EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES: FIELD MANUAL

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RESEARCH PROGRAMS

Erosion and Sediment Control Best Management Practices: Field Manual

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The processes of soil erosion and deposition are natural, ongoing geological mechanisms caused by the transportation and settlement of soil particles through mechanisms like water or wind. While these mechanisms are natural processes that provide stream and floodplain formation and shaping, construction activities can accelerate these natural processes and produce more sediment than are beneficial to waterways. Highway construction activities occur in both rural and urbanized areas. In both circumstances, two mechanisms can occur that increase erosion and thereby increase sediment in waterways. First, construction activities and urbanization can significantly increase the impervious area, preventing precipitation from infiltrating into the soil. The resulting increase in the volume of runoff from a given area often results in higher water velocities in streams and drainage channels, thus increasing the potential for soils to be eroded. Secondly, construction activities generally necessitate the removal of natural ground cover that acts to hold topsoil in place during precipitation events. Removal of this vegetation leaves soil unprotected against storm runoff. Consequently, erosion and sedimentation are increased drastically, which results in reduced water drainage and storage capacities. This increase in erosion and sediment can cause flooding and significant degradation of the water quality in the receiving water bodies. Contaminants that are bound to sediment particles can also be transported into the waterways through storm water runoff. These contaminants, in combination with the sediment, can decrease water quality, harming both wildlife and vegetation. The purpose of this Erosion and Sediment Control Field Manual is to describe the procedures and methods to reduce erosion and sedimentation associated with highway-related pre-construction, construction and post construction activities.

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16. Abstract **The Erosion and Sediment Control Best Management Practices Construction Field Manual was developed to assist in design, construction, and post-construction phases of MDT projects. This manual provides background to concepts of Erosion and Sediment Control. Most of MDTs Best Management Practices are listed within the manual based on application categories. Each BMP is described; its applications and limitations are listed, as well as its design criteria. Construction phase and post-construction phase BMPs are described. This manual is a field guide and condensed version of the Erosion and Sediment Control Design Construction Best Management Practices Manual. For more detailed discussion on topic found within, refer to the Erosion and Sediment Control Construction Best Management Practices Manual.**		
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Section 1
Concepts of Erosion and Sedimentation

Highway Construction activities have the potential to cause excessive erosion and sedimentation.

Each year the Montana Department of Transportation (MDT) completes numerous construction projects where soils are disturbed. This disturbance can increase the potential for excess erosion if not properly addressed. Excess soil erosion from construction projects removes the soil surface layer, rich in nutrients, and transports the sediments into surface waters contributing to sediment loading and pollution transported with the sediments. The excess sediment collects in reservoirs, lakes, rivers, and streams reducing their water holding capacity and quality; and is detrimental to aquatic life. While erosion and sedimentation are natural processes that help shape Montana's rivers and valleys, activities such as highway construction can greatly accelerate these natural processes causing serious and costly problems. The implementation of Best Management Practices (BMPs) to prevent soil erosion and the resulting sedimentation from entering the waterways during the early stages of planning can significantly reduce serious and costly problems in the future.

Types of Erosion

Erosion is often described as the detachment of soil particles from the ground surface by running water, wind, ice, or other geological agents. Once detachment occurs, the particles are transported by water or wind.

Water Erosion

The types of erosion associated with the flow or movement of water can be categorized as follows:

Splash Erosion: This type of erosion is caused by the impact of raindrops on bare or sparsely vegetated soil. The soil particles are detached and transported by runoff creating a water/soil solution. Splash erosion destroys the soil structure forming a hard crust once the soil dries. The crust prevents future water from infiltrating, hindering plant establishment, which can cause further erosion.

Water erosion from bare slopes is a major source or erosion.

Sheet Erosion: As the name implies, this type of erosion is caused by sheet type water flows over soil surfaces. True sheet flow is uncommon because water most often concentrates in surface depressions. Soil particles dislodged or loosened by splash erosion are entrained in the runoff water and transported down gradient. This type of erosion is characterized by the uniform removal of material from the ground surface.

Rill/Gully Erosion: This type of erosion occurs when water flows over the surface of the soil and accumulates in depressions. Once the water reaches sufficient velocity to cut into the depression, it creates channels (rills), which transport sediment. As the scouring action of the water intensifies, larger channels (gullies) are created. This action releases large amounts of sediments.

Rill/Gully Erosion releases large amounts of sediments.

Stream Bank Erosion: This type of erosion occurs in natural drainage channels and occurs naturally in all streams. Stream bank erosion can be accelerated by upstream development or disturbances to the stream banks. This type of erosion can begin with erosion of the toe of the stream bank that may lead to bank sloughing into the creek.

Shoreline Erosion: This type of erosion occurs at lakeshores and ocean coastlines. It is characterized by sloughing of banks and mass wasting of material in to the water body. It is caused by high-energy wave action.

Stream Bank erosion can be caused by upstream construction activities.

Snow Melt Erosion: This type of erosion occurs when large volumes of snow are allowed to accumulate in disturbed areas and subsequently cause significant erosion. As moisture accumulates in the soils, the soil expands during freezing causing the soil particles to detach. The snow melts and becomes runoff transporting detached sediment downstream. Also, water stored in structures like sediment ponds tend to freeze, reducing their holding capacity and subsequently leading to flooding and concentrated flow.

Wind Erosion

The second main type of erosion is wind erosion. This type of erosion usually occurs in flat poorly vegetated areas. As the soil particles dry and loosen, the wind lifts the particles and transports them to other locations. Although this is a natural process, construction activities create temporary bare areas that are receptive to erosion.

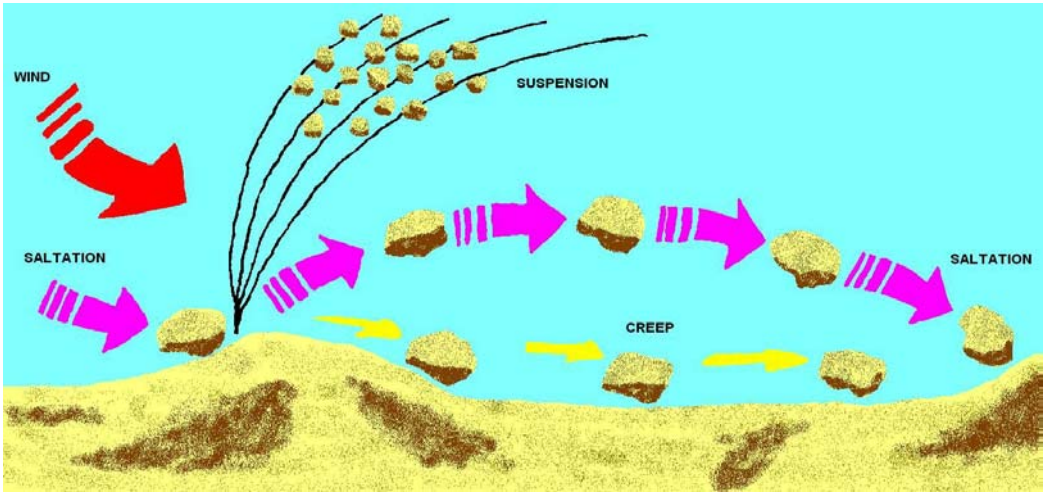
Bare construction areas are very receptive to wind erosion.

There are three main types of wind erosion which are described below:

Suspension Erosion: This type of erosion is attributed to the movement of very fine particles due to impact with other particles or due to the wind itself. The particles are suspended in the air and transported long distances at high altitudes.

Saltation Erosion: This type of erosion is when large quantities of soil particles are lifted into the air by the wind forces and moved mainly horizontally across the surface. The particles bounce onto the surface lifting other particles and causing damage to the surface and to the vegetation.

Surface Creep Erosion: This type of erosion is caused when heavy particles roll across the soil surface after they come in contact with smaller particles that moved by saltation or by suspension.



Wind Erosion can transport sediment by suspension, saltation or creep.

Sediments and Pollutants

High turbidity in waterways has environmental and economic implications

Erosion is the predominant source of suspended material in surface water. Erosion is a naturally occurring process, and as such, attention should focus on erosion rates above those occurring naturally or prior to development. Although erosion rates are difficult to determine, every effort should be made to reduce erosion caused by construction projects and existing facilities. This can be accomplished by implementing BMPs.

Suspended Sediment Material

(i.e., soil, gravel, etc.) in storm water runoff is considered a pollutant of primary importance. Excess suspended particles or high turbidity in waterways and water bodies have environmental and economic implications. The quality of aquatic life habitats degrades as the quantity of sediments increase. The high turbidity prevents the sunlight from reaching the lower sections of the water bodies; therefore, reducing photosynthesis and consequently reducing food production. The sunlight is absorbed in the water, increasing the temperature, which changes the natural aquatic habitats. The sediment settles on the bottom of the water bodies, creating a smooth crust that harms fish spawning habitats. Excess sediments can also be costly because they can affect adjacent properties and clog catch basins and storm

drains, causing flooding and resulting in higher maintenance costs. When sediments enter streams and lakes, they create cloudy or turbid water conditions as well as reducing the flow capacity of the water bodies. These conditions can interfere with industrial and recreational activities. In addition, sediments can transport many other pollutants, including metals, and other organic pollutants.

Contaminated sediments affect small creatures such as worms, crustaceans, and insect larvae that inhabit the bottom of a water body, known as the benthic environment. Some kinds of toxic sediments kill benthic organisms, reducing the food available to larger animals such as fish. EPA lists five major types of pollutants found in sediments: nutrients, bulk organics, halogenated hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and metals. EPA's description of these major pollutants is provided below:

Nutrients

Including phosphorous and nitrogen compounds such as ammonia, can be toxic to benthic organisms. Elevated levels of phosphorous can promote the unwanted growth of algae. This can lead to depletion of oxygen in the water causing the algae to die and to decay. Decomposition of vegetation can generate unpleasant odors and tastes, as well as unsightly conditions. Sources of elevated nutrient levels can be encountered when channels and storm drains are disturbed and where sewer lines and fertilized vegetated areas used are excavated.

Excessive nutrients in water can promote unwanted growth of algae, which can lead to depletion of oxygen in water bodies.

Bulk Organics

A class of hydrocarbons that includes oil and grease. Construction activities require the presence of hydrocarbons as fuels, solvent, lubricants and many other applications. If fuels, solvents, or lubricants, are released into the environment they might work they way into the water bodies via erosion. Hydrocarbons can be toxic to fish and plant habitats, as well as consume oxygen during their decay process resulting in fish kill and unsightly conditions. On construction sites, the storage, transfer, and usage of these compounds should be performed following all federal, state, and local regulations.

Oil and grease discovered or generated at construction sites must be kept out of waterways.

Halogenated Hydrocarbons or Persistent Organics

A group of chemicals that are very resistant to decay. Compounds such as DDT and PCBs are in this category. These compounds accumulate in the food chain becoming toxic to aquatic life, wildlife, and humans. The main sources of these compounds are atmospheric deposition, urban, industrial, and

municipal discharges from past and ongoing activities. When encountered, these compounds should be treated as hazardous waste and the appropriate governmental agencies should be contacted as well as all the federal, state, and local regulations shall be followed.

PAHs

Are a group of organic chemicals that includes several petroleum products and byproducts. These compounds are very toxic and most of them are carcinogens. They tend to be persistent in the environment, absorbent in soil particles, bioaccumulative in living tissue, and lethal to several organisms. Urban runoff from industrial, urban, and municipal sources is suspected to be a major contributor of PAH in water bodies, as well as atmospheric deposition.

Metals

Include iron, manganese, lead, cadmium, zinc, and mercury; metalloids include arsenic and selenium. The major sources of metals are inactive and active mines; atmospheric deposition from urban, industrial, and municipal discharges.

Abandoned tailings piles can be a source of metal contamination to waterways.

In Montana, many areas have been mined for precious metals. The mining areas typically exhibit high metal concentrations in the ore, waste rock, and tailings presenting a threat to human health and the environment. Erosion and sedimentation of these materials can be dangerous to the environment and should be avoided. Mine waste is often characterized by oxidation zones, which results in soils or wastes having a very uniform texture and colors such as all gray, red, or yellow. Special care should be taken when construction activities disturb areas affected by mine wastes. The appropriate MDT and DEQ environmental departments should be contacted and the federal, state, and local regulations should be followed.

Contaminated sediments do not always remain at the bottom of a water body. Any activity that stirs up the water, such as a storm or a boat's propeller, can resuspend sediments. Resuspension may mean that all of the animals in the water, and not just the bottom-dwelling organisms, can be directly exposed to toxic contaminants.

Principles of Erosion and Sediment Control

Erosion control practices during construction activities protect the soil surface by using soil stabilization BMPs. **Erosion control** treats soil as a valuable resource that needs to be protected from erosion mechanisms. **Sediment control** practices trap soil particles after they have been dislodged and prevent or minimize their movement off site. Sediment controls are generally passive systems that rely on filtering and/or settling soil particles before they leave the site.

Vegetation

Vegetation is the key to long-term soil stability. Therefore, sediment control is dependent on the reestablishment of vegetation on disturbed areas. Vegetation serves to physically impede runoff by the presence of stems and leaves which retard runoff shear stress and protects the soil surface. Vegetation also greatly increases water infiltration into the soil. A vegetated soil surface might exhibit 80-99% less runoff compared to a barren soil surface depending on the soil texture and vegetation cover. Rapid establishment of vegetation is a critically important component of long-term stability. A number of construction practices are available which promote successful vegetation development.

Vegetation is a key component of erosion and sediment control (BMPs SS-2, SS-4, SS-15).

Preserving existing vegetation within and adjacent to construction sites has a positive impact on erosion and sediment control (BMP SS-2).

Erosion control mats are often used to prevent erosion and aid in the reestablishment of vegetation (BMP SS-7).