How Do Saline Seeps Form?

Saline seep causes a salt buildup that reduces productivity of the soil. Saline conditions also contaminate groundwater and surface water used for domestic purposes, livestock, and wildlife. Saline seep water, predominantly sodium and magnesium sulfate salts, is often nearly as salty as sea water.

Water in excess of what can be stored in the annual-crop rooting zone or used by growing crops dissolves salts in the soil and leaches down to build up a water table on top of the bedrock. The artificially created water table gradually rises until the water reaches the surface to evaporate, leaving a white crust of salts. (*See Figures 1 and 2*)

Plant growth eventually is reduced or eliminated. Saline areas spread gradually and affect thousands of acres, sometimes affecting major portions of a watershed. Salinity has taken more than 300,000 acres of cropland out of production in Montana.

Figure 1. *The water table and soluble salts in the soil profile remain stable when native range or perennial vegetation utilizes the annual precipitation.*

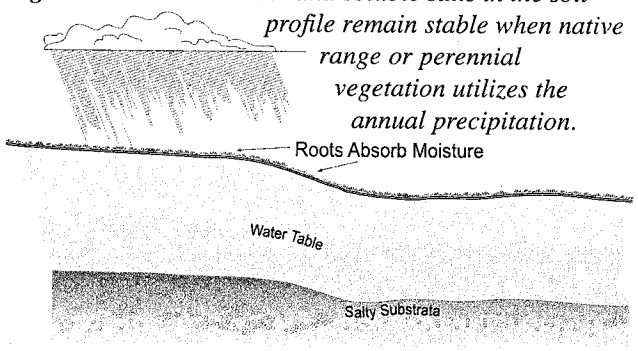
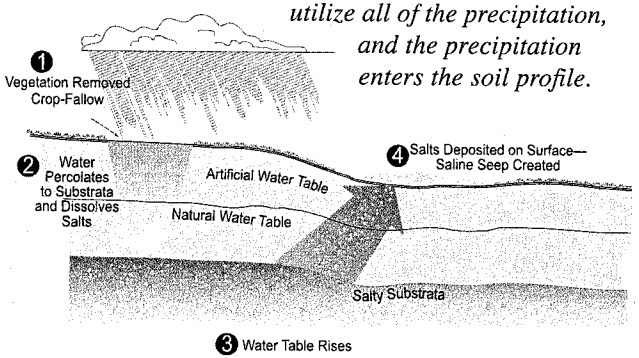


Figure 2. *Saline seeps form when vegetation does not utilize all of the precipitation, and the precipitation enters the soil profile.*



Where Do I Get Help?

Two organizations that can provide help are the Montana Salinity Control Association (MSCA) and your local conservation district. Each one will coordinate activities with the U.S. Department of Agriculture (USDA) and other agencies at your request to provide opportunities for financial and technical assistance.

The Montana Salinity Control Association provides a groundwater assessment and site-specific reclamation plan. MSCA does charge for the groundwater investigation; however, USDA cost-share is available. There is no charge for the initial site visit with the producer to see whether an in-depth investigation is needed or whether verbal recommendations are sufficient. Working with MSCA is voluntary, as is implementing any of the recommendations. MSCA can work with individual producers or small groups and on the watershed level.

Conservation districts grew from public concern for the condition of our natural resources in the early 1930s. Today, Montana's 58 conservation districts provide local citizens with an opportunity to shape resource planning in their areas. Conservation districts provide guidance to local U.S. Natural Resources Conservation Service (NRCS) personnel by defining local resource priorities, act as project sponsors and facilitators, and promote understanding of resource issues through workshops, tours, and educational outreach. MSCA is a satellite organization of Montana's conservation districts.

Montana Salinity Control Association
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SALINITY CONTROL in Montana

Before Photo. *A large flowing saline seep in a crop-fallow field in 1996 prior to any reclamation measures. Photo corresponds to Well 8 in Figure 6.*

After Photo. *Same saline-affected area in 2000 after the recharge area had been identified through a ground water investigation. The recharge area was rotated to a alfalfa-grass mixture and later the seep perimeter seeded to salt-tolerant grass species.*

What Causes Saline Seeps?

Saline conditions can be created by any change that converts native range or perennial forage to a land use less efficient in using precipitation or irrigation water. The predominant land use change in the Northern Great Plains has been to crop-fallow. Both the soil profile and underlying bedrock in central and eastern Montana have an elevated and highly soluble salt content. Most of the saline seeps have formed since the 1940s with the advent of large-scale crop production.

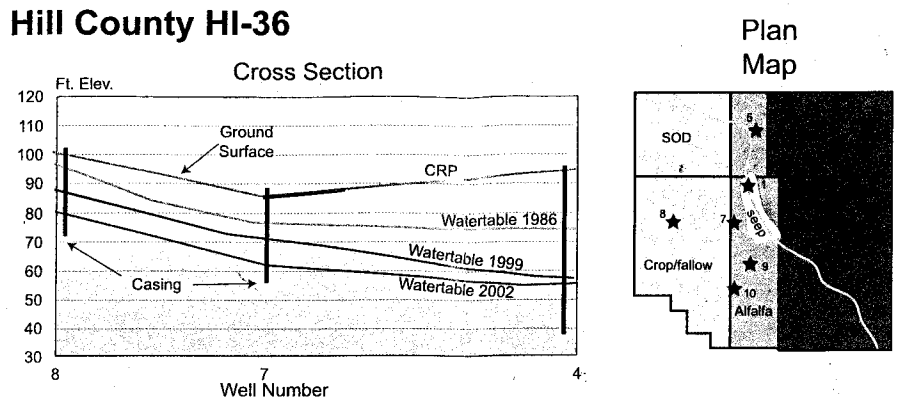
Salinity problems are generated by salts leaching from the soil into the groundwater. The recharge areas for the seepage are generally within 1 or 2 miles from the discharge area and often much closer.

Groundwater does not recognize surface boundaries, so often the recharge area ownership is shared or controlled by other producers.

Solutions to Seeps

Montanans have three general solutions to address saline seeps. They may be used separately or in conjunction with each other.

- Saline seeps, developed with the advent of crop-fallow, can be reclaimed with a 5–to 10–year rotation from crop to perennial forage for haying/grazing in the recharge area. The deep-rooted crop most commonly used is alfalfa, but other legumes and grasses can be used. (*See Figure 3*)
- Perennial vegetation planted under the Conservation Reserve Program (CRP) mimics alfalfa hay in lowering the static water table when placed in the recharge area. (*See Figure 4*)
- Switching from the crop-fallow system to a flexible but more intensive annual cropping system can help prevent salinity problems. The flex-crop system should always follow the forage rotation and can include cereal grain, oilseed, and annual legume crops.



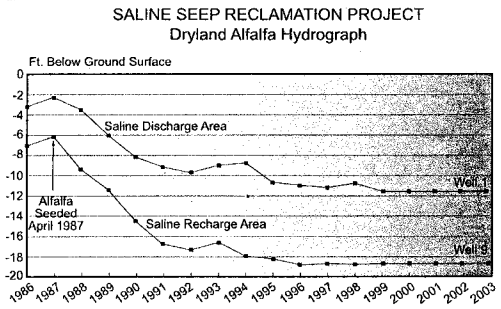


Figure 3. Hydrograph showing ground water level decline from 1986 to 2003, with alfalfa in the recharge area and salt-tolerant forage in the seep/ discharge area. This is the traditional method of saline seep reclamation.

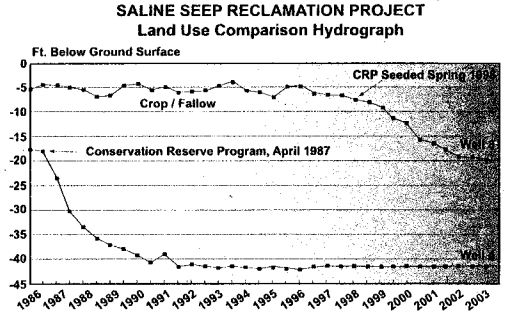


Figure 4. Hydrograph showing the general ground water decline from 1986 to 2003 in an area enrolled in CRP perennial vegetation. The hydrograph from an adjacent crop-fallow field fluctuated with seasonal precipitation until the field was enrolled in CRP in 1999.

The two common barriers to land use changes are:

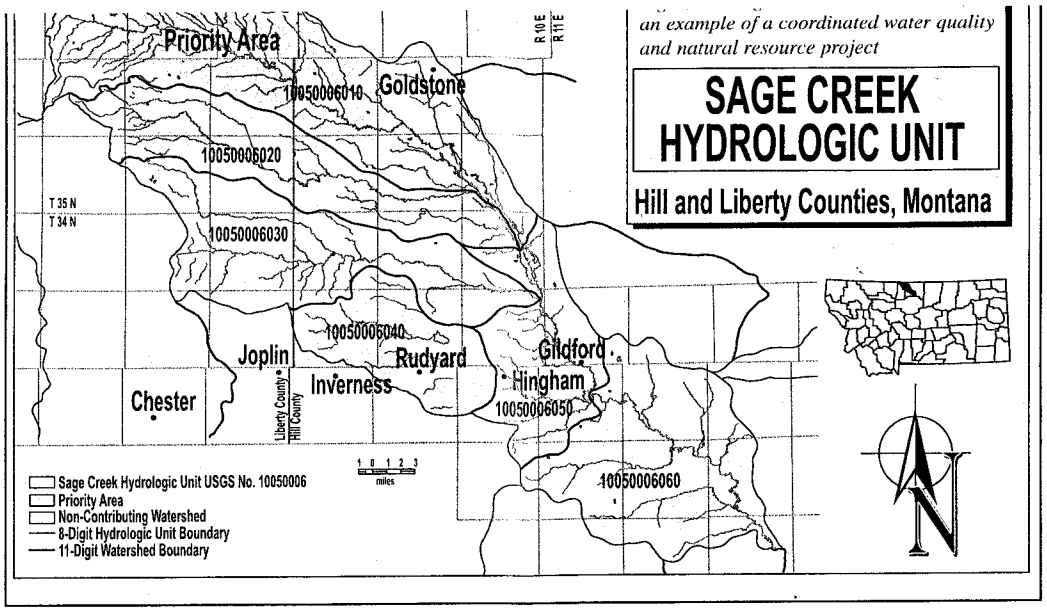
- the problem of making arrangements for haying equipment and marketing
- the lack of an assured yield in a flex-crop system

However, these problems are often perceived, rather than real. Producers generally find that the diversification of hay and alternative crops can improve their long-term productivity.

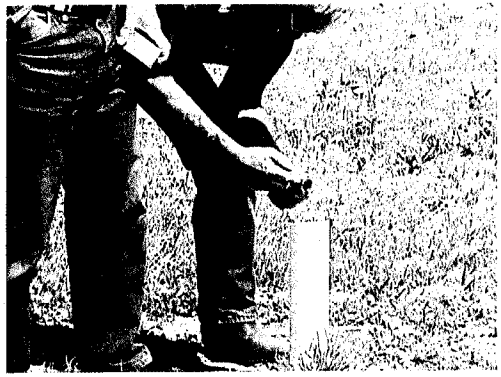
Saline seep is caused by a dynamic situation; it will recur eventually if the recharge area is returned to annual cropping. Therefore, the perennial forage will need to be rotated back every 10 to 20 years. Shallow monitoring wells installed in a groundwater investigation will help predict when the rotation is needed.

How Do I Tackle Saline Seeps?

Two approaches can be taken to address a saline seep problem, depending on who controls the recharge area. If the recharge area is under your control, then you will implement your own management scheme. However, at times it may be necessary to involve adjacent landowners on a larger watershed scale.



Cropland saline seep.



Shallow ground water monitoring well.

Alfalfa/grass mixture planted in recharge area at site in Figure 6.

Drainage does not solve the salinity probelm, it just transfers the problem to people, land

Watershed Approach

Natural resource concerns often can be addressed most efficiently within a defined watershed area or boundary. Local viewpoints and economic and social issues should be considered, along with the obvious agricultural and natural resource problems.

The Sage Creek Alliance is one example of a locally derived watershed project. In 1996, rural residents in northern Liberty and Hill Counties noticed the extreme degradation of the Sage Creek winter runoff. The creek was yellow and frothy, typical of highly saline discharge. Local residents held meetings to evaluate the situation and formed a landowner association to provide direction to the technical and financial agencies. The watershed (*see Figure 5*) covers over 500,000 acres, of which 30,000 acres, or 6 percent of the land, is saline-affected. Resource concerns include saline soil, soil erosion, noxious weeds, and providing a reliable supply of clean water for agricultural use. State and federal funding has been secured for a groundwater and surface water assessment, as well as technical planning for the resource concerns. Possible solutions include alternative crops, perennial crop rotations, and management of range and pasture.

Watershed project participants include the landowners/producers, conservation districts, Montana Salinity Control Association, Montana Department of Natural Resources and Conservation, Montana Bureau of Mines and Geology, U.S. Natural Resources Conservation Service, U.S. Farm Services Agency, Montana Department of Environmental Quality, Montana Department of Fish, Wildlife and Parks, Extension Service, and county weed districts. Funding to implement the management changes could come from the USDA's Environmental Quality Incentive Program (EQIP) and Conservation Reserve Program (CRP), Clean Water Action Plan, producer-generated funds, and other potential sources.

Individual Approach

The individual approach works well if the landowner controls both the recharge and discharge areas (*example project shown in Figures 6 and 7*). Any perennial crop will be significantly better than annual crops at preventing recharge to the water table. Alfalfa has proven over time to be the best available crop to lower the water table in the recharge area by preventing leaching over a long growing season. The Conservation Reserve Program has also proven an effective tool for water quality improvement, reducing soil erosion and providing other environmental benefits. Well hydrographs depict the gradual decline in the artificial water table when perennial forage is planted in the recharge area. CRP grasses can lower the water table in a manner similar to managed alfalfa hay stands to reclaim saline soil and reduce water quality problems (*see Figures 3 and 4*). CRP is most effective when it is in the defined recharge area and consists of a mixture of grasses and legume species. The process to reclaim saline seeps can take from 5 to 10 years and is a long-term commitment.

What is the Outlook For Addressing Saline Seeps?

Saline seeps have both economic and environmental effects. By taking steps now, future seeps can be prevented, and existing seeps can be reclaimed. Cropland and grazing land can be brought back into production after years of being saline-affected. Changing the surface land management gradually lowers the artificially elevated water table. Precipitation then leaches the salts down below the root zone, and no soil amendments are needed. For localized seeps, landowners need to implement the changes that will address the problem on their own property. If the saline problem involves multiple persons or groups, then involvement in a watershed approach such as the Sage Creek Alliance may be more appropriate.

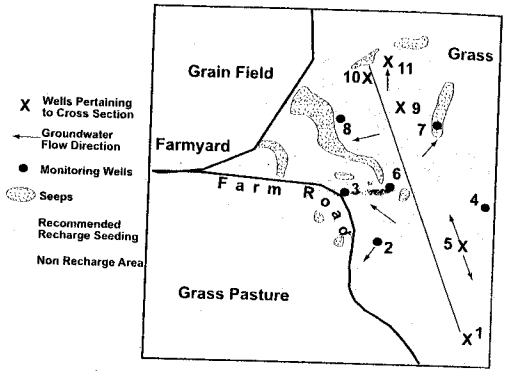


Figure 6. Map showing monitoring wells used to determine groundwater flow direction and identify the recharge area impacting the saline seeps. Using the information gathered, part of the field was not considered recharge for the salinized areas.

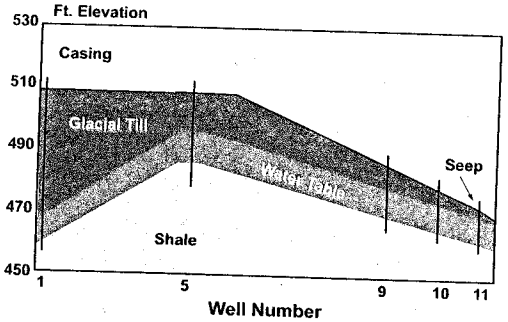
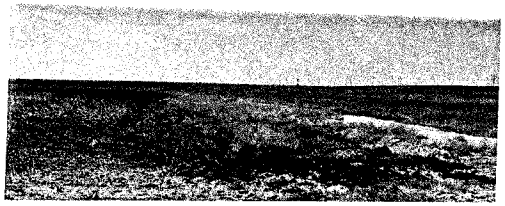
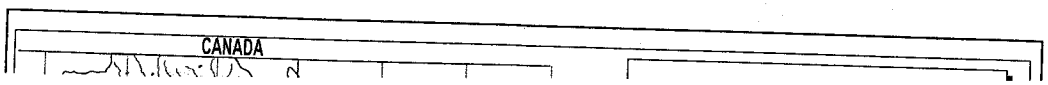



Figure 7. Cross section corresponding to Figure 6. The cross section shows the hydrogeologic relationship between the ground surface, the water table, and the bedrock encountered during drilling.