Key to Conservation Assessment and Ranking Tool (CART) Organization of Resource Concerns.

CART organizes resource concerns differently from the NRCS planning documents: NPPH and National Resource Concern List and Planning Criteria . This table provides an alphabetized list of the core resource concerns (right columns) as a key to finding them in CART's 'category' (left columns) vs. the planning documents 'SWAPA+H' (colors) organizations.

↓ CART Organization: Resource Concerns within Alphabetized Resource Concern Categories, as below ↓

Resource Concern Category	Resource Concern
Air quality emissions	Emissions of airborne reactive nitrogen
	Emissions of greenhouse gases - GHGs
	Emissions of ozone precursors
	Emissions of particulate matter (PM) and PM precursors
	Objectionable odor
Aquatic habitat	Aquatic habitat for fish and other organisms
	Elevated water temperature
Concentrated erosion	Bank erosion from streams, shorelines or water conveyance channels
	Classic gully erosion
	Ephemeral gully erosion
Degraded plant condition	Plant productivity and health
	Plant structure and composition
Field pesticide loss	Pesticides transported to groundwater
	Pesticides transported to surface water
Field sediment, nutrient and pathogen loss	Nutrients transported to groundwater
	Nutrients transported to surface water
	Pathogens and chemicals from manure, biosolids or compost applications transported to groundwater
	Pathogens and chemicals from manure, biosolids or compost applications transported to surface water
	Sediment transported to surface water
Fire management	Wildfire hazard from biomass accumulation
Inefficient energy use	Energy efficiency of equipment and facilities
	Energy efficiency of farming/ranching practices and field operations
Livestock production limitation	Feed and forage balance
	Inadequate livestock shelter
	Inadequate livestock water quantity, quality and distribution
Long term protection of land	Loss of functions and values
	Threat of conversion
Pest pressure	Plant pest pressure
Salt losses to water	Salts transported to groundwater
	Salts transported to surface water
Soil quality limitations	Aggregate instability
	Compaction
	Concentration of salts or other chemicals
	Organic matter depletion
	Soil organism habitat loss or degradation
	Subsidence
Source water depletion	Groundwater depletion
	Inefficient irrigation water use
	Surface water depletion
Storage and handling of pollutants	Nutrients transported to groundwater
	Nutrients transported to surface water
	Petroleum, heavy metals and other pollutants transported to groundwater
	Petroleum, heavy metals and other pollutants transported to surface water
Terrestrial habitat	Terrestrial habitat for wildlife and invertebrates
Weather resilience	Drifted snow
	Naturally available moisture use
	Ponding and flooding
	Seasonal high water table
	Seeps
Wind and water erosion	Sheet and rill erosion
	Wind erosion

SWAPA+H Legend*
Soil
Water
Air
Plant
Animal
Energy
Long Term Protection of Land†

†Unique to CART

*For use in referring to National Planning Procedures Handbook and the National Resource Concern List and Planning Criteria document linked in FOTG Section III. SWAPA+H = Soil, Water, Air, Plant, Animal + Human.

◊Duplicate nutrients transported reflect whether nutrients originate from being spread on fields vs. from storage and handling in farmsteads.

Athens, GA NRCS State Office

Feb. 10, 2020

↓ Key: Columns Switched and Resource Concerns Alphabetized, CART Category to Right ↓

Resource Concern	Resource Concern Category
Aggregate instability	Soil quality limitations
Aquatic habitat for fish and other organisms	Aquatic habitat
Bank erosion from streams, shorelines or water conveyance channels	Concentrated erosion
Classic gully erosion	Concentrated erosion
Compaction	Soil quality limitations
Concentration of salts or other chemicals	Soil quality limitations
Drifted snow	Weather resilience
Elevated water temperature	Aquatic habitat
Emissions of airborne reactive nitrogen	Air quality emissions
Emissions of greenhouse gases - GHGs	Air quality emissions
Emissions of ozone precursors	Air quality emissions
Emissions of particulate matter (PM) and PM precursors	Air quality emissions
Energy efficiency of equipment and facilities	Inefficient energy use
Energy efficiency of farming/ranching practices and field operations	Inefficient energy use
Ephemeral gully erosion	Concentrated erosion
Feed and forage balance	Livestock production limitation
Groundwater depletion	Source water depletion
Inadequate livestock shelter	Livestock production limitation
Inadequate livestock water quantity, quality and distribution	Livestock production limitation
Inefficient irrigation water use	Source water depletion
Loss of functions and values	Long term protection of land
Naturally available moisture use	Weather resilience
Nutrients transported to groundwater◊	Field sediment, nutrient and pathogen loss
Nutrients transported to groundwater◊	Storage and handling of pollutants
Nutrients transported to surface water◊	Field sediment, nutrient and pathogen loss
Nutrients transported to surface water◊	Storage and handling of pollutants
Objectionable odor	Air quality emissions
Organic matter depletion	Soil quality limitations
Pathogens and chemicals from manure, biosolids or compost applications transported to groundwater	Field sediment, nutrient and pathogen loss
Pathogens and chemicals from manure, biosolids or compost applications transported to surface water	Field sediment, nutrient and pathogen loss
Pesticides transported to groundwater	Field pesticide loss
Pesticides transported to surface water	Field pesticide loss
Petroleum, heavy metals and other pollutants transported to groundwater	Storage and handling of pollutants
Petroleum, heavy metals and other pollutants transported to surface water	Storage and handling of pollutants
Plant pest pressure	Pest pressure
Plant productivity and health	Degraded plant condition
Plant structure and composition	Degraded plant condition
Ponding and flooding	Weather resilience
Salts transported to groundwater	Salt losses to water
Salts transported to surface water	Salt losses to water
Seasonal high water table	Weather resilience
Sediment transported to surface water	Field sediment, nutrient and pathogen loss
Seeps	Weather resilience
Sheet and rill erosion	Wind and water erosion
Soil organism habitat loss or degradation	Soil quality limitations
Subsidence	Soil quality limitations
Surface water depletion	Source water depletion
Terrestrial habitat for wildlife and invertebrates	Terrestrial habitat
Threat of conversion	Long term protection of land
Wildfire hazard from biomass accumulation	Fire management
Wind erosion	Wind and water erosion

SOIL
Bank Erosion

Bank Erosion from Streams, Shorelines, Channels

Erosion resulting from poor land management practices, storm events, wave action, rain, ice, wind, runoff, loss of vegetation, hydrologic dynamics, stream isolation from floodplains, and/or other disturbed/altered geomorphological processes.

What is it?

Stream stability is an active process, and while streambank erosion is a natural part of this process, it is often accelerated by altering the stream system. Streambank erosion is that part of channel erosion in which material is eroded from the streambank and deposited at the base of the slope or in the channel. Streambank erosion is usually associated with erosion of the streambed. It occurs along perennial, intermittent, and ephemeral streams.

Why is it important?

The benefits of proper streambank stabilization go far beyond preventing loss of land and keeping sediment out of streams. Streambank erosion increases sediment in the stream degrading water quality and resulting in the loss of fertile bottomland. The quality of wildlife habitat is impacted both on land and in the stream. Streambank erosion increases the stream's sediment load and changes its shape and function. When this happens, the stream loses its ability to transport sediment which can cause it to become wide and shallow. The stream channel can become braided, quality habitat lost, and the increased sediment can reduce overall biological productivity.

What can be done about it?

Determining the cause of accelerated streambank erosion is the first step in solving the problem. Development in the watershed often alters the stream equilibrium by changing rainfall-runoff relationships. Many of the traditional methods of dealing with streambank erosion, such as rock revetments, are expensive to install and maintain. While hard solutions are often needed to protect infrastructure, these treatments may solve the problem at the expense of habitat and stream corridor aesthetics. There are some promising developments in the area of streambank stabilization and stream restoration. Greener and more natural treatment alternatives are being more widely adopted. Soil bioengineering practices, native material revetments, combinations of rock and vegetation, and instream structures help to stabilize eroding banks. These techniques can be used to move a stream toward a healthy, stable and self-maintaining system.

Bank Erosion from Streams, Shorelines, Channels at a Glance

Problems / Indicators—Eroding Banks, degrading streambed, and manipulated stream channels	
Typical Causes	Examples of Typical Solutions
• Increased runoff due to land use changes in the watershed • Eroding or unstable streambanks • Exposed tree roots along banks • Large runoff events • Degraded riparian areas • Uncontrolled livestock access	• Bank armor and protection (rock or other approved material) • Soil bioengineering practices • Instream structures • Native material revetments • Riparian areas with native or locally adapted vegetation • Control livestock access to the water bodies

SOIL
Classic Gully Erosion

Classic Gully Erosion

Gullies created by runoff that can enlarge a channel progressively by head cutting and/or lateral widening.

What is it?

Classic gully is a form of erosion created by the concentrated flow of water. Classic gullies are easily identified through visual observation or light detection and ranging (LiDAR). Classic gully erosion generally occurs in well-defined drainage ways. Classic gullies are not possible to cross by typical farm machinery and cannot be removed by typical tillage equipment. In some situations, erosion continues and aids in advancing the gully upstream.

Why is it important?

Classic gullies can form on all land uses. Concentrated flow erosion removes surface soil, which often has the highest biological activity and soil organic matter. Nutrients removed by erosion are no longer available to support plant growth onsite, and when they accumulate in water they may lead to algal blooms, lake eutrophication, and depleted dissolved oxygen levels that lead to fish kills. Deposition of eroded materials can obstruct roadways and fill drainage channels. Gullies can impact farm operations by creating barriers that change traffic patterns and create hazards that can damage farm equipment. This can have a negative economic impact on the farm and offsite.

What can be done about it?

Gully formations can be difficult to control if remedial measures are not designed and properly constructed. Correcting concentrated flow erosion involves stabilizing an actively eroding gully and addressing its cause. The cause of increased concentrated water flow across the landscape must be considered, and the corrective action usually requires a system of management practices in addition to stabilizing the classic gully. To reduce or prevent classic gully erosion, reduce tillage, include high residue, perennial, and sod-forming crops in the cropping system, grow cover crops, and manage crop residues to remain on the soil surface to minimize the amount and speed of runoff from the land upstream of the gully. Permanent vegetation may be required to stabilize areas above the gully not controlled through management practices. Corrective actions such as grade stabilization structures, drop structures, waterways, and properly designed outlets are used to stabilize a classic gully.

Classic Gully Erosion at a Glance

Problems / Indicators—Branching or tree-like pattern of rills, gullies, headcuts	
Typical Causes	**Examples of Typical Solutions**
• Bare or unprotected soil • Poor soil structure • Reduced infiltration • Excess runoff • Inadequate outlet for water • Unusually large storm event	• Reduce tillage using residue and tillage management • Cover crops • Grassed or lined waterways • Grade stabilization structure • Water and sediment control basin

United States Department of Agriculture
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SOIL
Ephemeral Gully Erosion

Soil

Ephemeral Gully Erosion

Soil erosion that results in small gullies in the same flow area that can be obscured by tillage.

What is it?

Ephemeral gully erosion is a form of erosion created when soil is detached from areas of concentrated flow. An ephemeral cropland gully is larger than a rill and smaller than a classic gully. They usually result from the junction of rills that form a dendritic (branching or tree-like) pattern of channels and are easily identified through visual observation or light detection and ranging (LiDAR). Ephemeral gullies usually appear on cultivated fields during the planting or growing season but can be driven over by typical farm machinery and by typical cultivation tillage equipment. Under the same management system, ephemeral gullies can reappear at or near the same location.

Why is it important?

Ephemeral gully erosion removes valuable surface soil. The deposition of eroded materials can obstruct roadways and fill drainage channels and result in crop losses. Nutrients removed by erosion can accumulate in water and may lead to algal blooms, lake eutrophication, and depleted dissolved oxygen levels that lead to fish kills. When ephemeral gully erosion is not treated it can lead to further complications such as the formation of classic gully erosion. This can have a negative economic impact on the farm and offsite.

What can be done about it?

Ephemeral erosion can be challenging due to the reappearance of the erosion after significant storms or on a yearly basis. The cause of increased water flow across the landscape must be considered when addressing ephemeral gully erosion. Cropping practices that increase water infiltration into the soil result in less runoff and decrease concentrated flow. To reduce ephemeral gully erosion, reduce tillage, include high residue crops, perennial, and/or sod-forming crops in the cropping system, grow cover crops, and manage crop residues to remain on the soil surface as a system of conservation practices in addition to stabilizing the ephemeral gully. Permanent vegetation may be required to stabilize areas not controlled through management practices.

Ephemeral Gully Erosion at a Glance

Problems / Indicators—Branching or tree-like pattern of rills in areas of concentrated flow	
Typical Causes	**Examples of Typical Solutions**
• Bare or unprotected soil • Soil disturbing activities such as tillage • Decreased infiltration by compaction or poor soil structure	• Reduce tillage using residue and tillage management • Conservation crop rotations • Cover crops • Terraces • Grassed waterways • Permanent vegetative cover • Water and sediment control basins

SOIL
Sheet and Rill Erosion

Sheet and Rill Erosion

Detachment and transport of soil particles caused by rainfall, melting snow, or irrigation.

What is it?

Sheet and rill erosion is the physical removal of soil from the land surface by the action of rainfall, melting snow, irrigation, and/or runoff. Sheet and rill erosion is not always readily visible, even when soil loss exceeds unsustainable levels. The loss of only $^1/_{32}$ of an inch can easily represent more than 5 ton/acre soil losses. Symptoms of soil erosion by water may be identified by small rills and channels on the soil surface, soil deposited at the base of slopes, sediment in streams, lakes, and reservoirs, and pedestals of soil supporting pebbles and plant material. Sheet and rill erosion can be apparent in different field situations especially on steep slopes and land that has been disturbed.

Why is it important?

Sheet and rill erosion removes surface soil material (topsoil), reduces levels of soil organic matter, and contributes to the breakdown of soil structure. This creates a less favorable environment for plant growth and productivity. Erosion removes topsoil, which often has the highest biological activity and greatest amount of soil organic matter. Nutrients removed by erosion are no longer available to support plant growth onsite, and when they accumulate in water, they may lead to algal blooms, lake eutrophication, and depleted dissolved oxygen levels that lead to fish kills. In soils that have shallow rooting zones, erosion decreases available rooting depth, which decreases the amount of water, air, and nutrients available to plants. The deposition of the eroded materials can result in crop losses, obstruct roadways, and fill drainage channels. This can have a negative economic impact on the farm and offsite.

What can be done about it?

Soil erosion can be avoided by increasing infiltration rates, maintaining a protective cover on the soil, and modifying the landscape to control runoff amounts and rates. To reduce sheet and rill erosion, reduce tillage, include high-residue crops, perennial and sod-forming crops in the cropping system, grow cover crops, manage crop residues to remain on the soil surface, and shorten the length and steepness of slopes. A systems approach of conservation practices is the best approach.

Sheet and Rill Erosion at a Glance

Problems / Indicators—Changes in soil horizon thickness, soil deposition in fields and water courses, and decreased organic matter	
Typical Causes	**Examples of Typical Solutions**
• Bare or unprotected soil • Soil disturbing activities such as tillage and construction site activities • Long and steep slopes • Significant and intense rainfall or irrigation events when residue cover is at a minimum • Decreased infiltration by compaction or poor soil structure	• Reduce tillage using residue and tillage management • Conservation crop rotations • Cover crops • Contour farming and contour buffer strips • Stripcropping • Terraces • Prescribed grazing

United States Department of Agriculture

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SOIL Subsidence

Soil

Subsidence

Loss of volume and depth of organic soils due to oxidation caused by above normal microbial activity resulting from excessive water drainage, soil disturbance, or extended drought. This excludes karst sinkholes and issues, or depressions caused by underground activities. This resource concern is only applicable when the soil is a histosol.

What is it?

Subsidence is a gradual lowering of the surface elevation of an organic soil, or a reduction in the thickness of organic matter. Organic soils (histosols) are those that are predominantly organic soil materials. They are commonly called bogs, moors, or peats and mucks. The most important cause of organic soil subsidence is a process commonly termed "oxidation." A high water table creates anaerobic conditions that slow the breakdown of organic materials. The balance between accumulation and decomposition of organic material shifts dramatically when soil is drained. Oxidation under aerobic conditions converts the organic carbon in the plant tissue to carbon dioxide gas and water. Aerobic decomposition under drained conditions is much more efficient thereby causing the loss of organic matter.

Why is it important?

Soil subsidence is usually irreversible. The natural rate of accumulation of organic soil is on the order of a few inches per 100 years; the rate of loss of drained organic soil can be 100 times greater, up to a few inches per year in extreme cases. Thus, deposits that have accumulated over hundreds of years can disappear relatively quickly in response to human activity. In time, the remaining organic material becomes diluted through the incorporation of the organic layer into the mineral subsoil. This reduces the productivity of the soil.

What can be done about it?

Once oxidation depletes the organic matter, it generally cannot be restored. The oxidation rate of organic matter can be minimized by managing water table levels to reduce aeration. In non-crop situations, keep the water table as close to the soil surface as possible. During the cropping season, maintain the water table at the optimum level for the crop being grown. Use cover crops to keep the soil covered and to return organic matter to the soil.

Subsidence at a Glance

Problems / Indicators—Loss of volume and depth of organic soils	
Typical Causes	Examples of Typical Solutions
• Drainage • Cultivation/soil disturbance	• Water table management • Diverse, high biomass crop rotations • Cover crops • Conservation tillage • Perennial crops

USDA United States Department of Agriculture
Natural Resources Conservation Service

SOIL
Wind Erosion

Soil

- Bank Erosion from Streams, Shorelines, Channels
- Classic Gully Erosion
- Ephemeral Gully Erosion
- Sheet and Rill Erosion
- Subsidence
- Wind Erosion
- Aggregate Instability
- Compaction
- Organic Matter Depletion
- Salts and Other Chemicals
- Soil Organism Habitat Loss or Degradation

Wind Erosion

Detachment and transport of soil particles caused by wind.

What is it?

Wind erosion is the physical wearing of the earth's surface by wind action. Erosion is not always readily visible, even when soil loss exceeds unsustainable levels. Symptoms of wind erosion may be identified by dust clouds, soil accumulation along fence lines or snowbanks, and a drifted appearance of the soil surface. Wind erosion occurs from removing soil from one place and depositing the soil in another place through suspension, saltation, or surface creep.

Why is it important?

Erosion removes surface soil material (topsoil), reduces levels of soil organic matter, and contributes to the breakdown of soil structure. This creates a less favorable environment for plant growth. Loss of only $^{1}/_{32}$ of an inch can easily represent more than 5 ton/acre soil loss. In soils that have restrictions to root growth, erosion decreases rooting depth, which decreases the amount of water, air, and nutrients available to plants. Erosion removes surface soil, which often has the highest biological activity and greatest amount of soil organic matter. Nutrients removed by erosion are no longer available to support plant growth onsite, and when they accumulate in water, they may lead to algal blooms, lake eutrophication, and depleted dissolved oxygen levels that lead to fish kills. Deposition of eroded materials can obstruct roadways and fill drainage channels. This can have a negative economic impact on the farm and offsite. Blowing dust can affect human health and create public safety hazards on roads.

What can be done about it?

Wind erosion can be avoided by maintaining a protective cover on the soil surface. To avoid wind erosion, keep soil covered with plants or residue, plant windbreaks, use stripcropping, and maintain soil aggregates. In emergency situations, increasing surface roughness can provide some level of protection over bare soils with smooth surfaces (e.g. clean-tilled field). Surface roughening is a temporary solution to address wind erosion.

Wind Erosion at a Glance

Problems / Indicators—Changes in soil horizon thickness, soil deposition in fields and water, and decreased organic matter	
Typical Causes	Examples of Typical Solutions
• Bare or unprotected soil • Long slopes • Intense wind events when residue cover is at a minimum • Decreased infiltration by compaction or poor soil structure	• Residue and tillage management • Conservation crop rotations • Cover crops • Stripcropping • Windbreaks • Permanent vegetative cover • Herbaceous wind barrier

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SOIL

Aggregate Instability

Aggregate Instability

Management-induced degradation of water stable soil aggregates resulting in destabilized soil carbon; surface crusting; reduced water infiltration, water holding capacity, and aeration; depressed resilience to extreme weather; increased ponding and flooding; increased soil erosion and plant stress; and reduced habitat and soil biological activity.

What is it?

A soil aggregate, also called water stable aggregate, is a composite of particles of sand, silt, clay, and organic matter that is bonded together both chemically and biologically. The chemical binding is mostly derived from the inherent soil texture and parent material and to a lesser extent affected by management. The biological binding agents play a greater role in overall aggregate stability, especially near the soil surface. These consist mainly of fungal hyphal strands and root hairs entangling and enmeshing soil particles along with complex carbohydrates, or polysaccharides, often referred to as organic exudates and mucilages. The exudates can come from plant roots as a product of photosynthesis, fungal hyphae, or certain forms of bacteria. These carbohydrates serve as binding agents, or glues, to which soil particles can be adsorbed and bound together. Many of the management activities used on working lands can lead to degradation of soil structure and aggregate stability. Most important agricultural soil functions are tied directly to soil aggregate stability. Improving and protecting aggregate stability by integrating the four management principles for soil health fosters habitat for soil organisms needed to regenerate water stable aggregates.

Why is it important?

A soil with good aggregate stability has significantly improved soil functions such as: improved water infiltration and storage, air and gas exchange, nutrient cycling, physical stability, habitat provisioning for soil micro and meso fauna and support, and filtering and buffering capability. The first step in erosion is the breakdown of surface aggregates. Aggregates at the soil surface are weakened if the binding agents degrade at rates exceeding replenishment rates. Aggregates can be disrupted by outside forces, such as raindrops, wind, sunlight, temperature variation, and tillage among the most important. Changes in soil chemistry, such as increased sodicity of the soil, can also contribute to aggregate breakdown. As aggregates become unstable and break down, the component particles clog surface pores and surface sealing and crusting follow. As a result, water infiltration is decreased and ponding, runoff, erosion, and sediment transport on and offsite increase. Aggregate instability can be reduced with management that buffers against outside forces.

What can be done about it?

The use of a system that incorporates the core Soil Health Management Principles facilitates an environment for developing and maintaining water stable aggregates. The core principles are: 1) minimize disturbance, 2) maximize soil cover, 3) maximize biodiversity, and 4) maximize presence of living roots. Minimizing physical, chemical, and biological disturbance reduces destruction of water stable aggregates. Keeping the soil covered reduces the aggregate-disruptive effects of raindrops, wind, sunlight, and temperature variation, while providing a more favorable habitat for soil organisms. Living roots enmesh soil particles, host fungi that enmesh soil particles, and provide a carbon food source needed by the organisms that enmesh aggregates or produce biotic glues. Increasing biodiversity

(continued)

Aggregate Instability (continued)

provides a diverse population of plant types capable of producing a diversity of belowground exudates from roots that attract and feed many types of microfauna capable of producing aggregate-stabilizing compounds. A well planned and managed system that includes multiple practices is usually necessary to develop and then protect soil aggregates. Minimize disturbance by using no-till and or reduced tillage, nutrient and pest management, and prescribed grazing. Increase biodiversity by using cover crops, crop rotation, prescribed grazing, conservation cover, range planting, forage and biomass planting, and tree planting. Keep the soil covered by using no-till, reduced till, cover crops, and mulching. Add more living roots by using cover crops, conservation cover, forage and biomass planting, range planting, and tree planting.

Aggregate Instability at a Glance

Problems / Indicators—Soil cover, crusting, water stable aggregates, soil structure, plant roots, biological diversity, and biopores	
Typical Causes	Examples of Typical Solutions
• Soil disturbance (physical, chemical, and/or biological) • Monoculture cropping systems • Fallow • Low crop biomass (surface) and excessive crop biomass (surface) • Burning harvesting or otherwise removing crop residue • Simplified crop rotations	• Cover crops • Diverse crop rotations that include high residue crops • No-till/strip-till cropping systems • Nutrient management • Prescribed grazing • Maintain evenly spread crop residues on the surface • Well managed animal manure and compost applications • Irrigation water management • Drainage water management • Mulching • Reduced tillage • Integrated pest management

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SOIL
Compaction

Soil

- Bank Erosion from Streams, Shorelines, Channels
- Classic Gully Erosion
- Ephemeral Gully Erosion
- Sheet and Rill Erosion
- Subsidence
- Wind Erosion
- Aggregate Instability
- Compaction
- Organic Matter Depletion
- Salts and Other Chemicals
- Soil Organism Habitat Loss or Degradation

Compaction

Management-induced soil compaction at any level throughout the soil profile resulting in reduced plant productivity, biological activity, infiltration, and aeration.

What is it?

Management-induced compaction occurs when pressure forces soil particles closer together, thus reducing pore space, particularly macro pore space. A severely compacted soil can become effectively impermeable to water or air. Certain soils, because of morphology, can tend to naturally form compacted layers irrespective of management. Compaction is assessed using measurements of bulk density, penetration resistance, porosity, and by observing root growth patterns.

Why is it important?

Compaction can restrict root growth and limit water and air movement into and through the soil. Compaction particularly stresses crops during excessive wetness due to lack of infiltration, drainage, and aeration, and during drought when soils become especially hard. When soil compaction inhibits root growth and increases plant stress, plant growth and crop yield and quality will be reduced. In addition, decreased plant growth may result in more of the soil surface being exposed to the erosive forces of rain and wind. Decreased water infiltration results in increased runoff and erosion, or ponding in flat areas, which can also increase pest pressure and negatively influence nutrient cycling.

What can be done about it?

Subsoil compaction may require initial deep tillage to shatter the compacted layer, or strategic deep-rooted cover crops or perennials, after which management should be changed to avoid future compaction. Surface compaction in cropland can normally be avoided with systems that incorporate cover crops, adequate crop residues, rotations that include perennial sods, and minimized tillage particularly on wet soil. Additionally, the use of multicrop rotations that include plants with different rooting depths can help prevent and sometimes alleviate compacted layers. Grazing systems that minimize livestock concentration, provide protected heavy use areas, avoid grazing wet soils, and adhere to recommended minimum grazing heights help minimize the potential for compaction development. To reduce existing compaction in grazing systems without subsoiling, active rooting in the compacted horizons needs to be stimulated.

Compaction at a Glance

Problems / Indicators—Bulk density, penetration resistance, porosity, root growth patterns	
Typical Causes	**Examples of Typical Solutions**
• Working or grazing wet soil • Excess traffic, machinery, or livestock • Heavy machinery • Repeated tillage at same depth • Poor aggregation • Low organic matter	• Avoid working or grazing wet soil • Reduce traffic/tillage operations • Controlled traffic patterns • Subsoil or rip compacted areas • Diversify cropping system • Conservation tillage • Cover crops • Well managed animal manure and compost applications • Prescribed grazing

SOIL
Organic Matter Depletion

Organic Matter Depletion

Management-induced depletion of any or all pools of soil organic matter resulting in limited soil function and processes that support plant productivity, biological activity, and water and nutrient cycling.

What is it?

For the purpose of conservation planning, the general term soil organic matter (SOM) is used to encompass all pools of organic matter in the soil. Soil organic matter is not a single substance but consists of a complex mixture of substances with each playing an important role for soil function. The term soil organic matter encompasses all organic components of a soil: 1) living biomass (intact plant and animal residues and microorganisms), 2) plant litter residues, 3) dissolved organic molecules (root and fungal exudates and bacterial mucilages), and 4) humus. The living components play an extremely important role in restoring function and building SOM pools. These pools of organic matter are in various stages of decomposition and variable states of stability.

Why is it important?

SOM is critical for the stabilization of soil structure, retention and release of plant nutrients, and maintenance of water holding capacity, thus making it a key indicator not only for agricultural productivity, but also environmental resilience. Because organic matter improves soil structure and enhances water and nutrient holding capacity, managing for soil carbon can enhance soil productivity and environmental quality, and it can reduce the severity and costs of natural phenomena, such as drought, flood, and disease. In addition, increasing soil organic matter levels can reduce atmospheric CO_2 levels that contribute to climate change, and improved soil quality/soil health reduces dust, allergens, and pathogens in the air. Ground and surface water quality improve because better structure, infiltration, and biological activity make soil a more effective filter. SOM can be manipulated by land management practices, some of which result in losses of organic components in soil. When organic matter is depleted, the soil's agricultural productivity and environmental resilience decrease.

What can be done about it?

Use a Soil Health Management System (SHMS) that follows the core Soil Health Management Principles. The core principles are: 1) minimize disturbance, 2) maximize soil cover, 3) maximize biodiversity, and 4) maximize presence of living roots. Minimizing physical, chemical, and biological disturbance reduces rapid oxidation and rapid microbial decomposition of organic matter. Maximizing soil cover reduces the impact of raindrops, wind, sunlight, and temperature on the labile pools of SOM located near the surface. Keeping the soil covered allows for improved soil habitat for important organisms involved in the production of organic materials. Maximizing living roots provides a readily available carbon food source needed by organisms that produce the biotic glues important for building protected pools of organic matter. Increasing biodiversity provides a diverse population of plants capable of producing diverse belowground roots with variable carbon composition and exudates that feed many types of micro and macrofauna. The most practical way to enhance soil health, and as a result air and water quality, and water quantity, is to promote better management of soil organic matter or carbon. A well planned and managed system combining several of the practices below will yield the highest outcome.

Organic Matter Depletion at a Glance

(continued)

Organic Matter Depletion (continued)

Organic Matter Depletion at a Glance

Problems / Indicators—Soil cover, crusting, residue breakdown, soil color, water stable aggregates, soil structure, plant roots, biological diversity, and biopores	
Typical Causes	Examples of Typical Solutions
• Soil disturbance (physical, chemical, and/or biological) • Fallow (extended periods without living roots and crop canopy) • Low crop biomass (surface and roots) • Burning, harvesting, or otherwise removing crop and other plant residue • Simplified crop rotations	• Cover crops (high residue) • Diverse crop rotations with high residue crops • No-till/strip-till cropping systems • Nutrient management (reduce over application of nitrogen) • Prescribed grazing • Maintain evenly spread crop residues on the surface • Well managed animal manure and compost applications • Irrigation water management • Drainage water management • Mulching • Reduced tillage • Restoring plant communities and maintaining ecologically appropriate levels of litter and large woody debris

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SOIL

Salts and Other Chemicals

Concentration of Salts and Other Chemicals

Concentration of salts leading to salinity and/or sodicity reducing productivity or limiting desired use, or concentrations of other chemicals impacting productivity, populations of beneficial organisms, or limiting desired use.

What is it?

Salinity is a condition when water soluble salts have accumulated in the soil. Saline soils are indicative of inadequate drainage to leach salts from the soil or upward migration of salt from shallow ground water. Sodic soils are high in sodium relative to concentrations of calcium and magnesium. Salinity or sodicity occurs naturally or may result from management practices. Soil formed on parent material high in salts, such as marine deposits, and with inadequate drainage, will be high in salts. Fertilizers, soil amendments (gypsum, lime), and manure may contribute to salinity problems, as well. Applications of saline and/or sodic water without adequate leaching or in the presence of a high water table increase soil electrical conductivity over time, eventually resulting in saline soil. Soils can also become saline through the process of saline seeps.

Why is it important?

Since few plants grow well on saline/sodic soils, cropping options on these soils may be limited. Salts in the soil can negatively affect water uptake by plants, and saline soils tend to inhibit germination and plant emergence. Growth patterns in cropped fields can be poor, with spotty stand establishment. Under severe salt stress, herbaceous crops appear bluish-green. Leaf tip burn and die-off of older leaves in cereal grains can result from salinity or related drought stress. Salinization degrades the quality of shallow ground water and surface water resources, such as ponds, sloughs, and dugouts.

What can be done about it?

Reducing the severity and extent of soil salinity is accomplished primarily with recharge and discharge water management. Recharge management is used on areas that contribute excess water to the soil and includes decreasing infiltration of excess saline/sodic water and irrigation to maintain salts at a level below the root zone. Discharge management is used on areas where excess water comes to the soil surface and includes growing salt tolerant crops, reducing deep tillage, and eliminating seepage.

Concentration of Salts and Other Chemicals at a Glance

Problems / Indicators—White crusting of soil, irregular crop growth, and lack of plant vigor	
Typical Causes	**Examples of Typical Solutions**
• Naturally occurring in soils with high concentrations of soluble salts, e.g., sodium, calcium, and magnesium sulfates • Decreased infiltration • Inadequate drainage to leach salt from the soil • Upward migration of salt from shallow ground water • Application of saline and/or sodic water	• Proper use of irrigation water • Salt-tolerant crops • Remove excess water from recharge areas • Maintain the water table at safe levels • Cropping and tillage systems that promote adequate infiltration and permeability • Reduce deep tillage

USDA United States Department of Agriculture

Natural Resources Conservation Service

SOIL

Soil Organism Habitat

Soil Organism Habitat Loss or Degradation

Quantity, quality, diversity, or connectivity of food, cover, space, shelter, and/or water is inadequate to meet the requirements of beneficial soil organisms.

What is it?

A healthy soil is a living ecosystem that supports an abundant and diverse biological community that aids in land use productivity by providing key services and functions. It is supported by soil aggregates, which provide good porosity for air and gas exchange, water infiltration and drainage, aeration, and space for soil fauna to reside. Living roots are a key food source, as well as crop residue on the soil surface.

Why is it important?

All biogeochemical processes or soil functions are affected by soil micro, meso, and macrofauna. As are organisms in other ecosystems, soil organisms survive and thrive in relation to the health of their habitat. Consequently, loss of function in many soils can be attributed in large measure to loss of soil organism habitat. The processes and capacities affected by soil organisms include air and gas exchange, nutrient cycling, water infiltration and storage, physical stability and support, pest suppression, and filtering and buffering capability. Loss or inhibition of these soil characteristics results in declining crop productivity, resilience to weather or pest stressors, and the need to overcome the loss with additional inputs and an increased intensity of management. In addition, a decline in naturally occurring soil function typically leads to undesirable societal consequences such as erosion and siltation, flooding, and contamination of surface and ground water with nutrients and other chemicals lost from agricultural fields. Improving and maintaining habitat for soil organisms allows this diverse ecosystem to function in a way that both production and environmental benefits are provided by our agricultural lands.

What can be done about it?

Use a Soil Health Management System (SHMS). Adopting production systems that include the appropriate application of the four soil health principles can contribute to habitat development which in turn allows organisms that are important to soil function to thrive. Physical disturbances such as tillage as well as misuse of chemicals that disrupt soil organism habitat and the entire soil ecosystem should be avoided. Systems with a diversity of plants and the presence of living roots throughout the year contribute to healthy organism habitat by providing resources necessary for supporting a diversity of organisms. Soil surfaces that are covered with plants, plant residue, or mulch help protect habitat from the destructive forces of wind, rain, and temperature extremes. A well planned and managed system that includes multiple practices contribute to improved soil organism habitat. Minimize disturbance by using no-till and reduced tillage, nutrient and pest management, and prescribed grazing. Increase biodiversity by using cover crops, crop rotation, prescribed grazing, conservation cover, range planting, forage and biomass planting, and tree planting. Keep the soil covered by using no-till, reduced till, cover crops, and mulching. Add more living roots by using cover crops, conservation cover, forage and biomass planting, range planting, and tree planting.

Soil Organism Habitat Loss or Degradation at a Glance

(continued)

Soil Organism Habitat (continued)

Soil Organism Habitat Loss or Degradation at a Glance

Problems / Indicators—Soil cover, residue breakdown, water stable aggregates, soil structure, plant roots, biological diversity, and biopores	
Typical Causes	Examples of Typical Solutions
• Soil disturbance • Fallow • Conventional tillage • Low crop biomass (surface) and excessive crop biomass (surface) • Burning, harvesting, or otherwise removing crop residue • Simplified crop rotations	• Cover crops • Diverse crop rotations • No-till cropping systems • Integrated pest management • Nutrient management • Prescribed grazing • Maintain crop residues on the soil surface • Well managed animal manure and compost applications • Irrigation water management • Mulching • Conservation tillage

USDA United States Department of Agriculture

Natural Resources Conservation Service

WATER

Drifted Snow

Water

Drifted Snow

Wind-blown snow accumulates around and over surface structures, which restricts access to humans or animals; or wind removes snow from desired location where it can be used to accumulate water.

What is it?

Snowdrifts can have negative impacts on humans, animals, structures, and energy use. Depending on their location, snowdrifts can have positive or negative impacts on runoff and moisture management.

Why is it important?

Wind driven snow and snowdrifts can create hazardous conditions for humans and animals, limit access to livestock or farmsteads, and affect actions and practices established for other resource concerns. Snowmelt water can impact cropland, feedlots, and farmsteads and negatively affect water quality. Managing snowdrift locations to capture snowmelt can benefit soil moisture and increase crop productivity.

What can be done about it?

Living snow fences made up of trees and shrubs, along with temporary or permanent structures (e.g. fence, rock-barrier, etc.), and conservation tillage practices can change accumulation and location of snowdrifts. Some living snow fences can double as windbreaks or shelterbelts, or they may be designed specifically for snow management. Sometimes living snow fences are supplemented with structural barriers such as vertical slat fences. Controlling blowing snow can prevent large snowdrifts from forming in farmsteads and feedlots and reduce the amount of labor and energy needed to move snow. Retaining stubble or a few rows of unharvested crops in fields is another way to capture snow and manage its distribution. This technique, along with field windbreaks, has the added benefit of conserving snowmelt water moisture for crops. Drifting of snow can be controlled to limit negative impacts to humans and animals and/or improve soil moisture management.

Drifted Snow at a Glance

Problems / Indicators—Cloudy or muddy water, stream/water body soil deposition	
Typical Causes	Examples of Typical Solutions
• Blowing snow encounters barriers such as terrain, structures, and vegetation • Snowdrifts form where the wind is slowed, typically in leeward positions • Snowdrifts may be small or large depending on snowfall amounts, wind speed and direction, and configuration of barriers.	• Living snow fences of trees and shrubs, sometimes doubling as windbreaks or shelterbelts, designed and placed to protect animals and structures, provide access, limit runoff, and benefit soil moisture • Snow fences or other structures configured to diminish effects of drifting snow • Conservation tillage practices that retain crop stubble or rough surface conditions help to spread accumulation of drifted snow on crop land

WATER
Ponding and Flooding

Ponding and Flooding
Water covering the land surface, along with saturated conditions below the surface, degrades natural resources, or restricts capability of land to support its intended use.

What is it?
Water can flood or pond and restrict plant growth and land use. Water may flow into or around buildings during periods of excess rain. If the soil has a dense layer, especially a layer of clay, flow of water through the soil may be restricted and water may pond.

Why is it important?
Flooding and ponding impacts plant growth and land use. Plant growth is essential for improving soil quality and increasing soil organic matter. Saturated soils increase the likelihood of diseases, significant losses of soil nitrogen due to denitrification and leaching of nitrate N, and soil damage due to heavy equipment.

What can be done about it?
Using a systems approach can help address excess water. Strategies include managing for drainage, conveyance, and multiple uses for crops and wildlife. Drainage systems must be compatible with crops grown, field layouts, and cultural practices such as crop rotation and cultivation. System choices include open ditches, tile drains, mole drains, and land forming for increased surface runoff. Planned systems can include diverting excess water and infiltration basins combined with roof runoff management systems. Restored and enhanced wetlands can also be key components in water management.

Ponding and Flooding at a Glance

Problems / Indicators—Little to no established vegetation due to excess water, wet areas due to restrictive soil layers, flood prone buildings and structures	
Typical Causes	Examples of Typical Solutions
• Decreased infiltration • Ponding • Stormwater runoff • Flood prone areas	• Drainage management and structures for water control • Roof runoff structures and capture for reuse methods • Floodplain management • Restore or enhance wetlands • Windbreak placement for protection and to provide access

USDA United States Department of Agriculture
Natural Resources Conservation Service

WATER
Seasonal High Water Table

Seasonal High Water Table

Ground water or a perched water table causing saturated conditions near the surface degrades water resources or restricts capability of land to support its intended use.

What is it?

It is a resource concern when ground water or a perched water table near the soil surface has caused degradation to water resources or restricted the capability of the land to support its intended use. Seasonal high water table conditions typically exist due to a normal wet season or altered hydrology.

Why is it important?

Seasonal high water table is an important factor in land use decisions. The depth to the seasonal high water table factors into siting, design, implementation, operation, and maintenance of farm practices such as irrigation and fertilizer application. A shallow water table can have adverse effects on the environment and users. Construction on sites where shallow water table conditions exist directly affect public health and safety by increasing the risk of flooding and property damage, negatively impacting erosion control, stormwater management, and waste treatment functions. Under shallow water table conditions soil pores are filled with soil water within the root zone for both plant roots and soil microorganisms. In addition, anaerobic soil environments limit microbial activity and consequently negatively impact soil health. A lack of oxygen results in shallow root systems and poor plant growth. Consequently, livestock production may be reduced due to low forage production. The location of a seasonable high water table is critical to the design of cut and fill depths for many farm practices. In addition, water table depth and duration affect nutrient management plans and crop management.

What can be done about it?

Strategies to address seasonal high water tables can include managing for drainage, irrigation, conveyance, and multiple uses for crops and wildlife. Drainage systems must be compatible with crops grown, field layouts, and cultural practices such as crop rotation and cultivation. System choices include, but are not limited to, open ditches, tile drains, mole drains, and land forming for increased surface runoff.

Seasonal High Water Table at a Glance

Problems / Indicators—Public health and safety concerns related to drainage systems, property and structures exposed to shallow ground water flooding, hindered plant growth and with impacts to livestock production, impacts to farming practices that involve excavation and manipulation of storage of water	
Typical Causes	Examples of Typical Solutions
• Water table becomes elevated due to precipitation rates, soil permeability, geological formations, drainage patterns, human impacts, and proximity to nearby surface water bodies	• Manage seasonal excess water with surface or subsurface drainage practices • Implement wetland restorative and enhancing practices to promote wetland function, value, habitat, and diversity to pre-disturbance conditions

USDA United States Department of Agriculture
Natural Resources Conservation Service

WATER
Seeps

Seeps
Sub-surface saturated flows that percolates slowly to the surface, degrades water resources, or restricts capability of land to support its intended use.

What is it?
Water can seep and restrict plant growth or degrade water resources. Water may flow into or around buildings if they are constructed over or near a spring or seep.

Why is it important?
Seeps and high water tables impact plant grow and land use. Plant growth is essential for improving soil quality and increasing soil organic matter. Saturated soils increase the likelihood of diseases, significant losses of soil nitrogen due to denitrification and leaching of nitrate N, and soil damage due to heavy equipment. Seeps and high water tables must be taken into account for conservation plantings and when evaluating sites for construction. Excess water can affect structures and slope stability.

What can be done about it?
Using a systems approach can help address excess water. Strategies include managing for drainage, conveyance, and multiple uses for crops and wildlife. Drainage systems must be compatible with crops grown, field layouts, and cultural practices such as crop rotation and cultivation. System choices include open ditches, tile drains, mole drains, and land forming for directed water flow. Restored and enhanced wetlands can also be key components in water management.

Seeps at a Glance

Problems / Indicators—Little to no established vegetation due to excess water, wet areas due to restrictive soil layers, flood prone buildings and structures	
Typical Causes	Examples of Typical Solutions
• High water table • Natural soil conditions • Sub surface water due to prior development or land shaping	• Restore or enhance wetlands • Wet meadow management • Drainage management and structures for water control • Tree Planting, windbreak placement for water use and to provide access

USDA United States Department of Agriculture

Natural Resources Conservation Service

WATER
Ground Water Depletion

Ground Water Depletion
Underground water is used at a rate greater than aquifer recharge.

What is it?
It is a resource concern when ground water is used at a rate that is detrimental to ecological functions or other identified uses and threatens the sustainability of ground water when rate of use exceeds aquifer recharge. These long-term water level declines are most commonly caused by sustained ground water pumping. Ground water depletion can also occur naturally as a result of changes in our climate.

Why is it important?
Ground water is the earth's most extracted raw material. It is the source of drinking water for about half the nation and it provides over 50 billion gallons per day in support of the nation's agriculture. Ground water depletion can have negative effects on the environment and users. As the water table lowers, a well may not yield as much water. Also, the well owner or nearby well owners may have to deepen their wells, drill a new well, or attempt to lower the pump, to maintain the quantity of water supplied by the well for their agricultural needs. As the depth to water increases, the water must be lifted higher to reach the land surface. If pumps are used to lift the water (as opposed to artesian wells), more energy is required to drive the pump. Using the well can become prohibitively expensive. Surface and ground water are interconnected with each contributing water to the other in varying amounts, depending on geography, geology, and climate. Ground water depletion can reduce the amount of ground water that flows into surface water bodies (streams, lakes, springs, seeps, and wetlands). If ground water levels fall below the depth to contribute to surface water bodies, it can have detrimental effects on wetland ecosystems, can cause the loss of riparian buffers, and have a negative impact on wildlife habitat. In such cases, if ground water does not contribute to surface water bodies, then the surface water bodies will recharge the aquifer and potentially reduce the ground water quality. Saltwater intrusion along coastal areas is a good example of this. Depending on the permeability of the aquifer, bacteria or hazardous chemicals in inland surface water bodies can contaminate well water. Sometimes when the water table is lowered and water is taken out of the soil, the soil collapses, compacts, and land subsidence occurs causing differential settling of soil. Differential settling can disrupt surface water drainage gradients, reducing their conveyance capacity or increasing their velocities and causing bank erosion. It can also cause damage to drainpipes, well casings, buildings, and bridges. Water consumption and subsequent production of crops and livestock are reduced due to a lack of water availability.

What can be done about it?
Manage ground water withdrawal rates to meet the client's natural resource management and land use objectives while avoiding perpetuating existing natural resource concerns or creating new natural resource concerns..

Ground Water Depletion at a Glance
(continued)

Ground Water Depletion (continued)

Ground Water Depletion at a Glance

Problems / Indicators—Well water levels decreased, water withdrawal cost, decreased water levels of surface water bodies, deterioration of water quality, land subsidence, stressed vegetation and livestock, impact on neighboring water resources	
Typical Causes	Examples of Typical Solutions
• The use of ground water at a rate greater than aquifer recharge	• Manage ground water withdrawal rates to meet the client's natural resource management and land use objectives while avoiding perpetuating existing natural resource concerns or creating new natural resource concerns • Implement conservation practices that recharge ground water resources such as water harvesting catchment facilities and rain gardens • Convert from lower efficiency to higher efficiency irrigation systems • Irrigation tailwater recovery to reuse water • Capture surface water with ponds and reservoirs

United States Department of Agriculture
Natural Resources Conservation Service

WATER
Surface Water Depletion

Surface Water Depletion

Water from collected precipitation runoff, ponds, lakes, surface watercourses and reservoirs is used at a rate that is detrimental to ecological functions or other identified uses and threatens sustained availability of surface water.

What is it?

It is a resource concern when surface water is used at a rate that is detrimental to ecological functions or other identified uses and threatens the sustainability of surface water when rate of use exceeds surface water body replenishment. Surface water depletion is commonly caused by a combination of human activities, such as landscape modification and lands use changes, which affect the distribution, quantity, and quality of water resources. Surface water depletion can also occur naturally as a result of changes in our climate.

Why is it important?

Approximately 70% of the freshwater used in the United States comes from surface water sources. Surface water is an important natural resource used for many purposes, especially irrigation and public supply. Surface water depletion can have negative effects on the environment and users. Surface water provides habitat for wetland and riverine ecosystems which often include threatened or endangered species. These habitats are adversely impacted when essential inflows are not achieved due to surface water depletion. As the depth to water surface increases, the water must be lifted higher to reach the land surface. If pumps are used to lift the water (as opposed to artesian wells), more energy is required to drive the pump. When surface water is depleted, the quantity of water available for natural aquifer recharge decreases. With less water entering the aquifer, the water table in the aquifer is susceptible to decline, leading to resource concerns associated with ground water overdraft. During periods of surface water depletion, nutrient contributions from point source and nonpoint source polluters are increased, comparative to surface water flow. The subsequent reduced dilution of nutrients results in an increased susceptibility to adverse impacts associated with eutrophication. Water consumption and subsequent production of crops and livestock are reduced due to a lack of water availability.

What can be done about it?

Surface water bodies interact with ground water in all types of landscapes. Accordingly, manage ground and surface water withdrawal rates to meet the client's natural resource management and land use objectives while avoiding perpetuating existing natural resource concerns or creating new natural resource concerns.

Surface Water Depletion at a Glance

(continued)

Surface Water Depletion (continued)

Surface Water Depletion at a Glance

Problems / Indicators—Decreased water levels of surface water bodies and ground water resources, increased withdrawal cost, deterioration of water quality, stressed vegetation and livestock, impact on neighboring water resources, degradation of wildlife habitat	
Typical Causes	Examples of Typical Solutions
• The use of surface water at a rate greater than surface water body replenishment • Drainage of surface water that negatively impacts wildlife habitat functions	• Manage surface water withdrawal rates to meet the client's natural resource management and land use objectives while avoiding perpetuating existing natural resource concerns or creating new natural resource concerns • Implement conservation practices that develop and replenish surface water resources, such as tailwater recovery irrigation systems and irrigation reservoirs • Convert from lower efficiency to higher efficiency irrigation systems • Decrease the baseline amount of water that crops require for growth by cultivating water-thrifty crops • Restore surface water to wetlands and streams

Inefficient Irrigation Water Use

Inefficient Irrigation Water Use

Irrigation water is not stored, delivered, scheduled, and/or applied efficiently.

What is it?

Inefficient use of irrigation water impacts onsite and offsite water quantity and quality. Irrigation systems and water management practices can waste water and negatively affect farm profitability.

Why is it important?

Irrigated agriculture is essential in meeting the nation's food and fiber production needs. Agriculture is the nation's largest water user, accounting for more than 85% of the nation's annual water consumption. Emerging problems that further complicate resource protection and water allocation include: serious long-term drought conditions, critical ground water declines occurring in agricultural production areas, saltwater intrusion into ground water supplies, and competition for water among a multitude of water users, including power generation, drinking water supplies, wildlife, recreation, etc.

What can be done about it?

Solutions are available to address many of the competing water resource needs. Choices generally include conservation of the water used, conversion to other crops that use less water, and conversion to other sources of water. Conserving water could include improvements in irrigation water use efficiencies, off stream storage of water during periods of excess runoff, water re-use and water recycling, and ground water recharge. Under most onfarm inefficient irrigation water use circumstances, proper irrigation water management (IWM) is a must. This includes employing an irrigation scheduling strategy that applies the right amount of water, at the right time, and at the right place. Use of soil moisture sensors and crop water use information is highly recommended for this purpose.

Inefficient Irrigation Water Use at a Glance

Problems / Indicators—Irrigated crops, plant stress, insufficient water supply	
Typical Causes	Examples of Typical Solutions
• Open earthen ditches • Irrigation water allowed to run off of fields • Losses due to improper system design, installation, or maintenance • Over irrigation causing excess deep percolation • Untimely irrigation • Irrigation resulting in degraded wildlife habitat	• Line ditches or install pipe; improve water transport systems • Manage applications to reduce runoff; tailwater return systems • Audit system and retrofit or replace where warranted

USDA United States Department of Agriculture
Natural Resources Conservation Service

WATER
Naturally Available Moisture

Naturally Available Moisture Use

Natural precipitation is not optimally managed to support desired land use goals or ecological processes.

What is it?

Every soil is subject to extremes in climate. The moisture status of the soil must be characterized by probability. Precipitation patterns, including the annual amount of rainfall, seasonal distribution in relation to the growing season, and the intensity, duration, and frequency of rain events are dynamic. Long-term weather patterns of precipitation, temperature, and wind are helpful in estimating soil moisture status but must be tempered by topography, landscape position, slope, aspect, surface condition, infiltration, soil structure, available water capacity, internal water movement restrictions, vegetation, and land use. Accumulation of snow affects the amount of moisture provided to the soil and also impacts soil temperature and frost depth. Good soil management and improving soil health are important in managing soil moisture to provide more resiliency to weather extremes. Soil moisture data can be obtained from several sources. For most soils, actual data may be based on field observations, field notes, and climatic data from the area. Check for soil moisture studies and piezometer measurements in dissertations and other university studies, scientific papers, or in NRCS project reports. Computer models may be helpful to assess potential soil moisture availability during a growing season.

Why is it important?

Soil moisture impacts plant growth, soil settling, susceptibility to compaction, ease of excavation, and installation of conservation practices. Soil moisture becomes an even bigger concern on whether the cover crop will use all the available moisture that is being stored for the cash crop. Soil moisture budgeting can inform a grower on whether the cover crop will use all the available moisture that is being stored for the cash crop.

What can be done about it?

Soil management activities or actions can be managed to maintain or enhance water infiltration rates, minimize evaporation, and reduce runoff to use as much natural precipitation as possible. Limiting soil disturbance activity, leaving surface residues and including cover crops can moderate losses of soil moisture.

Naturally Available Moisture Use at a Glance

Problems / Indicators—Soil erosion, poor plant growth	
Typical Causes	**Examples of Typical Solutions**
• Clean or traditional tillage • Unnaturally low organic matter • Overgrazing of horses and livestock	• Use reduced/mulch tillage or no-till cropland strategies • Increase soil organic matter by using cover crops, compost, and/or manure • Reduce chemical inputs that kill naturally functioning organic components • Manage grazing to optimize plant cover and regrowth to maintain roots for soil aggregation and improved water infiltration • Drainage water management and tailwater recovery

United States Department of Agriculture

Natural Resources Conservation Service

WATER

Nutrients to Surface Water

Nutrients Transported to Surface Water

Nutrients (organic and inorganic) stored, concentrated, or applied are transported to receiving surface waters in quantities that degrade water quality and limit its use for intended purposes.

What is it?

Water bodies require nutrients, such as nitrogen and phosphorus, to be healthy, but too many nutrients can be harmful. Many of our nation's waters, including streams, rivers, wetlands, estuaries, and coastal waters, are affected by applied nutrients to neighboring fields. The effect to a given water body depends on its location and the source of nutrients.

Why is it important?

High levels of nitrate in drinking water can cause serious public health concerns. Additionally, increased nitrogen and phosphorus levels in water can produce excessive aquatic vegetation and algal blooms resulting in reduced dissolved oxygen, harmful toxins, and increased water temperature. In extreme cases dissolved oxygen may be so low that dead zones, known as hypoxia, exist where most aquatic life cannot survive. Algal blooms can impart an undesirable taste to potable water that is difficult to remove by water treatment. High ammonia levels are toxic to some freshwater fish species.

What can be done about it?

Management is the key to protecting water quality by reducing the transport of nutrients into surface water. Nutrient management specifies the rate, source, placement, and timing of plant nutrients needed for production , while minimizing movement of the nutrients to surface waters. Nutrients may also be lost due to erosion, runoff, irrigation, and drainage, so applicable practices should be installed to address these concerns. Nutrients should not be applied to sensitive areas such as established setbacks, wetlands, sinkholes, wells, or rapidly permeable soil areas.

Nutrients Transported to Surface Water at a Glance

Problems / Indicators—Algae blooms, mass death of fish or aquatic organisms, dissolved oxygen concentrations, hypoxia	
Typical Causes	**Examples of Typical Solutions**
• Overusing fertilizer (both residential and agricultural usage) • Soluble nutrients • Poor soil structure • Decreased infiltration • Conventional tillage • Erosion of nutrient-laden soil • Runoff from cropland, animal feeding operations and pastures, picking up nutrients and depositing them in water bodies • Low nutrient holding capacity of soil	• Nutrient management planning to address the form, rate, placement, and timing of plant nutrient application • Cover crops • Crop rotations • Conservation buffers and setbacks from surface water • Residue management to improve the soil's ability to retain nutrients • Livestock production practices, such as feed management, animal waste storage, and handling animal mortality • Drainage water management • Irrigation water management • Constructed wetlands

United States Department of Agriculture
Natural Resources Conservation Service

WATER

Nutrients to Ground Water

Water

Nutrients Transported to Ground Water

Nutrients (organic and inorganic) stored, concentrated, or applied are transported to ground waters in quantities that degrade water quality and limit its use for intended purposes.

What is it?

Water bodies require nutrients, such as nitrogen and phosphorus, to be healthy, but too many nutrients can be harmful. Many of our nation's waters, including streams, rivers, wetlands, estuaries, and coastal waters, are affected by applied nutrients. The effect to a given water body depends on its location and the source of nutrients.

Why is it important?

Ground water contaminated by excess nitrogen, as nitrates, when withdrawn by water wells, is a health concern specifically for human babies, the elderly, and some livestock during certain life stages. Shallow ground water can move laterally to surface water. Increased nitrogen and phosphorus levels in water can cause increased aquatic vegetation and algal blooms resulting in reduced dissolved oxygen, harmful toxins, and increased water temperature. In extreme cases, dissolved oxygen may be so low that dead zones, known as hypoxia, exist where most aquatic life cannot survive. Algal blooms can also impart an undesirable taste to potable water that is difficult to remove by water treatment. High ammonia levels are toxic to some freshwater fish species.

What can be done about it?

Management is the key to protecting water quality by reducing transport of nutrients into ground water. Nutrient management specifies the rate, source, placement, and timing of plant nutrients needed for production, while minimizing movement of the nutrients to ground water. Nutrients should not be applied to sensitive areas such as established setbacks, sinkholes, wetlands, wells, or rapidly permeable soil areas.

Nutrients Transported to Ground Water at a Glance

Problems / Indicators—Algae blooms, mass death of fish or aquatic organisms, dissolved oxygen concentrations, hypoxia	
Typical Causes	Examples of Typical Solutions
• Overusing fertilizer (both residential and agricultural usage) • Soluble nutrients • Runoff from cropland, animal feeding operations, and pastures, picking up nutrients and depositing them in water bodies and ground water access points • Low nutrient holding capacity of soil	• Nutrient management to address the rate, source, placement, and timing of plant nutrient application • Cover crops • Crop rotations • Conservation buffers and setbacks from sensitive areas • Residue management to improve the soil's ability to retain nutrients • Livestock production practices, such as feed management, animal waste storage, and handling animal mortality • Drainage water management • Irrigation water management

United States Department of Agriculture
Natural Resources Conservation Service

WATER

Pathogens to Surface Water

Pathogens and Chemicals Transported to Surface Water

Pathogens, pharmaceuticals, leachate, and chemicals from manure, biosolids or compost transported to receiving waters in quantities that degrade water quality and limit uses.

What is it?

Potential pathogens (disease-causing microorganisms) and chemicals can be found in manure, biosolids, and compost. The pathogens include bacteria, protozoa, and viruses. If manure, biosolids, and compost are not adequately treated and contained, pathogens may enter surface water posing a potential risk to human and animal health.

Why is it important?

Pathogens can be transmitted to humans directly through contact with animals, animal manures, or indirectly through contaminated water or food. Human illness and death can result from exposure to pathogens from improperly treated livestock and poultry manure, biosolids, and compost. Pathogens can also be transmitted to domestic and wild animals with similar results.

What can be done about it?

The most effective tool in eliminating pathogens, from both practical and economic standpoints, is time. If manure, biosolids, and compost are allowed to sit undisturbed in storage or in soil, the concentration of pathogens will decrease with time as they die off or are overgrown by native microbes. Managing manure, biosolids, and compost for pathogens is approached in two phases: 1) collection and storage and 2) land treatment. It is also important to manage livestock access to surface water (streams, rivers and water bodies). Pathogens can threaten humans who are exposed to runoff, have direct contact with manure, biosolids, and compost, or consume food or water contaminated with manure. Application rates and seasonal conditions are important factors contributing to the transfer of pathogens from lands where manure has recently been applied to nearby surface water. Managing the rate, timing, and method of application of manure are critical elements in managing for pathogens. Keeping a buffer zone or setback distance between manure application areas and water bodies is a common practice that greatly decreases the transport of pathogens to those water bodies.

Pathogens and Chemicals Transported to Surface Water at a Glance

Problems / Indicators—Storage, handling, and application of manure, biosolids, or compost	
Typical Causes	**Examples of Typical Solutions**
• Improper collection, handling, and storage of manure, biosolids, and compost • Land application of infected manure, biosolids, or compost • Improper disposal of dead animals	• Proper collection, handling, and storage system for agricultural waste • Biological treatment (anaerobic storage, composting, anaerobic digesters) • Vegetative filter strips, setbacks, and buffer zones • Crop residue and tillage management • Cover crops • Manage livestock access to water • Manage the rate, timing, and method of application of manure, biosolids, and compost • Animal mortality management for routine mortality

United States Department of Agriculture
Natural Resources Conservation Service

WATER
Pathogens to Ground Water

Pathogens and Chemicals Transported to Ground Water

Pathogens, pharmaceuticals, leachate, and chemicals from manure, biosolids, or compost transported to ground waters in quantities that degrade water quality and limit uses.

What is it?

It is a resource concern if manure, biosolids, and compost are not adequately treated and contained, allowing the constituents of concern to enter ground water, posing a potential risk to human and animal health.

Why is it important?

Pathogens, pharmaceuticals, leachate, and polluting chemicals can be transmitted to humans via contaminated domestic drinking water supply. Human illness and death have resulted from exposure to pathogens from livestock and poultry manure. Pathogens can also be transmitted to domestic and wild animals with similar results.

What can be done about it?

Keeping a buffer zone or setback distance between manure application areas and direct connections to ground water such as sinkholes or water wells can address this problem. It may also be necessary to direct contaminated runoff away from these sensitive areas.

Pathogens and Chemicals Transported to Ground Water at a Glance

Problems / Indicators—Storage, handling, and application of manure, biosolids, or compost	
Typical Causes	Examples of Typical Solutions
• Improper collection, handling, and storage of manure near sensitive areas • Land application of manure, biosolids, and compost on sensitive areas • Improper installation of wells	• Proper collection, handling, and storage system for agricultural waste • Sinkhole treatment • Diversions • Proper installation of water wells • Well decommissioning

WATER

Pesticides to Surface Water

Pesticides Transported to Surface Water

Pesticides are lost from their application area and transported to surface water sources in quantities that degrade water quality and limit its use for intended purposes.

What is it?

The term "pesticide" is a composite term that includes all chemicals that are used to kill or control pests. Pesticides can be harmful to people and the environment. Part of the problem is the toxicity of some pesticides, but even more important is the sheer volume of pesticides used in this country every year. Some of this pesticide finds its way to our water, air, and soil.

Why is it important?

Protecting surface water from chemical pollutants is a national initiative. Water is an exceptionally valuable natural asset. The health and livelihood of Americans depends on the availability of a safe drinking water supply. Equally important is the role of water quality on fish and aquatic ecosystems. Indirect benefits of water quality are provided by recreational boating, sport fishing, swimming, relaxation, and natural beauty.

What can be done about it?

The ecological impacts of pesticides in water are determined by their toxicity, persistence, degradates, and environmental fate. The use of integrated pest management strategies and techniques involving prevention, avoidance, monitoring, and suppression are effective means to reduce the risks associated with pesticide use. A risk assessment tool can be used to identify risks and guide the mitigation of off-site pesticide hazards. Mitigating practices include residue management, cover crops, conservation crop rotation, and integrated pest management.

Pesticides Transported to Surface Water at a Glance

Problems / Indicators—Pesticide use in the farm/ranch operation	
Typical Causes	Examples of Typical Solutions

• Pesticide use near sensitive waters
• Use of pesticides with intermediate or higher hazard rating and
  • Where ground is cultivated
  • With drift potential
  • With impacts to beneficial organisms
	• Integrated pest management strategies
	  • Prevention, avoidance, monitoring, etc.
	  • Timing, formulations, equipment, etc.
	• Alternative pest suppression strategies
	• Agrichemical handling facilities
	• Vegetative buffers
	• Residue management
	• Cover crops
	• Conservation crop rotation
	• Drainage water management
	• Proper use and storage

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WATER
Pesticides to Ground Water

Pesticides Transported to Ground Water

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Why is it important?

Water is a vital component of successful agriculture. Sufficient amounts of clean, usable water enable crops and livestock to thrive. Aside from agricultural benefits, water is also necessary to preserve the environments of many sensitive or protected lands such as wetlands.

What can be done about it?

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Pesticides Transported to Ground Water at a Glance

Problems / Indicators—Pesticide use in the farm/ranch operation	
Typical Causes	**Examples of Typical Solutions**

• Pesticide use near sensitive waters
• Use of pesticides with intermediate or higher hazard risk
  • In areas with leaching soils
  • In aquifer recharge areas
	• Integrated pest management strategies
	  • Prevention, avoidance, monitoring, etc.
	  • Timing, formulations, equipment, etc.
	• Alternative pest suppression strategies
	• Agrichemical handling facilities
	• Vegetative buffers
	• Residue management
	• Cover crops
	• Conservation crop rotation
	• Drainage water management
	• Proper use and storage

WATER

Pollutants to Surface Water

Petroleum, Heavy Metals, Pollutants Transported to Surface Water

Petroleum, heavy metals, and other chemical pollutants for onfarm use are lost from areas of concentration (handling, storage, or processing facilities and areas) to receiving surface waters in quantities that degrade water quality and limits its use for intended purposes. This resource concern does not cover pathogens/manure, sediment (although sediment contaminated with petroleum, heavy metals, or other chemical pollutants would be covered), nor naturally occurring salts.

What is it?

Petroleum is generally thought of in terms of crude oil products but also includes all liquid, gaseous, and solid hydrocarbons. Petroleum contamination in agriculture typically occurs through point source spills and from nonpoint sources, where small amounts of petroleum are collected through runoff from asphalt-covered roads and parking areas, and over a long period of time add up to large-scale effects. A heavy metal can be defined as a chemical element with a specific gravity that is at least five times that of water. Examples of heavy metals include arsenic, cadmium, iron, lead, chromium, copper, zinc, nickel, and mercury. Heavy metal contamination is typically through the use and application of biosludge, contaminated animal manure, and inorganic fertilizers.

Why is it important?

In large concentrations, the hydrocarbon molecules that make up crude oil and petroleum products are highly toxic to many organisms, including humans. Petroleum products can have a detrimental effect on oxygen demand and transfer in surface water, and it can restrict the penetration of sunlight to aquatic plants. Heavy metals are also toxic and can affect other systems by leaching or runoff. Sufficient amounts of clean, usable water enable crops and livestock to thrive. Water is also necessary to preserve the environments of many sensitive or protected lands such as wetlands.

What can be done about it?

The key to addressing petroleum and heavy metal transport to surface water is prevention. The proper handling and storage of petroleum and chemical products can prevent contamination of the soil and water. Containment systems are very effective in containing spills. Heavy metals buildup can be addressed through the proper use, application, and monitoring of levels over time of biosludge, animal manure and inorganic fertilizers.

Petroleum, Heavy Metals, Pollutants Transported to Surface Water at a Glance

Problems / Indicators—Storage and handling of petroleum; use of biosludge, contaminated animal manure, and inorganic fertilizers	
Typical Causes	**Examples of Typical Solutions**
• Inadequate storage and handling • Repeated application of biosludge or inorganic fertilizers over a long period of time • Unprotected surface water sources	• Proper storage and handling • Petroleum and chemical containment systems • Proper application, use, and monitoring of levels over time of biosludge and inorganic fertilizer • Protect surface water sources • Conservation buffers and application setbacks

United States Department of Agriculture

Natural Resources Conservation Service

WATER

Pollutants to Ground Water

Petroleum, Heavy Metals, Pollutants Transported to Ground Water

Petroleum, heavy metals, and other chemical pollutants for onfarm use are lost from areas of concentration (handling, storage, or processing facilities and areas) to receiving ground water in quantities that degrade water quality and limit its use for intended purposes. This resource concern does not cover pathogens/manure, sediment (although sediment contaminated with petroleum, heavy metals, or other chemical pollutants would be covered), nor naturally occurring salts.

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What can be done about it?

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Petroleum, Heavy Metals, Pollutants Transported to Ground Water at a Glance

Problems / Indicators—Storage and handling of petroleum; use of biosludge, contaminated animal manure, and inorganic fertilizers	
Typical Causes	Examples of Typical Solutions
• Inadequate storage and handling • Repeated application of biosludge or inorganic fertilizers over a long period of time • Unprotected ground water sources	• Proper storage and handling • Petroleum and chemical containment systems • Proper application, use, and monitoring of levels over time of biosludge and inorganic fertilizer • Protect ground water sources • Conservation buffers and application setbacks from sensitive areas

United States Department of Agriculture

Natural Resources Conservation Service

WATER

Salts to Surface Water

Salts Transported to Surface Water

Irrigation or rainfall runoff transports salts to receiving surface waters in quantities that degrade water quality and limit use for intended purposes.

What is it?

Salinity is a process by which water-soluble salts accumulate in the soil and water. Nearly all waters contain dissolved salts and trace elements, many of which result from the natural weathering of the earth's surface. In addition, drainage waters from irrigated lands and effluent from city sewage and industrial waste water can impact water quality. In most irrigation situations, the primary water quality concern is salinity levels since salts can affect both the soil structure and crop yield. Most salinity problems in agriculture result directly from the salts carried in irrigation water.

Why is it important?

Salinity increases the cost of treating water for drinking, reduces the availability of water for irrigation, and renders farmland useless, costing the economy millions each year. Salinity is an ecological factor, influencing the types of organisms that live in a body of water. It influences the kinds of plants that will grow either in a water body or on land fed by irrigation water. If water containing too much salt is applied during irrigation, salt tends to build up in the soil, reducing the amount of water available to plants. Salts in the soil increase the efforts by plant roots to take in water and can make water unavailable to plants at higher salt levels. Few plants grow well on saline soils, often restricting options for cropping in a given land area.

What can be done about it?

Salinity as a water quality issue is addressed through soil management activities. Reducing the severity and extent of salinity is accomplished primarily with recharge and discharge water management. Recharge management is used on areas that contribute excess water to the soil and includes decreasing infiltration of excess saline water and irrigation to maintain salts at a level below the root zone. Discharge management is used on areas where excess water comes to the soil surface and includes growing salt tolerant crops, reducing deep tillage, and eliminating seepage.

Salts Transported to Surface Water at a Glance

Problems / Indicators—White crusting of soil, irregular crop growth, and lack of plant vigor	
Typical Causes	Examples of Typical Solutions
• Naturally occurring in soils with concentrations of soluble salts, such as sulfates of sodium, calcium, and magnesium in the soil • Inadequate drainage to leach salt from the soil • Upward migration of salt from shallow ground water • Application of saline water	• Proper use of irrigation water • Salt-tolerant crops • Remove excess water from recharge areas • Maintain water table at a safe levels • Cropping and tillage systems that promote adequate infiltration and permeability • Reduce deep tillage

USDA United States Department of Agriculture
Natural Resources Conservation Service

WATER
Salts to Ground Water

Salts Transported to Ground Water

Irrigation or rainfall infiltration transports salts to ground water in quantities that degrade water quality and limit use for intended purposes.

What is it?

Salinity is a process by which water-soluble salts accumulate in the soil and water. Nearly all waters contain dissolved salts and trace elements, many of which result from the natural weathering of the earth's surface. In addition, drainage waters from irrigated lands and effluent from city sewage and industrial waste water can impact water quality. In most irrigation situations, the primary water quality concern is salinity levels since salts can affect both the soil structure and crop yield. Most salinity problems in agriculture result directly from the salts carried in irrigation water.

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Salts Transported to Ground Water at a Glance

Problems / Indicators—White crusting of soil, irregular crop growth, and lack of plant vigor	
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WATER

Sediment to Surface Water

Sediment Transported to Surface Water

Offsite transport of sediment to surface water degrades water quality and limits use for intended purposes.

What is it?

Wind or water erosion is the physical and chemical wearing of the earth's surface and is a natural ecosystem process. Problems arise when excess fine sediment enters surface water at rates and volumes greater than under natural conditions, resulting in turbidity and sedimentation. Typically, erosion related to human activities generates excessive sediment and should be controlled to acceptable levels.

Why is it important?

Sediment can have a significant impact on water quality and aquatic habitat. Not only does sediment carry nutrients and pesticides that can negatively impact water quality, but the physical characteristics of sediment can clog stream channels, silt in and reduce storage capacity of reservoirs, cover fish spawning grounds, and reduce downstream water quality. Sediment makes the water more turbid and restricts light penetration into the water, which impacts the ability of aquatic plants to perform photosynthesis. Suspended sediments can clog the gills of aquatic organisms and cause death. Sediment buildup on the stream bottom can lead to the suffocation of fish eggs and macroinvertebrates and impact natural spawning. Additionally, with an increased amount of particles in the water, dissolved oxygen levels may be reduced due to elevated water temperatures. Excessive sediment also impacts coastal area water quality as it can smother and kill coral tissue and reduces light levels and food supplied to the coral by symbiotic algae.

What can be done about it?

The issue of excessive sediments for water quality is managed by addressing the source and/or transport of soil. Controlling the source of soil erosion involves maintaining a protective cover on the soil and modifying the landscape to control runoff amounts and rates. Specific practices include growing perennial crops in rotation or as permanent cover, growing cover crops, managing crop residue, shortening the length and steepness of slopes, and increasing water infiltration rates. Controlling the transport of soil into water bodies involves buffers and edge of field treatments. Specific practices include grassed waterways, field borders, filter strips, and riparian forest/herbaceous buffers.

Sediment Transported to Surface Water at a Glance

Problems / Indicators—Cloudy or muddy water, stream/water body soil deposition	
Typical Causes	**Examples of Typical Solutions**
• Bare or unprotected soil • Long and steep slopes • Intense rainfall or irrigation events when residue cover is at a minimum • Decreased infiltration by compaction	• Residue management • Crop rotations with high biomass crops • Cover crops • Strip cropping • Terraces • Grassed waterways and grade stabilization structures • Buffers and filter strips to address the transport of sediment • Windbreaks • Streambank and shoreline protection

WATER

Elevated Water Temperature

Elevated Water Temperature

Surface water temperatures exceed State/Federal standards in downstream receiving waters which limits its use for intended purposes.

What is it?

Temperature has an important influence on water chemistry and aquatic organism habitat. As water temperature rises, there is a corresponding decrease in the availability of oxygen, carbon dioxide, and other gases important to aquatic life. Elevated water temperature also results in increases of dissolved minerals that can further degrade water quality. In some areas, State and/or Federal law regulate the temperature of surface water.

Why is it important?

Water temperature has extremely important ecological consequences. The metabolic rate of organisms rises with increasing water temperatures, resulting in increased oxygen demand. This is coupled with the reduced amount of oxygen that is available as the water temperature increases. During extended periods of warming, water may lose its potential to support healthy populations of fish and other aquatic organisms and may even kill desired species or lead to a change in species diversity. Warm water also has the potential to increase the presence of dissolved toxic substances that may restrict the suitability of water for human use.

What can be done about it?

There is actually very little an individual landowner can do to cool surface waters. Most conservation actions designed to address water temperature issues reduce additions of heat energy. Heat can enter surface water through direct sunlight and by the air directly above the water. Reestablishing or protecting riparian vegetation is often the first step to address water temperature issues. While riparian vegetation does not cool the water, on small water bodies it can block much of the sun and keep the air in direct contact with the water surface cooler. Ground water inflow and outflow, precipitation, runoff, and evaporation are also responsible for heat energy exchange. Water entering a water body from below ground flows tends to be much cooler than the surface water. Actions that conserve or increase shallow ground water may increase the amount of cool water entering a water body. The sediment load of a water body also plays a role in water temperature. When the sediment load increases, water tends to spread out over a larger area. Shallow, wide channels provide more surface area for solar energy to enter the stream, potentially increasing water temperature. In addition, turbidity raises water temperature because the suspended particles absorb the sun's heat. Actions to reduce sediment reaching a water body will help reduce warming of surface water.

Elevated Water Temperature at a Glance

(continued)

Elevated Water Temperature (continued)

Elevated Water Temperature at a Glance

Problems / Indicators—Water temperature exceeds legal standard, threatens the health of aquatic organisms, or limits the intended use by the client	
Typical Causes	Examples of Typical Solutions
• Surface water unprotected from direct sunlight • Little or no ground water contribution to water body • Sediment laden runoff reaching water body	• Reestablish riparian vegetation • Brush management and residue management • Terraces and water and sediment control basins • Grassed waterways and grade stabilization structures • Buffers and filter strips • Streambank and shoreline protection

AIR

Airborne Reactive Nitrogen

Emissions of Airborne Reactive Nitrogen

Emissions of airborne reactive nitrogen—ammonia and oxides of nitrogen—can negatively impact atmospheric chemistry, cause unwanted fertilization via deposition in sensitive ecosystems, and degrade regional visibility.

What is it?

Airborne reactive nitrogen is a term used to describe many nitrogen-containing compounds that participate in various atmospheric chemical reactions and that also can move from the atmosphere to land and/or water, contributing to potentially unwanted ecosystem effects. For this resource concern, NRCS is primarily focused on emissions of ammonia and oxides of nitrogen (nitric oxide [NO] and nitrogen dioxide [NO_2], or collectively referred to as NOx). Ammonia is mainly emitted from fertilizer application and animal operations. Combustion (e.g., fires, engines, etc.) is the main source of agricultural NOx emissions, although some NOx can be emitted from soils and manure management.

Why is it important?

Airborne reactive nitrogen can deposit on land and water, causing potentially unwanted ecosystem effects like excess fertilization of sensitive ecosystems and eutrophication of water bodies. Agricultural emissions of airborne reactive nitrogen can also participate in various atmospheric chemical reactions that can contribute to regional visibility degradation and impact atmospheric chemistry.

What can be done about it?

Proper application of organic and inorganic nitrogen fertilizers via nutrient management can reduce nitrogen losses from cropping operations, pastures, and forests. Improving feed management of nitrogen inputs can result in less nitrogen excretion from livestock and thus less nitrogen emissions in manure management systems. Ensuring efficient combustion and following Basic Smoke Management Practices for all fire events can reduce the potential for nitrogen emissions from fires. Nitrogen emissions from combustion sources such as engines, heaters, etc. can be reduced by ensuring proper maintenance and operation, switching to lower-emitting fuels, or replacing the combustion sources with newer, less-emitting combustion sources or electrical power alternatives.

Emissions of Airborne Reactive Nitrogen at a Glance

Problems / Indicators—Fertilizer application, burning, engines, and animal operations	
Typical Causes	Examples of Typical Solutions
• Nitrogen application • Combustion (engines, burning) • Animal operations	• Apply nitrogen using the 4Rs • Smoke management, ensure good combustion for applied fires • Proper engine/combustion unit maintenance and operation • Engine/combustion unit replacement and retrofit • Feed management for nitrogen-based nutrients • Proper manure management

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Natural Resources Conservation Service

AIR
Greenhouse Gases

Emissions of Greenhouse Gases

Emissions of methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2) increase atmospheric concentrations of greenhouse gases.

What is it?

Direct and indirect emissions of greenhouse gases (GHGs—primarily CO_2, CH_4, N_2O for agriculture) cause increased concentrations of GHGs in the atmosphere and can cause resultant changes in climate. Greenhouse gases from activities such as nitrogen fertilization, tillage and agricultural soils management, manure management, and livestock enteric fermentation contribute to excess agricultural GHG emissions to the atmosphere. A portion of nitrogen fertilizer that is applied to crops and grasslands is volatilized through a complex microbial process (nitrification and denitrification) and emitted to the atmosphere as N_2O. Tillage and land use changes can decompose soil organic matter and release soil carbon, in the form of CO_2, to the atmosphere. CH_4 is produced as part of the normal digestive processes in animals and through the anaerobic (i.e., without oxygen) decomposition of manure.

Why is it important?

Greenhouse gases in the atmosphere absorb and emit infrared radiation resulting in the “greenhouse effect” and can cause changes in climate.

What can be done about it?

The efficient use of nitrogen fertilizer can reduce N_2O emissions. Reducing tillage increases the ability of the soil to store carbon in the form of organic matter, and planting trees and other biomass can provide long-term CO_2 sequestration opportunities. Maintaining perennial cover on undrained hydric and organic soils can also prevent soil carbon loss as CO_2. Proper feed management can help to reduce enteric emissions. Using proper manure management techniques, including switching to aerobic manure treatment systems, or covering and re-using produced biogas from anaerobic systems can reduce emissions of CH_4.

Emissions of Greenhouse Gases at a Glance

Problems / Indicators—Greenhouse gas emissions	
Typical Causes	**Examples of Typical Solutions**
• Nitrogen application • Conventional tillage • Loss of carbon stocks from soils and biomass • CH_4 production from animal operations	• Apply nitrogen using the 4Rs • Conservation tillage and reduced soil disturbance • Maintain undrained hydric and organic soils with perennial cover • Feed management to reduce enteric methane emissions • Proper manure management • Use covers in manure management systems to capture and even reuse produced biogas

United States Department of Agriculture

Natural Resources Conservation Service

AIR
Objectionable Odors

Objectionable Odors

Emissions of odorous compounds—volatile organic compounds (VOCs), ammonia, and odorous sulfur compounds—can cause nuisance conditions.

What is it?

Agricultural odors are a complex mixture of gases that can evoke a wide range of emotional and physiological responses when encountered via the sense of smell. Many different compounds can be the potential cause of odors from agricultural operations. These compounds can generally be classified as VOCs, ammonia, or odorous sulfur compounds. The three primary sources of odor are manure storage facilities, animal housing, and land application of manure. Other sources can include applications of pesticides and fertilizers.

Why is it important?

Odors are mainly a community or individual perception issue; although some odorous compounds can cause health problems when encountered in high concentrations. Greater emphasis on addressing odors is likely to occur in areas that have negative community and individual perceptions of odors, especially in areas with a strong rural/urban interface.

What can be done about it?

Many common practices and management activities can help reduce the likelihood of odor impacts from animal operations. Among them are using good feed management to reduce excess sulfur and nitrogen inputs to animal systems, air filtration devices on enclosed manure storages and animal housing, manure management techniques that minimize, recover, or control emitted gases, and maintaining an appropriate moisture content (~25–40%) in and on open lot surfaces. Windbreaks can be used to diffuse odor from animal confinement areas and areas subject to the application of manure, pesticides, and fertilizers.

Objectionable Odors at a Glance

Problems / Indicators—Manure storage facilities, animal housing, manure and land application	
Typical Causes	Examples of Typical Solutions
• Confined animal areas • Manure and fertilizer application • Pesticide application	• Feed management to reduce excess sulfur and nitrogen inputs to animal systems • Air filtration of enclosed manure storages and animal housing • Manure management techniques to minimize, recover, or control emitted gases • Moisture management to control dust and odors associated with livestock confinement areas • Proper nutrient management and application • Windbreaks

USDA United States Department of Agriculture
Natural Resources Conservation Service

AIR
Ozone Precursors

Emissions of Ozone Precursors

Emissions of ozone precursors—oxides of nitrogen (NOx) and volatile organic compounds (VOCs)—result in formation of ground-level ozone, which can have negative impacts to human, plant, and animal health.

What is it?

Agriculture can be a source of ozone precursor gases, oxides of nitrogen (nitric oxide [NO] and nitrogen dioxide [NO_2], or collectively referred to as NOx) and volatile organic compounds (VOCs), which chemically react in the atmosphere producing ground-level ozone. Ozone is not directly emitted into the atmosphere. It is formed in the atmosphere through chemical reactions of NOx and VOCs in the presence of sunlight. Biological organisms emit VOCs naturally. There are many natural sources of VOCs—vegetation is the largest global source of VOCs—but NOx is more typically the result of combustion, including engines and fire. VOCs can also be emitted during pesticide application and from confinement-based animal production.

Why is it important?

Although ozone in the upper atmosphere forms a layer that provides protection from ultraviolet radiation, ozone in the lower atmosphere and at ground level can be harmful and cause negative impacts to human, plant, and animal health. Since ozone is an allotrope of oxygen, its similar structure allows it to displace oxygen in the lungs, causing respiratory issues in humans and other animals. Ozone is also an eye irritant causing red, itchy eyes. Plants are also affected by ozone. During the gas exchange process, ozone enters the leaves, causing chlorosis and necrosis. This reduces the plant's photosynthetic ability and can result in yield reductions.

What can be done about it?

Ensuring efficient combustion and following Basic Smoke Management Practices for all fire events can reduce the potential for nitrogen emissions from fires. Nitrogen emissions from combustion sources such as engines, heaters, etc. can be reduced by ensuring proper maintenance and operation, switching to lower-emitting fuels, or replacing the combustion sources with newer, less-emitting combustion sources or electrical power alternatives. Using integrated pest management to decrease the use of chemical pesticides can decrease VOC emissions. Proper manure management techniques, feed management, and utilizing air filtration devices on enclosed manure storages and animal housing can also reduce VOC emissions.

Emissions of Ozone Precursors at a Glance

Problems / Indicators—Engines, pesticides, burning, tillage, and animal operations	
Typical Causes	Examples of Typical Solutions
• Combustion (engines, burning) • Animal operations • Pesticide application	• Smoke management, ensure good combustion for applied fires • Proper engine/combustion unit maintenance and operation • Engine/combustion unit replacement and retrofit • Integrated pest management • Feed and manure management • Comprehensive nutrient management planning • Air filtration on enclosed manure storages and animal housing

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AIR
Particulate Matter

Emissions of Particulate Matter and Particulate Matter Precursors

Direct emissions of particulate matter (PM)—dust and smoke—as well as the formation of fine particulate matter in the atmosphere from other agricultural emissions—ammonia, oxides of nitrogen (NOx), and volatile organic compounds (VOCs)—can cause multiple negative environmental impacts.

What is it?

PM in the atmosphere is a mixture of solid particles and liquid droplets, many of which are not visible to the human eye. PM can be directly-emitted or formed by chemical or physical processes in the atmosphere. For this resource concern, NRCS is primarily focused on direct emissions of PM (e.g., dust, smoke, etc.) or precursor emissions that form PM in the atmosphere, including ammonia, oxides of nitrogen (nitric oxide [NO] and nitrogen dioxide [NO_2], or collectively referred to as NOx), and VOCs. PM can be directly emitted by combustion (e.g., engines, fires, etc.), chemical pesticide drift, field operations (e.g., tillage, harvesting, etc.), unpaved roads, wind action, and animal activity. Precursor emissions can also be emitted from nitrogen fertilizer application and confinement-based animal production.

Why is it important?

PM in the atmosphere can cause human and animal health impacts and lead to local and regional visibility degradation. It can also impact ecosystems when it deposits out of the atmosphere. The body's natural defenses can filter out larger particles, but smaller particles can get past the nasal passageways getting into the lungs. PM can also create poor visibility which affects transportation (ex. dust or smoke) and federally protected scenic vistas. Deposition may adversely affect ecosystems by causing nuisance dusting, changing pH balance, damaging plants or by adding additional nitrogen to the environment.

What can be done about it?

Ensuring efficient combustion and following Basic Smoke Management Practices for all fire events can reduce the potential for nitrogen emissions from fires. Nitrogen emissions from combustion sources such as engines, heaters, etc. can be reduced by ensuring proper maintenance and operation, switching to lower-emitting fuels, or replacing the combustion sources with newer, less-emitting combustion sources or electrical power alternatives. Preventing chemical drift via windbreaks or integrated pest management techniques can reduce PM from drift. Proper application of organic and inorganic nitrogen fertilizers via nutrient management can reduce ammonia losses. Reducing vehicular traffic or treating unpaved roads with a suppressant can reduce dust. Utilizing conservation tillage, ensuring vegetative cover, and reducing soil disturbance activities can also reduce PM emissions from field operations. Good feed management techniques, frequent harvesting of excess manure in open lot systems, utilizing sprinkler systems to maintain proper moisture management, and utilizing air filtration on enclosed manure storages and animal housing can reduce dust and ammonia emissions from animal operations. Windbreaks can intercept airborne PM and modify the wind patterns such that PM entrainment and transport are reduced.

Emissions of Particulate Matter and Particulate Matter Precursors at a Glance

(continued)

Particulate Matter (continued)

Air

Emissions of Particulate Matter and Particulate Matter Precursors at a Glance

Problems / Indicators—Dust, smoke, chemical and fertilizer use, animal activities	
Typical Causes	**Examples of Typical Solutions**
• Combustion (engines, burning) • Chemical pesticide drift • Nitrogen application • Field operations (tillage, harvesting, etc.) • Unpaved roads • Windblown dust • Confinement-based animal operations	• Smoke management, ensure good combustion for applied fires • Proper engine/combustion unit maintenance and operation • Engine/combustion unit replacement and retrofit • Windbreaks or other wind barriers • Reduce travel/speed and treat unpaved roads • Residue management, conservation tillage, maintaining vegetative cover • Open lot manure harvesting and sprinkler systems • Air filtration on enclosed manure storages and animal housing

USDA United States Department of Agriculture
Natural Resources Conservation Service

PLANTS
Plant Pest Pressure

Plants

- Plant Pest Pressure
- Productivity and Health
- Structure and Composition
- Wildfire Hazard from Biomass Accumulation

Plant Pest Pressure

Excessive damage to plant communities from pests such as undesired plants, insects, diseases, animals, soil borne pathogens, and nematodes. This concern addresses invasive plant, animal and insect species.

What is it?

Plants provide food for many forms of life. Human beings and grazing animals depend on plants for food. Large numbers of other much smaller creatures, such as insects and their larvae, also feed on plants. Other plants, insects, fungi, bacteria, and viruses use plants as a host during part of their life cycle. Generally, these interactions are symbiotic, predictable, and benign. However, we apply the term "pest" to any animal, insect, bacteria, or virus when any of these interactions become unbalanced and unacceptable plant damage occurs. Pests can also take the form of any organism that competes for space, nutrients, or water (e.g., weeds). Heat, drought, wind, sun, and cold create stress on plants that make them more susceptible to pests. Pests can vary from place to place, crop to crop, year to year.

Why is it important?

For plants to produce a desired yield, preferred products, or favored environmental outcomes, plant communities must be protected from undesirable pests such as weeds, insects, fungi, bacteria, viruses and animals.

What can be done about it?

Management, monitoring, and record-keeping can help stifle damage from plant pests within tolerable limits. Integrated pest management is an effective and environmentally sensitive approach to pest management that relies on a combination of common treatments. Set Thresholds: Before taking any pest control action, set a point at which pest populations or environmental conditions indicate that pest control action must be taken. Monitor and Identify Pests: Not all insects, weeds, and other living organisms require control. For grazing lands, weeds or invasive plants outcompete the desired crop or desired plant community when plants are weak and not thriving, or they are overused. Identify pests accurately so appropriate control decisions can be made in conjunction with action thresholds. Prevention: The first line of pest control is to manage and prevent pests from becoming a threat. Rotate crops and select pest-resistant varieties. Rotate forms and mode of action in pesticides to prevent and alleviate pesticide resistance. On grazing lands, maintain native plant communities or desired plants with adequate cover to protect sites from plant pest establishment. Control: If pest control is required, evaluate control methods for effectiveness and risk. Use low-risk pest controls first, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring indicates controls are not working, additional pest control methods such as targeted spraying of pesticides/herbicides should be used. Use the application of non-selective pesticides as a final method when thresholds and conditions warrant their use.

Plant Pest Pressure at a Glance

(continued)

Plant Pest Pressure (continued)

Plant Pest Pressure at a Glance

Problems / Indicators—Animal, insect, and/or disease damage, or competition from common weeds or invasive plants substantially reduces yield, growth, or desired plant community composition or structure	
Typical Causes	Examples of Typical Solutions
• Plants suffer from attacks by pests or disease • Weeds or invasive plants outcompete desired crop or desired plant community • Plants are weak or not thriving	• Use integrated pest management to employ early detection, avoidance, and treatment of pests • Consider brush management, vegetative weed control, mulching, or prescribed grazing or burning • Use plants adapted to climate and soils • Use of local, source-identified seed of native species when available

PLANTS

Plant Productivity and Health

Plant Productivity and Health

Improper fertility, management, or plants not adapted to site negatively impact plant productivity, vigor, and/or quality.

What is it?

Plants established in locations where the climate, soils, or moisture availability are unfavorable can be stressed and may not thrive even with excellent management. Natural events such as drought or cultural practices such as grazing and mowing can cause plant stress. Improper management (e.g., exorbitant plant populations)are a stressor that can affect plant productivity and health. Plants under stress are more susceptible to disease and insect damage. Symptoms of poor plant vigor and health may include slow growth, discoloration of leaves, wilting or drooping foliage, leaf drop, root pruning, changes in growth form and discolored roots, and even plant death.

Why is it important?

To meet productivity and conservation goals, it is important that plants are adapted to the site on which they are growing, established in proper populations, provided with enough nutrients, water, and sunshine, and protected from excessive levels of stress.

What can be done about it?

Using conservation practices can help establish and maintain plant productivity and health. Assistance from a crop specialist, grazing land specialist, forester, or biologist may be needed to set realistic production and conservation goals that consider species suitability, soils, climate, management options, and local data for similar cropping/forestry systems. The NRCS Web Soil Survey (http://websoilsurvey.nrcs.usda.gov) is a source of soils information for the growth of crops and trees. Extension programs and educators from local universities are resources for cultural and management practices that keep plants healthy and productive. Nutrient management guides the rate, source, timing, and placement of nutrients as needed to meet production and health goals. Integrated pest management provides techniques to detect, avoid, and treat pests and diseases. Forestry conservation practices can remove and replace unhealthy trees and treat woody debris to reduce risks from insects and diseases. Conservation practices in cropping systems address soil problems such as erosion, compaction, low organic matter, or contaminants through the use of cover crops, new crop rotations, or changes in tillage and/or harvesting methods. Conservation practices in grazing systems can assist in alleviating stressors such as plant vigor and reduced production yields by increasing grazing distribution, managing forage stubble heights, and providing adequate rest periods during seasonal growth variations.

Plant Productivity and Health at a Glance

(continued)

Plant Productivity and Health (continued)

Plant Productivity and Health at a Glance

Problems / Indicators—Yield or growth is substantially less than expected, plants are disease and/or pest-ridden, plants fail to thrive	
Typical Causes	**Examples of Typical Solutions**
• Plants receive inadequate nutrition during critical growth periods • Plants fail to thrive due to poor soil conditions • Plants wilt, freeze or rot even during normal climate conditions • Plants not adapted to site • Plants are grazed or harvested below adequate stubble heights for adequate energy reserves • Plant community not resistant or resilient to natural or cultural stressors • Plant community management using inappropriate methods, timing, extent, duration, or frequency	• Use nutrient management to address the form, rate, placement, and timing of nutrient application • Consider crop rotations, deep rooted cover crops, drainage, and deep tillage • Consider alternate crops/trees or different plant varieties • Manage grazing periods to alter timing frequency, duration during seasonal growth variations • Manage harvest heights and timing to increase plant vigor and production yields • Improve plant community diversity and structure to restore and maintain plant community health and productivity • Use site-suited, genetically appropriate plant materials • Implement management practices to achieve desired plant community composition, structure, and productivity to maintain ecosystem health • Use appropriate timing, duration, and extent, and frequency of management practices to achieve desired productivity and health outcomes

PLANTS
Structure and Composition

Plant Structure and Composition

Plant communities have insufficient composition and structure to achieve ecological functions and management objectives. This resource concern includes degradation of wetland habitat, targeted ecosystems, or unique plant communities.

What is it?

Degraded plant composition occurs when there is a lack of diversity of plant species within a geographic area or an imbalance in the relative abundance of plant species or their interactions with other organisms (e.g., bacteria, fungi, pollinators, animals, etc.). Degraded structure refers to plant density, distribution patterns, or height and layering that is not suited to providing the desired conservation benefits and products.

Why is it important?

Achieving conservation and production goals requires effective management within the structure and composition of plant communities and their changes over time. The interactions among plants, other organisms, and environmental factors such as soil, climate, and topography influence how a plant community functions to cycle water and nutrients, protect and build soil, nurture wildlife, and produce usable products.

What can be done about it?

Conservation practices used to correct problems with structure and composition vary depending on conservation goals, the plant community desired, as well as site conditions and projected future environmental change. Activities that adjust structure and composition include removing undesirable plants and establishing native or adapted species according to a site plan that addresses spacing, distribution patterns, and vertical canopy layering. Practices such as grazing, mowing, pruning, fertilization, and burning can encourage or suppress certain species to help meet the desired structure and composition. Additionally, planting woody and/or herbaceous species can be effective in meeting conservation goals for the desired plant structure and composition.

Plant Structure and Composition at a Glance

Problems / Indicators—Inadequate structure and composition	
Typical Causes	Examples of Typical Solutions
• Pests, disease, fire exclusion, wildfire, and/or mismanagement reduces or eliminates key components of the plant community • Invasive species outcompete desired plants • Loss of or change in natural disturbance regimes (e.g., fire, wind, flooding, weather patterns)	• Employ or modify use of cultural practices (e.g., grazing, burning, mowing, pruning) • Treat or remove vegetation to reestablish desired habitat • Control invasive species and use integrated pest management techniques to maintain the plant community • Reestablish desired plant community

United States Department of Agriculture
Natural Resources Conservation Service

PLANTS
Wildfire Hazard

Plants

Wildfire Hazard from Biomass Accumulation

The kinds and amounts of plant biomass create wildfire hazards that pose risks to human safety, structures, plants, animals, and air resources.

What is it?

All plants produce litter from leaves, stalks, or stems. When the rate of utilization and/or decomposition is slower than the rate of biomass production, residues can accumulate to the point of becoming a fire hazard.

Why is it important?

Fire can be an important and often beneficial part of the natural ecosystem; however, uncontrolled or “wild” fire can pose threats to life, health, and property. Excessive fuel loads can result in a fire too intense, causing damage to the desired plant community and site conditions. In addition, the secondary effects of some wildfires, including erosion, landslides, introduction of invasive species, and changes in water quality, are often more disastrous than the fire itself.

What can be done about it?

The amount of flammable biomass can be reduced to decrease the incidence of wildfires. The distribution of biomass can be manipulated to influence the direction and rate at which wildfires spread. Managing ladder fuels can reduce the opportunity for crown fires. Management of wildland urban interface (WUI) areas can protect life and property to lessen the impacts of wildfires.

Wildfire Hazard from Biomass Accumulation at a Glance

Problems / Indicators—Excess biomass, biomass distribution, lack of preparedness	
Typical Causes	Examples of Typical Solutions

• Overstocked forest increases the risk of fire outbreak
• Continuous fuels increases the risk of the spread of fire
• Abundance of ladder fuels increase fire intensity and potential rate of spread
• Lack of planning on how to respond to fire increases risk to life and property
• Excessive fuel loads that may pose a significant risk to the desired plant community composition and structure if inappropriate burn prescriptions are planned
	• Thin excess trees and brush
	• Reduce ladder fuels
	• Treat or remove vegetation, debris, and detritus
	• Implement management in wildland urban interface (WUI) areas
	• Create and implement a wildfire plan:
	  ◦ Post fire control agency phone numbers
	  ◦ Locate and map water sources
	  ◦ Map out evacuation routes
	  ◦ Equip vehicles with fire fighting tools
	• Adapt and finely hone burn prescriptions to address excessive fuel loads that may negatively impact desired plant conditions during a burn

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ANIMALS

Aquatic Habitat

Aquatic Habitat for Fish and Other Organisms

Habitat requirements of identified fish and other organisms are inadequate.

What is it?

Because of deficient habitat, aquatic organisms may lack water that is sufficient in quality and extent to meet target species or guild habitat requirements. Aquatic habitat includes the food, water (quality and quantity), cover, and connectivity required by identified fish and other aquatic organisms to complete all or parts of their life cycle.

Why is it important?

The greatest threat to fish and other organisms is the destruction or modification of their habitat. Reduced instream or riparian habitat complexity, poor water quality or quantity, or lack of access can be deficient for aquatic dependent species. Quality aquatic habitat includes multiple habitat features within and adjacent to the water body; water in enough quantity and quality to sustain native organisms; and access to upstream and downstream habitats. Conserving existing habitat and restoring degraded habitat improves the odds that fish and associated communities will thrive.

What can be done about it?

Creating new habitat or restoring degraded habitat are ways that landowners can address habitat limitations on their property. Landowners and producers can implement an array of NRCS conservation practices proven to be beneficial to aquatic organisms.

Aquatic Habitat for Fish and Other Organisms at a Glance

Problems / Indicators—Loss of habitat to support desired wildlife species	
Typical Causes	Examples of Typical Solutions
• Lack of structure and cover for aquatic organisms • Insufficient water quantity or quality • Barriers to movement • Duration, timing, and connectivity with floodplain and off-channel habitats • Lack of instream complexity (pools, riffles, detritus, wood, etc.) • Water temperature	• Restore and enhance water bodies, instream and floodplain wood placement, reestablish native species • Maintain or expand herbaceous or tree and shrub buffers and ephemeral water bodies • Replace culverts to remove restrictions to movement of aquatic species • Restore wetlands • Restore instream and floodplain connectivity • Restore instream complexity, such as for sinuosity, pools, riffles, the channel, and bank stability • Restore water quality

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ANIMALS

Terrestrial Habitat

Terrestrial Habitat for Wildlife and Invertebrates

Quantity, quality or connectivity of food, cover, space, shelter, and/or water is inadequate to meet requirements of identified terrestrial wildlife or invertebrate species.

What is it?

Upland and wetland dependent organisms lack adequate habitat. Wildlife habitat includes the food, water, cover, and space required by identified terrestrial wildlife or invertebrate species to complete all or parts of their life cycle. Examples include locating a mate, obtaining sufficient water, or finding areas to rest.

Why is it important?

Perhaps the greatest threat to wildlife is habitat loss through lack of management, invasive plants, and habitat conversion or destruction. Upland and wetland habitat dependent organisms that lack adequate tree, shrub, or herbaceous plant cover necessary for mating and nesting, or shelter and cover for nesting, feeding, and resting will not thrive. Maintaining or increasing habitat is critical to sustain long-term population stability. Conserving, restoring, and connecting habitat improves the odds that wildlife communities will thrive.

What can be done about it?

Maintaining a sustainable population often requires the cooperation of multiple landowners. Individual landowners can address shortcomings on their property by establishing new habitat or enhancing existing habitat by installing wildlife structures such as nest boxes or brush piles. Systematic planting of appropriate tree, shrub, and herbaceous plants, and properly arranging and connecting habitat components across a landscape are important to ensure that each component benefits the target species of concern. Accomplishing this goal requires an understanding of the specific cover, mating, and nesting needs of the target wildlife or invertebrate species.

Terrestrial Habitat for Wildlife and Invertebrates at a Glance

Problems / Indicators—Loss of habitat to support desired wildlife species	
Typical Causes	**Examples of Typical Solutions**
• Insufficient shelter/cover • Insufficient food • Insufficient water quantity or quality • Fragmented habitat	• Add shelter features, such as nest boxes or platforms, brush piles, rock piles, and root wads • Leave portions of crop fields unharvested • Create or restore wetlands and ephemeral water features • Add herbaceous buffers and tree or shrub plantings, such as shelterbelts, hedgerows, windbreaks, and similar plant structures

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ANIMALS
Feed and Forage Imbalance

Feed and Forage Imbalance
Feed and forage quality or quantity is inadequate for nutritional needs and production goals of the kinds and classes of livestock.

What is it?
There is an imbalance between the number of animals using the forage and the quantity and quality of forage produced that is limiting the production of livestock. Livestock require five major classes of nutrients: energy (carbohydrates), protein, minerals, vitamins, and water. All five are essential for normal health and production. Next to water, the greatest requirement is for energy, followed by protein, and in smaller amounts minerals and vitamins. Without sufficient energy from feed or forage, utilization of other nutrients is impaired.

Why is it important?
Providing adequate feed and forage helps to ensure animal health and performance. To sustain the resource base, it is critical to balance the required livestock nutritional demands with the types of feed and forage and the number and class of animals in the operation. Stocking rates and timing must be adjusted, with supplemental forage and/or feed provided, as needed, for livestock grazing pasture or rangeland. Improving animal feed and forage availability can improve livestock productivity and income for the operation.

What can be done about it?
Applying the principles of forage growth and production for livestock requires an understanding of how plants interact with soil and climate, as well as understanding the nutritional needs of the animals. Prescribed Grazing is the management of grazing land to adjust intensity, frequency, timing, and duration to meet the desired objectives for the plant communities and the grazing and/or browsing animal. A proper system manages animal number, grazing distribution, and length of grazing periods to provide grazed plants proper recovery time for plant vigor and diversity. Feed and forage balance sheets along with forage growth curves can be used to make decisions about stocking rates and timing of grazing rotations based on plant growth and animal demands. Fencing and placement of livestock water can facilitate proper grazing distribution and forage management. Conservation practices, such as pasture and hayland planting and forage harvest management provide guidance to improve the forage base to support the prescribed grazing system.

Feed and Forage Imbalance at a Glance

Problems / Indicators—Feed and forage not adequate to support the livestock operation	
Typical Causes	**Examples of Typical Solutions**
• Insufficient forage and livestock feed • Overstocking of livestock • Inadequate distribution of livestock grazing • Poor feed quality • Weed, insect, or disease problems	• Prescribed grazing systems • Adequate water distribution • Production of high quality feed and forage • Forage analysis for nutrient quantity and quality

USDA United States Department of Agriculture
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ANIMALS
Inadequate Livestock Shelter

Inadequate Livestock Shelter

Livestock lack adequate shelter from climatic conditions to meet basic needs.

What is it?

Natural vegetation or landscape features are not adequate to provide shelter for livestock during periods of severe climatic circumstances.

Why is it important?

Livestock performance is reduced during periods of high heat with high humidity or extreme cold temperatures with precipitation. Providing adequate shelter to offset these climatic conditions is beneficial to animal performance and health. Without adequate shelter, livestock may seek shelter in low-lying areas, such as streams or forested areas. Sheltering in stream corridors may cause riparian area deterioration and/or water quality issues. Sheltering in forested areas may cause excessive erosion and/or water quality issues.

What can be done about it?

Shelters or windbreaks can be provided using natural vegetation or constructed structures to give animals adequate protection from harsh climatic conditions. When livestock shelter is constructed or planted with ample buffer distances from riparian areas or water bodies, and in locations not susceptible to runoff and erosion, environmental risks associated with livestock concentration areas are minimized. Further, use of portable structures that are periodically moved helps prevent areas of heavy use and increased erosion possibilities.

Inadequate Livestock Shelter at a Glance

Problems / Indicators—Vegetative, landscape, and/or structural options for livestock shelter do not exist; livestock are exposed to severe climatic conditions	
Typical Causes	Examples of Typical Solutions
• Exposure to extreme wind and cold in system that supports tree growth • Historical shelterbelt is partially functioning • Exposure to extreme wind, cold and heat in area where plant options are limited or temporary shelter is preferred	• Permanent windbreak establishment using native or naturally occurring plant materials • Renovate partially existing shelter belt • Permanent or portable livestock shelter structure

ANIMALS

Inadequate Livestock Water

Inadequate Livestock Water Quantity, Quality and Distribution

Quantity and quality of drinking water are insufficient to meet basic needs for the kind and class of livestock and improper distribution negatively impacts other resources.

What is it?

Water is an important but often overlooked nutrient for livestock. Water makes up over 98 percent of all molecules in the body and is necessary for regulation of body temperature, growth, reproduction, lactation, digestion, lubrication of joints, eyesight, and as a cleansing agent. Livestock water requirements are influenced by several factors, including rate of gain, pregnancy, lactation, activity, type of diet, feed intake, distance to acquire, and environmental temperature.

Why is it important?

Water quality for livestock consumption can be detrimental based on several parameters, such as nitrates, sulfates, salinity, bacteria, pH, pesticides, and total dissolved solids. Water quantity and distribution of suitable water sources can affect livestock based on the basic need to meet daily intake requirements and issues related to grazing patterns and travel distance to water that may result in surplus/deficient forage availability and excessive/insufficient plant utilization. These factors ultimately affect livestock performance and resource stability.

What can be done about it?

Water quality concerns, for both livestock health and the environment, can be addressed by limiting livestock access to ponds and water bodies or by installing watering facilities. Proper layout of water facilities provides an increased distribution of grazing across the landscape. This ultimately enhances forage production and utilization. When livestock graze or use areas that are remote from water sources, the water flow rate to the watering facility must be adequate for the herd requirement. Additionally, the size of the watering facility should be designed to store an adequate amount of water and avoid crowding. Evenly distributed watering facilities in a grazing system help circumvent forage utilization issues within the grazing system.

Inadequate Livestock Water at a Glance

Problems / Indicators—Lack of water, poor water quality, poor distribution can affect livestock health	
Typical Causes	Examples of Typical Solutions
• Water availability is limited • Water quality is compromised • Spring area trampled by livestock • Livestock in wetland, stream, or pond creating potential health concerns	• Inventory, evaluate, and plan watering system for livestock type • Use pipelines and watering facilities to increase water distribution across the grazing system • Establish select watering points and construct watering facilities to move livestock away from streams and ponds

United States Department of Agriculture

Natural Resources Conservation Service

ENERGY

Equipment and Facilities

Energy Efficiency of Equipment and Facilities

Stationary equipment and facilities are using energy inefficiently.

What is it?

Inefficient energy use occurs whenever equipment operates more than needed, is less efficient than currently available technology, poorly controlled, or improperly maintained. Unimproved facilities, such as agricultural buildings that are heated or cooled, contribute to inefficient energy use when not adequately sealed and insulated.

Why is it important?

Improving energy efficiency of agricultural operations contributes to the national goal of reducing reliance on fossil fuels and helps our nation to be energy independent. Conserving energy through improved energy efficiency on farms reduces energy costs while maintaining or increasing productivity, helping producers stay economically viable and competitive in the global marketplace.

What can be done about it?

Energy efficiency is improved when more energy efficient equipment is used or less energy efficient equipment is modified to operate more efficiently. NRCS staff can assess potential energy savings using NRCS Energy Estimators and other tools. NRCS staff may suggest practices to improve energy efficiency based on their analysis. NRCS staff may recommend an Agricultural Energy Management Plan (AgEMP) for more complex farming operations. Skilled energy analysts evaluate facilities, equipment, and operations in more detail to develop an AgEMP. These analysts can evaluate practices where energy conservation benefits are more dependent on site-specific conditions. Whether the result of the NRCS analysis or an AgEMP, most producers will discover options to implement at least a few cost-effective practices to improve energy efficiency, reduce energy use and costs, and maintain productivity.

Energy Efficiency of Equipment and Facilities at a Glance

Problems / Indicators—High energy costs	
Typical Causes	**Examples of Typical Solutions**
• Unvented, propane-fired heated systems • Throttling valves to control water flow • Using incandescent or T12 lights • Heat loss from building • Inefficient pumps	• Convert to a more energy efficient heat source such as radiant heating • Convert to variable displacement pump • Replace with LED or T8 lighting • Install air barrier system and insulation • Replace with high efficiency pumps

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ENERGY

Practices and Field Operations

Energy

Energy Efficiency of Equipment and Facilities

Energy Efficiency of Farming/Ranching Practices and Field Operations

Energy Efficiency of Farming/Ranching Practices and Field Operations

Mobile onfarm, ranching, forestry, or field operations are using energy inefficiently.

What is it?

Inefficient energy use occurs whenever machinery operates more than needed. Inefficient energy use also occurs when field operations are poorly controlled such as excessive number and inefficiency of passes by field equipment, and excessive field inputs are required.

Why is it important?

Improving energy efficiency of agricultural operations contributes to the national goal of reducing reliance on fossil fuels and helps our nation to be energy independent. Conserving energy through improved energy efficiency on farms reduces energy costs while maintaining or increasing productivity, helping producers stay economically viable and competitive in the global marketplace.

What can be done about it?

Energy efficiency is improved by modifying field operations and by adopting practices that help reduce energy-intensive inputs, such as soil amendments, fertilizers, or pesticides. NRCS staff can assess potential energy savings associated with changes in tillage, cultivation, and fertilizer use by using the NRCS Energy Estimator. This assessment helps identify steps to take to reduce field operations or improve efficiency. To reduce inputs, adopt a Pest Management System to reduce pesticide and fuel use and lower environmental risk. To reduce the use of fossil fuel-based commercial fertilizers, substitute manure for fertilizers, or use nitrogen-fixing legumes as cover crops or in crop rotations. Although tractor operations may increase, the overall energy use may be reduced.

Energy Efficiency of Practices and Field Operations at a Glance

Problems / Indicators—High energy costs	
Typical Causes	**Examples of Typical Solutions**
• Unnecessary trips across the field • Application of commercial fertilizer • Excessive insecticides	• Convert to minimum or no-till • Plant nitrogen-fixing legumes • Implement a Pest Management System

United States Department of Agriculture

Natural Resources Conservation Service

HUMAN Considerations

Soil

Water

Air

Plants

Animals

Energy

Human

Human Considerations

Human considerations include the potential social, economic, and cultural resource and historic property factors that are considered in the conservation planning process.

What is it?

Natural resources are defined by NRCS to include soil, water, air, plants, animals, human, and energy considerations (SWAPAE+H). Human considerations refer to the social and economic considerations that are addressed in the planning process. Cultural resources and historic properties are included in this concept. Human considerations are considered early in the planning process and guide the planner in providing the information the client needs to make informed decisions.

Why is it important?

Economic and social issues are important in formulating resource management systems that work for the participant. There are a host of personal, social, cultural, and economic barriers that serve as deterrents to underserved customers coming forward to request technical assistance for conservation planning and implementation.

What can be done about it?

Completing an initial determination of the client's problems, opportunities, and concerns related to natural resources and human considerations and identify the planning area are a good start. The challenge in conservation planning is to balance the short-term demands for production of goods and services with long-term sustainability of a quality environment. Exceptional conservation outcomes can result from the combined knowledge, experience, and expertise of the client and conservation planner working together with available resources.

Human Considerations at a Glance

Challenge—Conservation path forward that addresses the identified resource concerns and works well for the client	
Typical Causes	Examples of Typical Solutions
• Resource concerns impacting the farm or ranch operation and the environment • Pressures from development and landuse changes	• Conservation plans and easements • Listen to the client and present the evaluations in a manner easily understood by the stakeholders • A description of the resource setting • A description of the management system • A complete list of the type, amount, and timing of actions involved in the management system that may change as a result of the plan • Effects of the actions on the resources and human considerations