic behavior related to the conservation, management, enhancement and improvement of natural resources.

Minnesota Framework: MN.NRES.03. Develop plans to ensure sustainable production and processing of natural resources.

Performance Indicator: MN.NRES.03.01. Sustainably produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.

MN.NRES.03.01 Intro Course Benchmarks	NRES.03.01 Intermediate Course Benchmarks	MN.NRES.03.01 Advanced Course Benchmarks
NRES.03.01.01.a. Summarize forest harvesting methods.	NRES.03.01.01.b. Assess harvesting methods in regards to their economic value, environmental impact, and other factors.	NRES.03.01.01.c. Develop a forest harvesting plan that ensures economic, environmental and social sustainability.
NRES.03.01.02.a. Research and describe methods by which wildlife can be sustainably harvested (e.g., controlled harvests, hunting licenses, regulations, etc.).	NRES.03.01.02.b. Assess and apply techniques used to harvest wildlife in regards to sustainability, practicality and other factors.	NRES.03.01.02.c. Develop a method for the sustainable harvest of wildlife species.
NRES.03.01.03.a. Compare and contrast the costs and benefits (e.g., impacts on environment, economic, wildlife, etc.) of mineral extraction to a local, state and/or national economy.	NRES.03.01.03.b. Assess the economic impact of mineral extraction in regards to the costs and benefits to a local, state and/or national economy.	NRES.03.01.03.c. Evaluate methods used to extract and process minerals for economic, environmental and social sustainability.
NRES.03.01.04.a. Compare and contrast the costs and benefits (e.g., impacts on environment, economic, wildlife, etc.) of fossil fuels to a local, state and/or national economy.	NRES.03.01.04.b. Assess the economic impact of fossil fuel extraction in regards to the costs and benefits to a local, state, and/or national economy.	NRES.03.01.04.c. Evaluate methods used to extract and process fossil fuels for economic, environmental, and social sustainability.
NRES.03.01.05.a. Compare and contrast the costs and benefits (e.g., environmental impacts, etc.) of shale oil from fracking to a local, state and/or national economy.	NRES.03.01.05.b. Assess the economic impact of shale oil extraction (i.e., fracking) in regards to the costs and benefits to a local, state and/or national economy.	NRES.03.01.05.c. Evaluate methods used to extract and process shale oil for economic, environmental and social sustainability.
NRES.03.01.06.a. Compare and contrast the costs and benefits (e.g., environmental impacts, etc.) of alternative sources of energy (e.g., hydroelectric, solar, wind, biofuels, geothermal, etc.).	NRES.03.01.06.b. Assess and evaluate factors that affect the economic, environmental and social sustainability in regards to the use of alternative sources of energy.	NRES.03.01.06.c. Assess trends in energy production and consumption in order to predict how the impact of alternative energy will change in the future.

MN.NRES.03.01 Intro Course Benchmarks	NRES.03.01 Intermediate Course Benchmarks	MN.NRES.03.01 Advanced Course Benchmarks
NRES.03.01.07.a. Research and summarize how recreational uses of natural resources can be changed to improve sustainability.	NRES.03.01.07.b. Assess different options for improving the sustainability of outdoor recreation based on its impact on natural resources and likelihood of acceptance.	NRES.03.01.07.c. Evaluate an example of outdoor recreation and develop suggestions for how that activity can be made more sustainable in a manner that is acceptable to those who take part in that activity.
NRES.03.01.08.a. Categorize aquatic species used for commercial and recreational purposes.	NRES.03.01.08.b. Analyze and apply techniques used to acquire aquatic species for their environmental, economic and social sustainability.	NRES.03.01.08.c. Develop recommendations for the sustainable harvest of aquatic species.

Performance Indicator: MN.NRES.03.02. Demonstrate mapping skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context

MN.NRES.03.02 Intro Course Benchmarks	NRES.03.02 Intermediate Course Benchmarks	MN.NRES.03.02 Advanced Course Benchmarks
NRES.03.02.01.a. Summarize how to use maps and technologies to identify directions and land features, calculate actual distance and determine the elevations of points.	NRES.03.02.01.b. Apply cartographic skills and tools and technologies (e.g., land surveys, geographic coordinate systems, etc.) to locate natural resources.	NRES.03.02.01.c. Evaluate the availability of and threats to natural resources using cartographic skills, tools, and technologies (e.g., spread of invasive species, movement of wildlife populations, changes to biodiversity of edge of habitat versus interior, etc.).
NRES.03.02.02.a. Summarize how GIS can be used to manage, conserve, improve and enhance the natural resources of an area.	NRES.03.02.02.b. Analyze an area's resources using GIS technologies.	NRES.03.02.02.c. Use GIS data for a given area to devise a management plan for the management, conservation, improvement, and enhancement of its natural resources.

Minnesota Framework: MN.NRES.04. Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources

Performance Indicator: MN.NRES.04.01. Demonstrate natural resource protection, maintenance, enhancement and improvement techniques.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.

MN.NRES.04.01 Intro Course Benchmarks	NRES.04.01 Intermediate Course Benchmarks	MN.NRES.04.01 Advanced Course Benchmarks
NRES.04.01.01.a. Identify and categorize different kinds of streams.	NRES.04.01.01.b. Assess and explain indicators of the biological health of a stream.	NRES.04.01.01.c. Create an enhancement plan for a stream.
NRES.04.01.02.a. Identify and categorize characteristics of a healthy forest.	NRES.04.01.02.b. Assess and apply the methods used to improve a forest stand.	NRES.04.01.02.c. Create a timber stand improvement plan for a forest.
NRES.04.01.03.a. Identify and categorize characteristics of a healthy wildlife habitat.	NRES.04.01.03.b. Assess and apply methods of wildlife habitat improvement.	NRES.04.01.03.c. Devise a comprehensive improvement plan for a wildlife habitat.
NRES.04.01.04.a. Identify and categorize characteristics of healthy rangeland.	NRES.04.01.04.b. Assess and apply methods of rangeland improvement.	NRES.04.01.04.c. Evaluate and revise a rangeland management plan.
NRES.04.01.05.a. Identify and categorize characteristics of natural resources that make them desirable for recreational purposes.	NRES.04.01.05.b. Assess and apply management techniques for improving outdoor recreation opportunities.	NRES.04.01.05.c. Evaluate the impact of recreational activities on natural resources and create an improvement plan.
NRES.04.01.06.a. Identify and categorize characteristics of healthy marine and coastal natural resources.	NRES.04.01.06.b. Assess and apply methods to improve marine and coastal natural resources.	NRES.04.01.06.c. Create an improvement plan for marine or coastal natural resources.

Performance Indicator: MN.NRES.04.02. Diagnose plant and wildlife diseases and follow protocols to prevent their spread.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.4.4.2 Personal and community health can be affected by the environment, body functions and human behavior.

MN.NRES.04.02 Intro Course Benchmarks	NRES.04.02 Intermediate Course Benchmarks	MN.NRES.04.02 Advanced Course Benchmarks
NRES.04.02.01.a. Classify causes of diseases in plants and the correct authorities to whom some diseases should be reported.	NRES.04.02.01.b. Analyze a plant disease based on its symptoms, identify if the disease needs to be reported to authorities and determine which authorities it should be reported to.	NRES.04.02.01.c. Create a management plan to reduce infection and the spread of plant diseases in natural resource systems.
NRS.04.02.02.a. Classify causes of diseases in wildlife and aquatic species and determine the correct authorities to whom some diseases should be reported.	NRS.04.02.02.b. Analyze a wildlife or aquatic species disease based on its symptoms, identify if the disease needs to be reported to authorities and determine which authorities it should be reported to.	NRS.04.02.02.c. Create a management plan to reduce infection and spread of wildlife or aquatic species diseases in natural resource systems.

Performance Indicator: MN.NRES.04.03. Prevent or manage introduction of ecologically harmful species in a particular region.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
 - 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.
 - 9.4.2.1 The interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.

MN.NRES.04.03 Intro Course Benchmarks	NRES.04.03 Intermediate Course Benchmarks	MN.NRES.04.03 Advanced Course Benchmarks
NRES.04.03.01.a. Categorize harmful and beneficial insects, as well as signs of insect damage to natural resources.	NRES.04.03.01.b. Analyze signs of insect infestation, identify if it needs to be reported to authorities and determine which authorities it should be reported to.	NRES.04.03.01.c. Create a management plan to reduce spread of harmful insects in natural resource systems.
NRES.04.03.02.a. Identify and classify invasive species common to a particular region.	NRES.04.03.02.b. Analyze signs of the spread of invasive species, identify if it needs to be reported to authorities and determine which authorities it should be reported to.	NRES.04.03.02.c. Create a management plan to reduce spread of harmful invasive species in natural resource systems.
NRES.04.03.03.a. Research and summarize strategies and benefits of preventing the introduction of harmful species to a particular region.	NRES.04.03.03.b. Assess and implement a plan for preventing the spread of harmful species for its effectiveness.	NRES.04.03.03.c. Identify potentially invasive species and devise strategies to prevent ecological damage that would result from the introduction of that species.

Performance Indicator: MN.NRES.04.04. Manage fires in natural resource systems.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.
 - 9.4.2.2 Personal and community health can be affected by the environment, body functions and human behavior.

MN.NRES.04.04 Intro Course Benchmarks	NRES.04.04 Intermediate Course Benchmarks	MN.NRES.04.04 Advanced Course Benchmarks
NRES.04.04.01.a. Differentiate between desirable and undesirable fires and research the role fire plays in a healthy ecosystem.	NRES.04.04.01.b. Assess and apply techniques used to fight wildfires, manage prescribed fires and ensure human safety.	NRES.04.04.01.c. Develop a prevention plan for harmful fires for a particular region.
NRES.04.04.02.a. Research and summarize how fire management techniques have evolved.	NRES.04.04.02.b. Assess the effectiveness of techniques previously and currently used to prevent harmful fires.	NRES.04.04.02.c. Anticipate and predict how fire management techniques will evolve in the future.

Minnesota Framework: MN.NRES.05. Use analytical procedures and instruments to manage environmental service systems.

Performance Indicator: MN.NRES.05.01. Analyze and interpret laboratory and field samples in environmental service systems.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
 - 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.
 - 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.

MN.NRES.05.01 Intro Course Benchmarks	NRES.05.01 Intermediate Course Benchmarks	MN.NRES.05.01 Advanced Course Benchmarks
NRES.05.01.01.a. Identify sample types and sampling techniques used to collect laboratory and field data.	NRES.05.01.01.b. Determine the appropriate sampling techniques needed to generate data.	NRES.05.01.01.c. Collect and prepare sample measurements using appropriate data collection techniques.
NRES.05.01.02.a. Identify methods of statistical analysis commonly used in research (e.g., mean, standard deviation, standard error, error bars, etc.).	NRES.05.01.02.b. Summarize the purpose of statistical analysis methods commonly used in ESS research and explain examples of their use in practice.	NRES.05.01.02.c. Utilize data analysis to identify trends in a data sample and assess the confidence that can be drawn from those conclusions.

Performance Indicator: MN.RN.05.02. Properly utilize scientific instruments in environmental monitoring situations (e.g., laboratory equipment, environmental monitoring instruments, etc.).

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.2.1 Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.

MN.NRES.05.02 Intro Course Benchmarks	NRES.05.02 Intermediate Course Benchmarks	MN.NRES.05.02 Advanced Course Benchmarks
NRES.05.02.01.a. Identify basic laboratory equipment and explain their uses.	NRES.05.02.01.b. Demonstrate the proper use and maintenance of basic laboratory equipment.	NRES.05.02.01.c. Calibrate and use laboratory equipment according to standard operating procedures.
NRES.05.02.02.a. Identify basic environmental monitoring instruments and explain their uses.	NRES.05.02.02.b. Demonstrate the proper use and maintenance of environmental monitoring instruments.	NRES.05.02.02.c. Calibrate and use environmental monitoring instruments according to standard operating procedures.

Minnesota Framework: MN.NRES.06. Evaluate the impact of public policies and regulations on environmental service system operations.

Performance Indicator: MN.NRES.06.01. Interpret and evaluate the impact of laws, agencies, policies and practices affecting environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.

MN.NRES.06.01 Intro Course Benchmarks	NRES.06.01 Intermediate Course Benchmarks	MN.NRES.06.01 Advanced Course Benchmarks
NRES.06.01.01.a. Distinguish between the types of laws associated with ESS.	NRES.06.01.01.b. Analyze the structure of laws associated with ESS.	NRES.06.01.01.c. Evaluate the impact of laws associated with ESS for their impact on wildlife, people, the environment and the economy.
NRES.06.01.02.a. Distinguish between the types of government agencies (i.e., local, state and federal) associated with ESS.	NRES.06.01.02.b. Analyze the specific purpose of government agencies associated with ESS.	NRES.06.01.02.c. Evaluate the impact and effectiveness of government agencies (i.e., local, state, and federal) associated with ESS (e.g., regulation of consumption, prevention of damage to natural resources systems, management of ecological interactions, etc.).
NRES.06.01.03.a. Research policies, practices and initiatives common in business and advocacy groups associated with ESS (e.g., zero-waste, LEED-certified, locally-grown, etc.).	NRES.06.01.03.b. Assess the intent, feasibility and effectiveness of policies, practices and initiatives common in business and advocacy groups associated with ESS.	NRES.06.01.03.c. Evaluate the impact of policies, practices and initiatives common in business and advocacy groups associated with ESS on wildlife, people, the environment and the economy.

Performance Indicator: MN.NRES.06.02. Compare and contrast the impact of current trends on regulation of environmental service systems (e.g., climate change, population growth, international trade, etc.).

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.NRES.06.02 Intro Course Benchmarks	NRES.06.02 Intermediate Course Benchmarks	MN.NRES.06.02 Advanced Course Benchmarks
NRES.06.02.01.a. Research and categorize the purpose, implementation and impact of greenhouse gas emission policies (e.g., cap and-trade, emission offsetting, zero-emissions, carbon-neutrality, carbon sequestration, etc.).	NRES.06.02.01.b. Assess the effectiveness and impact of greenhouse gas emissions policies.	NRES.06.02.01.c. Devise new policies for controlling greenhouse gas emissions that reduce atmospheric carbon levels while generating additional economic activity.
NRES.06.02.02.a. Research the impact of ESS regulations on international trade.	NRES.06.02.02.b. Analyze how ESS regulations can both negatively and positively affect international trade.	NRES.06.02.02.c. Interpret and evaluate the impact of specific environmental service regulation policies (e.g., Clean Air Act, EISA, Clean Water Act, Superfund, etc.) on international trade.
NRES.06.02.03.a. Examine and summarize the impact that population growth has on ESS.	NRES.06.02.03.b. Analyze the correlation between increased population size and the need for regulation of ESS.	NRES.06.02.03.c. Predict the impact of future population growth on the regulation of ESS and evaluate how changes made today will impact future regulations.
NRES.06.02.04.a. Research current policies related to fracking and shale oil gas.	NRES.06.02.04.b. Assess whether current policies related to fracking and shale oil gas sufficiently address the needs of ESS.	NRES.06.02.04.c. Evaluate current fracking policies and create suggestions for modification of these policies to more thoroughly address the needs related to environmental, economic and social sustainability.

Performance Indicator: MN.NRES.06.03. Examine and summarize the impact of public perceptions and social movements on the regulation of environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.

MN.NRES.06.03 Intro Course Benchmarks	NRES.06.03 Intermediate Course Benchmarks	MN.NRES.06.03 Advanced Course Benchmarks
NRES.06.03.01.a. Research and summarize how the perception and regulation of ESS has changed over time.	NRES.06.03.01.b. Analyze and summarize specific changes to perceptions and regulations of ESS and their impact on reducing the ecological, economical and sociological impact.	NRES.06.03.01.c. Evaluate the impact of specific historical figures, or organizations, on the perception and regulation of ESS.
NRES.06.03.02.a. Examine how social views and movements (e.g., zero-waste philosophy, carbon footprints, recycling, etc.) have affected the implementation and need for regulation of ESS.	NRES.06.03.02.b. Assess the effectiveness of specific social movements related to regulation of ESS.	NRES.06.03.02.c. Research current issues related to modern or future ESS and devise strategies for engaging the public to address these issues through social movements.

Minnesota Framework: MN.NRES.07. Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry and ecology.

Performance Indicator: MN.NRES.07.01. Apply soil science and hydrology principles to environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.

MN.NRES.07.01 Intro Course Benchmarks	NRES.07.01 Intermediate Course Benchmarks	MN.NRES.07.01 Advanced Course Benchmarks
NRES.07.01.01.a. Differentiate and distinguish land uses, capability factors and land capability classes.	NRES.07.01.01.b. Use a soil survey to determine the land capability classes for different parcels of land in an area.	NRES.07.01.01.c. Design a master land-use management plan for a given area that utilizes land capability classes in order to minimize erosion and flooding, maximize development and preservation of topsoil, et cetera.
NRES.07.01.02.a. Research and describe the process of soil formation through weathering.	NRES.07.01.02.b. Differentiate rock types and relate the chemical composition of mineral matter in soils to the parent material.	NRES.07.01.02.c. Examine and explain how the physical qualities of the soil influence the infiltration and percolation of water. ESS.
NRES.07.01.03.a. Examine and explain how the physical qualities of the soil influence the infiltration and percolation of water.	NRES.07.01.03.b. Assess the physical qualities of the soil that determine its potential for filtration of groundwater supplies and likelihood for flooding.	NRES.07.01.03.c. Conduct tests of soil to determine its potential for filtration of groundwater supplies and likelihood for flooding.
NRES.07.01.04.a. Summarize environmental hazards associated with groundwater supplies.	NRES.07.01.04.b. Assess the effectiveness of precautions taken to prevent or reduce contamination of groundwater supplies.	NRES.07.01.04.c. Evaluate the methods used in a given example to protect groundwater supplies.
NRES.07.01.05.a. Research and summarize hydrogeology and differentiate between groundwater and surface water.	NRES.07.01.05.b. Analyze how interactions between groundwater and surface water affect flow and availability of water.	NRES.07.01.05.c. Construct explanations and solutions to situations involving the declining availability of water that incorporate groundwater flow equations as well as human activity.
NRES.07.01.06.a. Research and describe how groundwater and surface water interactions affect the existence of wetlands.	NRES.07.01.06.b. Analyze the importance of the roles played by wetlands in regards to water availability, prevention of flooding and other factors.	NRES.07.01.06.c Evaluate and select strategies for wetlands preservation and restoration that maximize services provided by wetlands while taking human concerns into consideration.

Performance Indicator: MN.NRES.07.02. Apply chemistry principles to environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.

MN.NRES.07.02 Intro Course Benchmarks	NRES.07.02 Intermediate Course Benchmarks	MN.NRES.07.02 Advanced Course Benchmarks
NRES.07.02.01.a. Examine and summarize how chemistry affects soil structure and function (e.g., pH, cation-exchange capacity, filtration capability, flooding likelihood, etc.).	NRES.07.02.01.b. Analyze the soil chemistry of a sample.	NRES.07.02.01.c. Evaluate a sample's soil chemistry and assess how the results may impact considerations in ESS.
NRES.07.02.02.a. Examine and summarize how chemistry affects water quality and function (e.g., oxygen saturation, pH, biomagnification, etc.).	NRES.07.02.02.b. Analyze the water chemistry of a sample.	NRES.07.02.02.c. Evaluate a sample's water chemistry and assess how the results may impact considerations in ESS.
NRES.07.02.03.a. Examine and summarize how chemistry affects air quality and function (e.g., heat retention, formation of smog and acid rain, etc.).	NRES.07.02.03.b. Analyze how components of atmospheric chemistry (e.g., air chemical components, heat, moisture, etc.) affect air quality.	NRES.07.02.03.c. Assess the impact of atmospheric chemistry on operational decisions in ESS.
NRES.07.02.04.a. Examine and summarize the relationship between water and soil chemistry and the formation of different kinds of wetlands (e.g., fens, peat bogs, potholes, etc.).	NRES.07.02.04.b. Assess how different kinds of wetlands are formed based on the different kinds of soil and water chemistry present in each case.	NRES.07.02.04.c. Evaluate the services provided by types of wetlands and predict how different types of wetlands respond to pressures due to human activity.

Performance Indicator: MN.NRES.07.03. Apply microbiology principles to Environmental Service Systems.

- Minnesota Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.

MN.NRES.07.03 Intro Course Benchmarks	NRES.07.03 Intermediate Course Benchmarks	MN.NRES.07.03 Advanced Course Benchmarks
NRES.07.03.01.a. Describe the microbial biodiversity found in soil and summarize the contribution of microbial biodiversity to the physical and chemical characteristics of soil.	NRES.07.03.01.b. Assess how the activities of microorganisms in soil affect ESS and ecosystem biodiversity.	NRES.07.03.01.c. Evaluate how soil microorganisms in ESS can be used to minimize waste, maximize nutrient cycling and increase ecosystem biodiversity.
NRES.07.03.02.a. Research and describe how microbial populations in an ecosystem affect carbon cycling.	NRES.07.03.02.b. Analyze the microbial populations present in an area and assess how carbon cycling is affected.	NRES.07.03.02.c. Develop strategies for negating air pollutants based on soil microbial populations (e.g., carbon sequestration and rates of decomposition).
NRES.07.04.03.a. Examine and explain the role that microbes play in wastewater treatment.	NRES.07.03.03.b. Assess the impact of wastewater treatment on ESS.	NRES.07.03.03.c. Evaluate modern uses of microbial waste water treatment and devise strategies to further reduce the environmental, economic and social impact of wastewater treatment.
NRES.07.03.04.a. Research the purposes of bioassay tests and describe potential applications for ESS.	NRES.07.03.04.b. Analyze procedures for a bioassay test.	NRES.07.03.04.c. Conduct bioassay tests related to ESS and interpret results.

Performance Indicator: MN.NRES.07.04. Apply ecology principles to environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.

MN.NRES.07.04 Intro Course Benchmarks	NRES.07.04 Intermediate Course Benchmarks	MN.NRES.07.04 Advanced Course Benchmarks
NRES.07.04.01.a. Research the role that biodiversity plays in ESS and how biodiversity can be measured.	NRES.07.04.01.b. Calculate the amount of biodiversity in a given area using an appropriate method (e.g., quadrat assessment, transect measurements, etc.).	NRES.07.04.01.c. Evaluate the biodiversity of an area and predict the impact of changing the levels of biodiversity on ESS.
NRES.07.04.02.a. Examine and explain the role played by habitats on ESS.	NRES.07.04.02.b. Assess the impact of the current rate of habitat loss on ESS.	NRES.07.04.02.c. Evaluate the importance of habitat to ESS and devise strategies to minimize the future loss of habitats.
NRES.07.04.03.a. Research and explain how carrying capacities relate to ESS (e.g., waste processing, rate or production of pollution, disease, etc.).	NRES.07.04.03.b. Assess and describe the impact of a population exceeding its carrying capacity on ESS.	NRES.07.04.03.c. Devise a strategy for monitoring and supporting ESS through management of a species' carrying capacity.
NRES.07.04.04.a. Examine and describe how ecological interactions can be used to assess ESS (i.e., macroinvertebrates and/or amphibians as bioindicators).	NRES.07.04.04.b. Evaluate the benefits and drawbacks of using bioindicator species in ESS.	NRES.07.04.04.c. Utilize evidence from bioindicator species to detect pollutants in a given area.

Minnesota Framework: MN.NRES.08. Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management and energy conservation).

Performance Indicator: MN.NRES.08.01. Use pollution control measures to maintain a safe facility and environment.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.

MN.NRES.08.01 Intro Course Benchmarks	NRES.08.01 Intermediate Course Benchmarks	MN.NRES.08.01 Advanced Course Benchmarks
NRES.08.01.01.a. Identify and distinguish types of pollution and distinguish between point source and nonpoint source pollution.	NRES.08.01.01.b. Assess how industrial and nonindustrial pollution has damaged the environment.	NRES.08.01.01.c. Evaluate evidence for a given area for industrial and nonindustrial pollution.
NRES.08.01.02.a. Research ways in which pollution can be managed and prevented and propose solutions to meet the needs of local systems.	NRES.08.01.02.b. Conduct tests to determine the presence and extent of pollution.	NRES.08.01.02.c. Create a plan for pollution remediation, management or prevention for a given area.
NRES.08.01.03.a. Interpret the conditions necessary for waste to be labeled as hazardous.	NRES.08.01.03.b. Classify examples of pollution as hazardous or nonhazardous.	NRES.08.01.03.c. Construct a plan for handling hazardous waste in given situations.

Performance Indicator: MN.NRES.08.02. Manage safe disposal of all categories of solid waste in environmental service systems.

Minnesota Academic Science Standards

- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context
- 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.

MN.NRES.08.02 Intro Course Benchmarks	NRES.08.02 Intermediate Course Benchmarks	MN.NRES.08.02 Advanced Course Benchmarks
NRES.08.02.01.a. Compare and contrast different types of solid waste and options for treating solid waste.	NRES.08.02.01.b. Analyze environmental hazards created by different types of solid waste, solid waste accumulation and solid waste disposal.	NRES.08.02.01.c. Develop a plan for solid waste disposal for a given situation that considers the environmental hazards, economic realities and social concerns associated with this task.
NRES.08.02.02.a. Examine and describe the components of disposing waste in sanitary landfills.	NRES.08.02.02.b. Analyze and document basic sanitary landfill operating procedures and design.	NRES.08.02.02.c. Evaluate sanitary landfill procedures for environmental, economic and social sustainability.
NRES.08.02.03.a. Research and summarize the benefits and processes of composting.	NRES.08.02.03.b. Apply scientific principles to explain the benefits and processes of composting.	NRES.08.02.03.c. Evaluate the appropriateness of composting methods in different situations.
NRES.08.02.04.a. Examine and describe the importance and potential impact of recycling.	NRES.08.02.04.b. Analyze and document different recycling methods and classify materials that can be recycled.	NRES.08.02.04.c. Survey and evaluate recycling programs and procedures.

Performance Indicator: MN.NRES.08.03. Apply techniques to ensure a safe supply of drinking water and adequate treatment of wastewater according to applicable rules and regulations.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.2.1 Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.
- 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.

MN.NRES.08.03 Intro Course Benchmarks	NRES.08.03 Intermediate Course Benchmarks	MN.NRES.08.03 Advanced Course Benchmarks
NRES.08.03.01.a. Categorize chemical and physical properties of drinking water.	NRES.08.03.01.b. Analyze and document all steps in the public drinking water treatment process according to applicable standards.	NRES.08.03.01.c. Evaluate samples of water and the processes necessary to verify that the samples are safe for consumption according to applicable standards.
NRES.08.03.02.a. Research methods commonly used to treat wastewater and septic waste.	NRES.08.03.02.b. Analyze and document the steps necessary to ensure that wastewater and septic waste can be safely released into the environment.	NRES.08.03.02.c. Evaluate examples of wastewater and/or septic waste for its potential to cause environmental, economic and/or social problems.

Performance Indicator: MN.NRES.08.04. Compare and contrast the impact of conventional and alternative energy sources on the environment and operation of environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.2.2 Engineering design is a analytical and creative process of devising a solution to meet a need or solve a specific problem.

MN.NRES.08.04 Intro Course Benchmarks	NRES.08.04 Intermediate Course Benchmarks	MN.NRES.08.04 Advanced Course Benchmarks
NRES.08.04.01.a. Research conventional energy sources and list conservation measures to reduce the impact on ESS.	NRES.08.04.01.b. Assess the advantages and disadvantages of conventional energy sources in regards to ESS.	NRES.08.04.01.c. Evaluate the impact burning of fossil fuels has on ESS.
NRES.08.04.02.a. Research alternative energy sources and describe the motivations for seeking alternatives to conventional energy sources as they relate to environmental monitoring.	NRES.08.04.02.b. Identify advantages and disadvantages of alternative energy sources as they pertain to ESS.	NRES.08.04.02.c. Evaluate the impact alternative energy sources have on environmental conditions.
NRES.08.04.03.a. Examine the factors that affect energy consumption and describe how these factors are related to environmental monitoring.	NRES.08.04.03.b. Analyze and document the main categories of energy consumption.	NRES.08.04.03.c. Evaluate strategies for reducing energy consumption to determine the most effective course of action based on the needs of ESS.
NRES.08.04.04.a. Research the impact on ESS that occur because of energy consumption.	NRES.08.04.04.b. Analyze and document the most significant impacts that energy consumption has on environmental monitoring.	NRES.08.04.04.c. Devise a strategy for improving future energy consumption in a manner consistent with the intents of ESS.
NRES.08.04.05.a. Examine and explain how energy consumption and the carbon cycle relate to environmental monitoring.	NRES.08.04.05.b. Calculate the impact of the carbon cycle imbalance (due to energy consumption) and assess how this imbalance affects ESS.	NRES.08.04.05.c. Use data from environmental monitoring to evaluate methods for reducing the imbalance in the carbon cycle through changes to energy consumption.
NRES.08.04.06.a. Research and describe the purpose and applications of life cycle assessments to ESS.	NRES.08.04.06.b. Interpret a life cycle assessment and explain how it can be utilized in ESS to assess the potential ecological impact of an energy source.	NRES.08.04.06.c. Conduct a life cycle assessment for a given source of energy and use this assessment to determine the best option for energy in regards to ESS. ESS.05. Use tools, equipment, machinery and technology common to

Minnesota Framework: MN.NRES.09. Use tools, equipment, machinery and technology common to tasks in environmental service systems.

Performance Indicator: MN.NRES.09.01. Use technological and mathematical tools to map land, facilities and infrastructure for environmental service systems.

Minnesota Academic Science Standards

- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.1.2.1 Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.

MN.NRES.09.01 Intro Course Benchmarks	NRES.09.01 Intermediate Course Benchmarks	MN.NRES.09.01 Advanced Course Benchmarks
NRES.09.01.01.a. Examine the importance and describe applications of surveying and mapping for ESS.	NRES.09.01.01.b. Apply surveying and mapping principles to a situation involving ESS and identify and explain the use of equipment for surveying and mapping.	NRES.09.01.01.c. Demonstrate surveying and cartographic skills to make site measurements in order to address concerns and needs within an ESS situation.
NRES.09.01.02.a. Research the methods in which GIS can be used in ESS (e.g., tracing of point pollution, control of the spread of invasive species, etc.).	NRES.09.01.02.b. Apply GIS skills to a situation specific to ESS.	NRES.09.01.02.c. Interpret and evaluate GIS data to come to a conclusion about a scenario specific to ESS.
NRES.09.01.03.a. Research how advancements in technology (e.g., unmanned aerial vehicles and drones, genetic modification, fracking, alternative energy, etc.) have changed ESS.	NRES.09.01.03.b. Analyze and document examples of utilization of breaking technology in ESS.	NRES.09.01.03.c. Evaluate trends in technology and develop predictions about how these advancements will change ESS.

Minnesota Framework: MN.NRES.10. Demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources (AFNR) systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

Performance Indicator: MN.NRES.10.01. Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering.

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.4.3.1 Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.

MN.NRES.10.01 Intro Course Benchmarks	NRES.10.01 Intermediate Course Benchmarks	MN.NRES.10.01 Advanced Course Benchmarks
NRES.10.01.01.a. Research and summarize methods used to determine water quality (e.g., dissolved oxygen, chemical tests, macroinvertebrates, etc.) and determine if a source of water has been contaminated.	NRES.10.01.01.b. Assess different measurements of water quality to determine their effectiveness and limitations.	NRES.10.01.01.c. Evaluate a sample of water to determine its quality and if it has been contaminated.
NRES.10.01.02.a. Research and summarize methods and tools used to measure soil health and determine if an area of land has been contaminated (e.g., soil probes, core monolith, soil fertility tests, etc.).	NRES.10.01.02.b. Assess different measurements of soil quality (e.g., soil horizons, soil texture, organic matter, soil respiration, etc.) to determine their effectiveness and limitations.	NRES.10.01.02.c. Evaluate a sample of soil to determine its quality and if it has been contaminated.
NRES.10.01.03.a. Research and summarize methods and tools used to determine air quality and determine if pollution is present (e.g., CO2 probe, particulate matter sampler, etc.).	NRES.10.01.03.b. Assess different measurements of air quality (e.g., ozone, carbon monoxide, particulate matter, etc.) to determine their effectiveness and limitations.	NRES.10.01.03.c. Perform an evaluation of air quality to determine and assess its impact of human and ecological populations.
NRES.10.01.04.a. Research and summarize methods used to determine ecological health and determine if an ecosystem is threatened (e.g., quadrat analysis, bioindicators, mark-recapture, etc.).	NRES.10.01.04.b. Assess different measurements of assessing ecological health (e.g., quadrat biodiversity assessments, transect surveys, population counts, detection of disease and invasive species, etc.) to determine their effectiveness and limitations.	NRES.10.01.04.c. Evaluate a habitat to determine its ecological quality and if it is threatened.

Performance Indicator: MN.NRES.10.02. Apply biotechnology principles, techniques and processes to protect the environment and maximize use of natural resources (e.g., biomass, bioprospecting, industrial biotechnology, etc.).

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.

MN.NRES.10.02 Intro Course Benchmarks	NRES.10.02 Intermediate Course Benchmarks	MN.NRES.10.02 Advanced Course Benchmarks
NRES.10.02.01.a. Summarize biological, social, agronomic and economic reasons for genetic modification of eukaryotes.	NRES.10.02.01.b. Analyze and document the processes and describe the techniques used to produce transgenic eukaryotes (e.g., microbial synthetic biology, gene knockout therapy, traditional gene insertion, etc.).	NRES.10.02.01.c. Design and conduct experiments to evaluate an existing transgenic eukaryote.
NRES.10.02.02.a. Summarize the process of transformation of eukaryotic cells with transgenic DNA.	NRES.10.02.02.b. Assess and argue the pros and cons of transgenic species in agriculture.	NRES.10.02.02.c. Transform plant or animal cells by performing a cellular transformation.
NRES.10.02.03.a. Analyze the benefits and risks associated with the use of biotechnology to increase productivity and improve quality of living species (e.g., plants, animals such as aquatic species, etc.).	NRES.10.02.03.b. Research and evaluate genetic engineering procedures used in the production of living species.	NRES.10.02.03.c. Conduct field or clinical trials for genetically modified species.
NRES.10.02.04.a. Define and summarize epigenetics and synthesize the relationship between mutation, migration and evolution of transgenes in the environment.	NRES.10.02.04.b. Analyze data to identify changes and patterns of transgenic species in the environment.	NRES.10.02.04.c. Conduct studies to track the movement of transgenes in the environment.

Performance Indicator: MN.NRES.10.03. Apply biotechnology principles, techniques and processes to produce biofuels (e.g., fermentation, transesterification, methanogenesis, etc.).

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.2.1.2 Chemical reactions involve the rearrangement of atoms as chemical bonds are broken and formed through transferring or sharing of electrons and the absorption or release of energy.

MN.NRES.10.03 Intro Course Benchmarks	NRES.10.03 Intermediate Course Benchmarks	MN.NRES.10.03 Advanced Course Benchmarks
NRES.10.03.01.a. Examine and synthesize the need for biofuels (e.g., cellulosic bioenergy, etc.).	NRES.10.03.01.b. Analyze the impact of the production and use of biofuels on the environment.	NRES.10.03.01.c. Evaluate and support how biofuels could solve a global issue (e.g., environmental, agricultural, etc.).
NRES.10.03.02.a. Differentiate between biomass and sources of biomass.	NRES.10.03.02.b. Assess the characteristics of biomass that make it useful for biofuels production.	NRES.10.03.02.c. Conduct a review of the technologies used to create biofuels from biomass and weigh the pros and cons of each method.
NRES.10.03.03.a. Research and explain the process of fermentation and its potential applications.	NRES.10.03.03.b. Correlate the relationship between fermentation and the process used to produce alcohol from biomass.	NRES.10.03.03.c. Produce alcohol and co-products from biomass.
NRES.10.03.04.a. Define and summarize the process of transesterification and its potential applications.	NRES.10.03.04.b. Analyze and document the process used to produce biodiesel from biomass.	NRES.10.03.04.c. Produce biodiesel and co-products from biomass.
NRES.10.03.05.a. Examine the process of methanogenesis and its potential applications.	NRES.10.03.05.b. Analyze and describe the process used to produce methane from biomass.	NRES.10.03.05.c. Produce methane and co-products from biomass.

Continued from Minnesota Framework: MN.NRES.10

Performance Indicator: MN.NRES.10.04. Apply biotechnology principles, techniques and processes to improve waste management (e.g., genetically modified organisms, bioremediation, etc.).

Minnesota Academic Science Standards

- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.NRES.10.04 Intro Course Benchmarks	NRES.10.04 Intermediate Course Benchmarks	MN.NRES.10.04 Advanced Course Benchmarks
NRES.10.04.01.a. Compare and contrast the use of natural organisms and genetically-engineered organisms in the treatment of wastes.	NRES.10.04.01.b. Analyze the process by which organisms are genetically engineered for waste treatment.	NRES.10.04.01.c. Conduct studies to evaluate the treatment of a waste product using a genetically engineered organism.
NRES.10.04.02.a. Summarize the purpose of microorganisms in biological waste management.	NRES.10.04.02.b. Assess and describe the processes involved in biotreatment of biological wastes.	NRES.10.04.02.c. Monitor and evaluate the treatment of biological wastes with microorganisms.