NATURAL RESOURCES CONSERVATION SERVICE

SOIL SALINITY MANAGEMENT –NONIRRIGATED (ACRE)

CODE 571

MONTANA CONSERVATION PRACTICE SPECIFICATION / JOB SHEET

COOPERATOR: ______________________________ TRACT(S): ______________

FIELD(S): ______________________________ DATE: ______________

DEFINITION: Management of land, water, and plants to control excess sub-surface soil water and minimize accumulations of salts on the soil and in the root zone of nonirrigated saline seep areas.

PURPOSE: As part of a resource management system soil salinity management is an essential practice for all nonirrigated land, where crops or forages are planted, to promote desired plant growth.

RESOURCE MANAGEMENT SYSTEM: Soil Salinity management is established as part of a resource management system to address the soil, water, air, plant, animal, and human needs as related to the owner's goals and objectives. It is important to consider crop rotation, nutrient and pest management, and other supportive conservation practices when designing a nonirrigated soil salinity management system.

BACKGROUND: Salinity is the concentration of dissolved mineral salts present in waters and soils. The major solutes comprising dissolved mineral salts are the cations Na, Mg, Ca, and K and the anions SO_4, HCO_3, CO_3, NO_3, and Cl. Other constituents that may contribute toward salinity in waters include Se, As, Fe, Mn, B, F, Al, Ba, Mo, Cd, Sr, Li, and Sio_2. The original, and to some extent, the direct source of all the salt constituents are the primary minerals found in soils and in the exposed rocks of the earth's crust.

Although weathering of primary minerals is the indirect source of nearly all soluble salts, there are probably few instances where sufficient salts have accumulated in place from this source alone to form a saline soil. Saline soils usually occur in areas that receive salts from other locations and water is the primary carrier.

Management techniques, which allow excess soil moisture to migrate beneath the rooting zone, create a saline shallow ground water flow system that moves down gradient to the discharge area to form a saline seep. The most common land use creating saline seeps is a cropping system that involves summer fallow.

Salt-affected sites are somewhat unique in that they have variations in levels of salinity, different kinds of salts, differences in climatic patterns, and varying soil materials. Salt-affected soils have been internationally classified into general categories. Salt-affected soils of primary concern in Montana, along with their descriptive parameters, are listed below:

a) Saline Soils	b) Saline-Sodic Soils
EC >4 mmhos/cm at 25^{o}C	EC >4 mmhos/cm at 25^{o}C
SAR 0-12	SAR >12
pH <8.5	pH usually <8.5
ESP < 15	ESP>15

Saline soils are commonly flocculated due to the presence of excess salts and the absence of significant amounts of exchangeable sodium. As a consequence infiltration rates and permeability are equal to or higher than that of similar non-saline soils.

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Saline-sodic soils are similar in appearance to the saline soils as long as excess salts are present. However, if leaching has occurred or been utilized, most of the excess soluble salts may be removed causing soil particles to disperse. The soil then becomes unfavorable for infiltration and the internal movement of water. The soil will also become difficult to till.

Restricted drainage is a factor that can contribute to the salinization of soils and may involve the presence of a high ground water table or low permeability of the soil. Due to the low precipitation in arid regions, surface drainageways may be poorly developed. As a consequence, there are drainage basins that may have no outlet to permanent streams. Under such conditions upward movement of saline groundwater or evaporation of surface water results in the formation of saline soil. The extent of saline areas thus formed may vary from a few acres to hundreds of square miles.

Low permeability of the soil causes poor drainage by impeding the downward movement of water. Low permeability may be the result of an unfavorable soil texture or structure or the presence of indurate layers (claypans, caliche layer, or silica hardpans).

Step 1. DETECTION OF SALINE SEEP

Early detection and diagnosis of a problem area are important in designing and implementing control and reclamation practices to prevent further damage.

Some visible symptoms of salt-affected soils are:

1. Identifiable when comparing historic aerial photos with recent aerial photos.

2. Certain weeds and native plants are commonly found on salt-affected soils and are indicators of saline soil areas. See TABLE 1, Native Plants and Introduced Weeds Found on Salt-Affected Areas. Kochia can be an indicator plant on cultivated land. Kochia growing vigorously after grain harvest, in small areas where normally the soil would be too dry to support weed growth, is an indicator. Examine these areas to see if the subsoil is wet.

3. Scattered salt crystals on a dry soil surface.

4. Prolonged soil surface wetness in small areas following a substantial rain. There will normally be uneven surface drying following a rain, but if a local area remains wet two to four days longer than the rest of the field, it may indicate a shallow water table. A soil moisture probe may show that the soil is unusually wet or that there is free water present.

5. Tractor wheel slippage or tractor bog-down in certain areas. Water often seeps into the wheel tracks and remains for a period of time. Salt crystals form on soil surface as the discharge area dries.

6. Excessive small grain vegetative growth accompanied by lodging in localized areas that produced normal growth in previous years. Reports may include crop yields that are unusually high. Such areas may be subirrigated by a rising water table, but the salt content is not yet high enough to reduce growth. These wet areas may become salinized and often expand quickly.

7. Foxtail barley infestations that increase with time may be another indicator. In a normally developed seep, the sequence of vegetation going from the center to the perimeter is bare soil, foxtail barley, and kochia. After several years, the kochia may move inside the foxtail barley area.

TABLE 1. Native Plants and Introduced Weeds Commonly Found on Salt-Affected Areas

COMMON NAME	LEVEL OF SALINIZATION
curly dock poverty weed kochia plains bluegrass	MODERATE
alkali cordgrass slender wheatgrass spear saltbush alkali bluegrass alkali sacaton foxtail barley	HIGH
greasewood Inland saltgrass Nuttall's alkaligrass shore arrowgrass red grasswort seepweed	VERY HIGH

8. Trees stunted or dying in a shelterbelt or windbreak. Leaves often turn light green or yellow.

9. Sloughed hillside, covered by native vegetation, adjacent to a cultivated field.

10. Other symptoms, including poor seed germination and abnormally mellow, dark- colored surface soil on lower slopes. The dark color would be caused by dispersed lignite or organic matter mixed with surface soil.

Step 2. IDENTIFY THE RECHARGE AREA

After the seep has been identified, the next step is to locate the recharge area. Most treatments for controlling the salt-affected area must be applied in the recharge area, which will normally be at a higher elevation than the discharge area. The recharge area must be accurately determined if treatment is to be successful. The recharge area may be located directly upslope or at an angle across the slope from the discharge area. Methods for determining the location and size of the recharge areas are only approximate. Following are some progressive steps of recharge area identification:

1. Soil Survey. Soil surveys may be used to locate gravelly or sandy soil area upslope from the salt-affected area. These areas usually serve as recharge areas and should be examined carefully. Areas of 0 to 2 percent slope and poorly drained areas (depressions and closed basins) may also be recharge sites.

2. USGS Ttopographic Maps and Aerial Photos. These may be useful in identifying and delineating land characteristics and overland water flow patterns.

3. Soil Probe. Recharge areas can often be located by probing the area upslope from the saline soil with a soil probe. Upslope areas with soil wet to more than 40 inches deep are potential recharge areas. Deeper probing to six feet or more provides further assessment of the extent of the recharge area. If the upslope area is uniformly wet to more than 40 inches, the probe procedure should not be used to detect recharge areas during that particular season. If a saline soil is surrounded by higher topography on several sides, the soil probe can be used to identify direction of recharge area from the saline soil.

For example, if the soil is abnormally wet in one direction, this indicates the potential recharge area.

4. Inductive Electromagnetic Soil Conductivity Method (EM 31 or EM 38). These instruments provide relative readings of electro-conductivity of a soil and must be calibrated to obtain accurate EC measurements.

5. Drilling (auger or core). Although not required, drilling monitor wells may be useful. Based on topographic maps, aerial photos and field observations, several holes are drilled in both the discharge and the suspected recharge areas. Wells are carefully logged noting depths too dense (clay and shale) and highly permeable (sand, gravel, and lignite) zones. Depth to free water should also be noted. These wells will identify the water transmission zone. Information from well logs, water table levels, and topography are used to delineate the recharge area. After monitoring wells are installed, monthly elevations should be obtained on all investigation wells to assist in determining movement and source of groundwater. This will also aid in the identification of the recharge area. Monitoring should be continued until the water table levels are determined and then seasonally throughout the life of the practice until the saline soil is reclaimed.

Step 3. CONTROLLING WATER IN THE RECHARGE AREA

1. Plant deep-rooted perennials such as alfalfa to dry the soil profile in the recharge area. Deep-rooted perennial forages should be seeded on a significant portion of the recharge area. Seeded area should include the acreage of highest water table elevation within the defined recharge area.

2. When a saline soil has been identified and establishing permanent vegetation is not an option, annual cropping will be used starting with the acreage of highest water table elevation.

3. Select plants from TABLES 2 and 3 that remove excess moisture from the recharge area. To establish vegetation, properly use planting dates and seedbed preparation procedures found in the FOTG, Section IV, 512–Pasture and Hayland Planting and Plant Materials Technical Note No. 26.

4. After the groundwater has been removed from the recharge area, an intensive cropping system must be applied to prevent the buildup of new water. See "Flex Cropping" in the FOTG, Section IV, 328–Conservation Cropping Sequence. Crops should be grown in sequential order with increasing rooting depths, until the depth and amount of soil water removed exceeds soil water recharge.

5. An appropriate soil fertility program must be implemented if flex cropping or annual cropping is utilized to ensure a successful crop and maximizing the crops rooting ability and moisture extraction. See FOTG, Section IV, 590–Nutrient Management.

6. Maintenance measures such as mowing, clipping, and removing excess vegetation must be completed to maintain vigorous growth for water use. In some cases, fertilization may be required to invigorate vegetative growth.

TABLE 2. **Relative Rooting Depth and Soil Water Depletion of Various Crops** [1/]

CROP	RELATIVE ROOTING DEPTH (FT.)	NET WATER DEPLETION (IN.)
Safflower	7	10
Sunflower	6	7
Oriental Mustard	5	7
Flax	5	7
Yellow Mustard	4	6
Turnip Rape	5	7
Brown Mustard	5	7
Argentine Rape	4	7
Winter Wheat	6	7
Barley	5	6
Spring Wheat	4	6*
Corn	4	4*
Sweet Clover		
1st year	6	11*
2nd year	9	16*
Peas	<4	<4*
Lentils	<4	<4*

[1/] Actual results will vary depending on soil characteristics, soil climatic conditions, and management.

* Designates soil water use (average annual water used by the plant) rather than net soil water depletion.

TABLE 3. **Relative Rooting Depth and Net Soil Water Depletion of Various Grasses and Forages** [1/]

CROP	RELATIVE ROOTING DEPTH (FT.)	NET SOIL WATER DEPLETION (IN.)
Alfalfa (average)	20	28
Altai wildrye	14	(HIGH)
Basin wildrye	18	26
Cicer milkvetch	15	23
Crested wheatgrass	13	16
Green needlegrass	15	23
Inter. wheatgrass	15	29
Pub. wheatgrass	15	22
Russian wildrye grass	10	19
Sainfoin	14	23
Slender wheatgrass	15	22
Tall Fescue	15	25
Tall wheatgrass	9	17
Western wheatgrass	11	20

[1/] Results will vary depending on soil characteristics, climatic conditions, and management.

Step 4. ESTABLISHING PLANTS IN SALINE SOILS

1. An Electrical Conductivity (EC) test must be made of the plow layer or top few inches of the soil. This information is used to determine what plant materials can be established in the saline soil. See TABLE 4.

2. Soil sampling should be completed to determine appropriate species to establish. When collecting soil, it is important to combine several samples from various parts of a field to get an average sample. For example, in a homogeneous or uniform field, ten samples taken from different locations should be adequate however, separate samples may be needed in distinct areas of concern. Depth of sampling is important. Saline soils should be sampled from 0–6 inches, 6–12 inches, and 12–24 inches. These three depth increments should be analyzed separately. Samples should be sent to qualified laboratories for analysis.

3. Before reclaiming a saline soil area, the depth of the water table must be low enough to prevent salts from moving up by capillary action into the rooting zone. A general rule of thumb is that if the depth of the water table in the saline soil exceeds 5 feet, reclamation procedures to remove salts from the root zone can proceed.

4. To control the buildup of salt on the soil surface, vegetation should be established in the saline area as soon as planting conditions allow.

5. Undesirable vegetation must be controlled, preferably by herbicide, prior to vegetative establishment. Mechanical seedbed preparation may be implemented if the site is not too wet. However, mechanical seedbed preparation may increase evaporation and salt accumulation.

6. Seed should be planted with a drill whenever possible. Wet soils may be planted by broadcasting after weed control has been successful. Wet sites may also be planted by drilling on frozen ground (frost seeding). Seeding rates should follow TABLE 5–Seeding Rates for Salinity Management.

7. Mixtures of multiple salt-tolerant species are not always cost-effective or even necessary. Some species, like tall wheatgrass and Russian wildrye, will out-compete others. The decision to use them should be based on long-term management of that area and the EC. A single dominant species should be mixed with 1-2 lb./ac each of slender wheatgrass and alfalfa. Otherwise, use the expected management and EC to choose adapted species from TABLE 4, with or without a mixture. Always include the alfalfa and slender wheatgrass at low rates.

8. If the water table is less than four feet below the soil surface, mow and remove all vegetation in the fall to prevent excess snow accumulation and rise of water table. If the water table is below four feet, vegetation can be left to catch snow. Resulting snowmelt will leach the salt downward through the soil, improving growing conditions.

TABLE 4. Relative Salt Tolerance of Herbaceous Crops

COMMON NAME CROPS	THRESHOLD mmhos/m
Barley	8
Corn	3
Oats	4
Safflower	6
Sugarbeet	7
Wheat	6
FORAGES/WET	
Beardless wildrye	12
Tall wheatgrass	12
Hybrid wheatgrass	10
Slender wheatgrass	10
Tall fescue	7
Western wheatgrass	6
Strawberry clover	6
Creeping foxtail	5
Meadow bromegrass	4
Cicer milkvetch	4
Orchardgrass	3
FORAGES/DRY	
Russian wildrye	12
Tall wheatgrass	12
Altai wildrye	10
Slender wheatgrass	10
Crested wheatgrass	6
Pubescent wheatgrass	6
Interm. wheatgrass	6
Smooth bromegrass	5
Yellow sweetclover	5
Birdsfoot trefoil	5
Alfalfa	4
NATIVES	
Nuttall's alkaligrass	14
Alkali sacton	14
Beardless wildrye	12
Alkali cordgrass	12
Alkali bluegrass	12
Slender wheatgrass	10
Plains bluegrass	10
Western wheatgrass	6
Thickspike wheatgrass	6

TABLE 5. **Seeding Rates for Salinity Management**

SPECIES [1/] CULTIVARS	SEEDING RATE [2/] lb. PLS/Ac DRILLED	 BROADCAST
Beardless Wildrye	7	14
Shoshone		
Tall Wheatgrass	14	28
Jose, Largo, Alkar, Orbit, Tyrell		
Altai Wildrye	12	24
Prairieland, Pert Eejay		
Hybrid Wheatgrass	8	16
NewHy		
Slender Wheatgrass	8	16
Pryor, San Luis, Revenue		
Interm. Wheatgrass	7	14
Rush, Oahe, Reliant, Greenar		
Orchardgrass	4	8
Pauite, Latar		
Pubesc. Wheatgrass	7	14
Manska, Luna, Topar		
Smooth Brome	5	10
Manchar		
Tall Fescue	6	12
Alta, Fawn		
Russian Wildrye	7	14
Bozoisky-Select, Swift, Mankota		
Western Wheatgrass	7	14
Rodan, Rosana		
Creeping Foxtail	3	6
Garrison, Retain		
Crested Wheatgrass		
Fairway	4	8
Fairway, Ephriam		
Standard	5	10
Nordan, Summit		
Hybrid Wheatgrass	7	14
Parkway, Hycrest		
Siberian Wheatgrass	7	14
P-27, Vavilov		
Birdsfoot Trefoil	5	10
Steadfast, Empire, Leo, Dawn		
Alfalfa	5	10
Beaver, Roamer, Spredor 3, Ladak		
Cicer Milkvetch	8	16
Lutana, Monarch, Windsor		
Barley	80	80
Haybet, Horsford		
Strawberry Clover	4	8
Common		
Alsike Clover	4	8
Common		

[1/] If species are not listed, use FOTG, Section IV, 512–Pasture and Hayland Planting rates.

[2/] All seeding rates are lbs. PLS/ac.

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NO INFORMATION