Fugitive Dust

A Guide to the Control of Windblown Dust on Agricultural Lands in Nevada

January 2007

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Introduction

Why is this Guide needed?

Windblown dust ***(fugitive dust)*** can impact the environment and cause health effects. As wind blows over areas where soil has been recently disturbed, soil particles become airborne, often resulting in the loss of valuable top soil, damaging crops, and causing health problems in livestock. Fugitive dust has caused vehicle accidents due to reduced visibility; damage to homes; destroyed landscaping; removed paint from vehicles; and increased the incidence of respiratory problems and cardiovascular conditions.

Soils in agricultural production often contain pesticides, herbicides, bacteria, fungi, and other constituents that can create health problems in humans and animals. Fugitive dust has become an increasingly important issue to agricultural operations in Nevada due to the encroachment of residential development into rural farm and ranch areas.

This Guide has been prepared by the Southern Nye County Conservation District, the Conservation District of Southern Nevada, and, the High Desert Resource Conservation and Development Council Inc., to assist agricultural enterprises in Nevada evaluate the potential for dust production associated with their agricultural practices and to provide information on practical measures to reduce dust production. This Guide discusses practical and economical methods to reduce and prevent topsoil from becoming airborne during agricultural activities and can assist landowners in understanding their role in protecting the environment, their neighbors, and their employees and livestock.

The USDA-Natural Resources Conservation Service (NRCS) provided technical review and assistance in preparation of the Guide. NRCS staff are available to help identify reasonable control measures that may be appropriate for a farm or ranching operation.

A listing of the NRCS field offices in Nevada is provided at the back of this Guide.

Air Quality and the Quality of Life

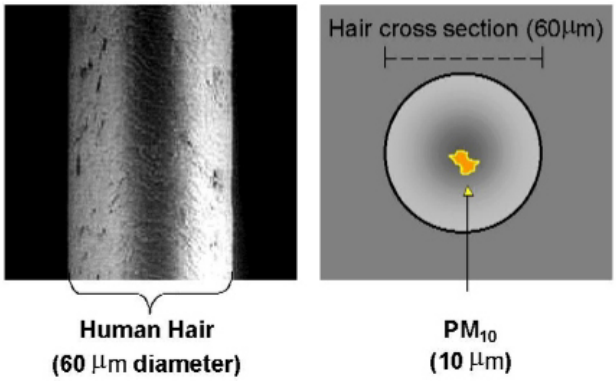
Airborne dust is a natural process particularly in arid environments such as Nevada where dry, windy conditions and sparse vegetation can result in substantial dust production. Although fugitive dust production is a natural phenomenon, human activities can also greatly affect dust levels.

Fugitive dust is comprised of dust particles that can be introduced into the air through agricultural activities such as soil cultivation, or vehicles operating on open fields or dirt roadways.

Particulate matter studies have indicated that agricultural burning, fallow fields, and the tillage, planting, and harvesting of cropland fields, are major contributors to dust formation in rural areas.

Particulate matter (PM) can be any material except water (however, PM can exist as a mixture composed of solid particles and liquid droplets). Solid particles are typically dust (and sometimes smoke) from agricultural burning and other (wood) combustion sources. Some of these particles are large enough to be seen as dust or dirt. Others are so small they can only be detected with a microscope. $PM_{2.5}$ describes the "fine" (barely-visible) particles that are less than or equal to 2.5-microns in diameter. Particles that are greater than 2.5-microns are referred to as PM_{10}, which are 10-microns in diameter. PM_{10} is about one-seventh the diameter of a human hair.

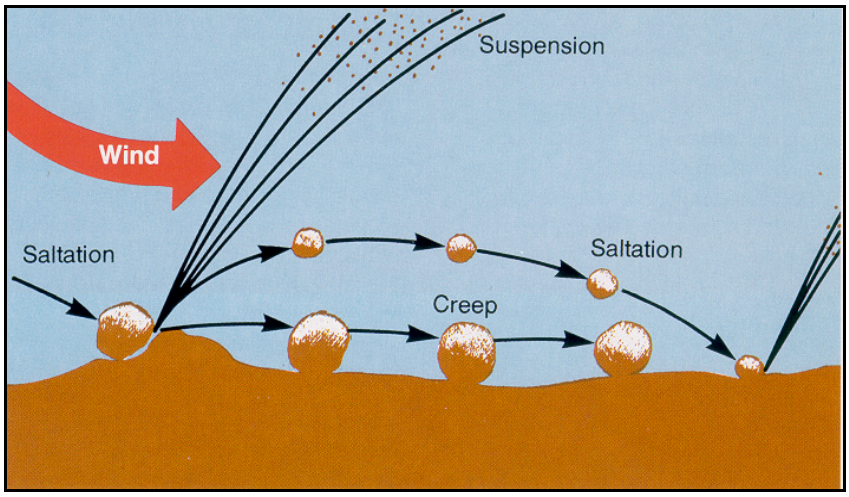
HOW SMALL IS PM_{10}?



From: Clark County Department of Air Quality and Environmental Management (2004)

Because $PM_{2.5}$ and PM_{10} are so small, they can be inhaled deep into the lungs. In general, the finer the particle, the deeper the penetration, and the more entrapped it can become. Many health problems have been connected with long-term exposure to PM. Fine dust particles trapped in the lungs can aggravate respiratory conditions such as asthma, bronchitis, pneumonitis, wheezing, and coughing, and have also been connected to heart conditions such as cardiac artery disease, cardiac arrhythmias and heart attacks. Sensitive populations (including children, the elderly, those suffering from asthma or bronchitis, and people with heart or lung disease) are at higher risk of developing problems from airborne dust.

The Wind Erosion Process



From: USDA Soil Conservation Service 1994

The Wind Erosion Process

Wind erosion is a serious environmental problem. It is a common phenomenon occurring mostly in flat, bare areas having dry, sandy soils; or anywhere the soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing soil from one place and depositing it in another. It causes soil loss, dryness and deterioration of soil structure, nutrient and productivity losses, and air pollution. Suspended dust is inevitably deposited over everything. It blows on and inside homes, covers roads and highways, and smothers crops. Sediment (soil) transport and deposition are significant factors in the geological changes which occur on the land around us and over long periods of time are important in the soil formation process.

Soil movement is initiated as a result of wind forces exerted against the surface of the ground. For each specific soil type and surface condition there is a minimum velocity required to move soil particles. This is called the threshold velocity. Once this velocity is reached, the quantity of soil moved is dependent upon soil particle size, the "cloddiness" of the soil particles, and the wind velocity itself.

Suspension, **saltation**, and **surface creep** are the three types of soil movement that occur during wind erosion. While soil can be blown away at virtually any height above the ground, the majority (over 93%) of soil movement takes place at or below three feet.

Suspension occurs when very fine soil and dust particles are lifted into the wind. They can be thrown into the air through impact with other particles or by the wind itself. Once in the atmosphere, these particles can be carried very high and transported over extremely long distances. Soil moved by suspension is the most spectacular and easiest to recognize of the three forms of movement.

Saltation - The major volume of soil moved by the wind is through the process of saltation. In saltation, fine soil particles are lifted into the air by the wind and drift horizontally across the surface increasing in velocity as they go. Soil particles moved in this process of saltation can cause severe damage to the soil surface and vegetation. Soil particles travel approximately four times longer in distance than in height. When they strike the surface again they either rebound back into the air or knock other particles into the air.

Creep - The large particles that are too heavy to be lifted into the air are moved through a process called surface creep. In this process, the particles are rolled across the surface after coming into contact with the soil particles in saltation.

Surface soil texture is the best indicator of a given site's susceptibility to wind erosion. Coarse textured, single-grained, sandy soils are most susceptible to soil loss due to wind erosion.

Management Strategies and Conservation Practices

Windblown PM_{10} emissions from agricultural fields can originate from practices that break-up, or pulverize, the top soil leaving bare ground susceptible to wind erosion.

The quantity of PM_{10} that is generated is closely linked to the management of soils and the amount of mechanical disturbance. Soil disturbances alter soil structure by breaking-up soil aggregates and allowing particles smaller than 10-µm in size to be easily suspended in the air by wind.

Most methods for controlling PM_{10} and dust emissions from agricultural fields correspond to management and cultural practices implemented for wind erosion control and are based on principles that contain or slow soil movement from fields.

Methods of wind erosion control are based on two principles: (1) reducing the direct force of wind on erodible soil particles; and, (2) modifying the soil surface to resist wind action or limit particle movement.

Properly managed crop residues, carefully timed soil tillage, and accurately placed crop strips and wind barriers can all effectively reduce wind erosion. Establishment of windbreaks, crop strips, and other types of wind barriers address the first principle of wind erosion control. Additionally, cover provided by plants and crop residues protects soil particles on the surface by absorbing a portion of the direct force of the wind transmitted to the soil. Cultural treatments, soil amendments, and other techniques that increase the non-erodible fraction of the surface soil utilize the second principle of wind erosion control. Soil modifications include using soil stabilizers that bind soil particles and maintain non-erodible aggregates or clods on the surface, and creating ridge roughness and soil "cloddiness" with tillage implements.

As discussed above, fugitive dust is often a by-product of agricultural production. However, there are cost-effective steps that can be implemented to minimize dust production during typical farming or ranching operations. This Guide focuses on those management actions and cultural practices proven effective for controlling wind erosion on vulnerable agricultural areas.

Dust Storm on Farmland

Implementation of the practices and management actions presented in this Guide is not calculated to completely eliminate dust emissions, but is expected to reduce wind erosion to "reasonable" levels.

Reasonable fugitive dust control measures take into consideration the cost to the grower using these practices and balance them against health and other benefits of improved air quality.

The practices recommended in this Guide have been proven to reduce wind erosion significantly below that which would occur with bare, tilled, soil under similar conditions. One or more of the listed practices may be implemented to address a particular fugitive dust problem, but the individual landowner must ultimately determine the suitability of a given practice for his or her farm or ranch.

Not all practices will work equally well for their intended purpose on every site because of variations in wind, soils, cropping systems, and moisture conditions, and in some cases the management approaches of individual growers. Because of the many factors that affect vulnerability to wind erosion, the effectiveness of a given practice on a given field can be extremely variable. The dynamics of how cropping systems and weather interact may produce conditions when certain practices will not be effective at controlling windblown dust and associated PM_{10} emissions.

For convenience in presentation, management actions and conservation practices for the control of PM_{10} emissions listed in this Guide have been grouped into three categories: **tillage, planting, and harvest**; **crop production (including hay)**; and, **non-cropland areas**. The *tillage, planting, and harvest* category groups field operations such as plowing, disking, land leveling, harrowing, planting, and harvesting that stir-up loose soil. The *crop production* category groups practices and management that are appropriate once a crop is mature enough to provide ground cover or to act as a windbreak. The grouping of practices and management for *non-cropland areas* relate to land that is not in crop production but is an integral component of the agricultural operation. Non-cropland areas include equipment and storage yards, private roads, and irrigation/drainage system infrastructure.

Table I provides a listing of the management strategies and conservation practices recognized in this Guide and the category into which these practices have been grouped.

Appendix II offers a more comprehensive listing of management and practices that can be applied to control PM_{10} emissions.

Dust blowing across a hay field

TABLE I

Key Management Strategies and Conservation Practices for Fugitive Dust Control in Nevada

PRACTICE or MANAGEMENT STRATEGY

CATEGORY		
Tillage, Planting, and Harvest	**Crop Production**	**Non-Cropland Areas**
Chemical irrigation	Artificial wind barrier	Access restriction
Combining tractor operations	Cover crop	Aggregate cover
Equipment modification	Cross-wind ridges	Artificial wind barrier
Limited activity during a high wind event	Cross-wind strip-cropping	Critical area planting
Planting based on soil moisture	Cross-wind vegetative strips	Manure application
Reduced tillage system	Manure application	Reduced vehicle speed
Surface roughening	Mulching	Synthetic particulate suppressant
Tillage based on soil moisture	Multi-year crop	Track-out control system
Timing of tillage operations	Permanent cover	Tree, shrub, or windbreak planting
	Residue management	Watering
	Sequential cropping	
	Tree, shrub, or windbreak planting	

Tillage, Planting and Harvest

Mechanical practices that physically disturb crop soils

Chemical Irrigation

Reference to NRCS Conservation Practice:
Irrigation Water Management (Code 449)
Nutrient Management (Code 590)
Pest Management (Code 595)

Practice Definition

"Chemical irrigation" means applying a fertilizer, pesticide, or other agricultural chemical to cropland through an irrigation system.

Purpose

Chemical irrigation reduces the number of passes across a field with tractors, sprayers, fertilizer applicators and machinery. Reducing the number of field operations reduces the emissions associated with those activities and the amount of soil disturbed.

Suggestions for Implementation

- All product application recommendations should be followed to ensure proper implementation.
- The field operations eliminated should be documented to demonstrate the implementation of the practice.

Chemical irrigation system

Combining Tractor Operations

Practice Definition

"Combining tractor operations" means performing two or more tillage, cultivation, planting, or harvesting operations with a single tractor or harvester pass.

Purpose

Combining tractor operations reduces the number of passes or trips that a tractor, implement, harvester or other farming support vehicle makes across a field or unpaved surface, thereby reducing the amount of soil disturbed.

Suggestions for Implementation

Combining tractor operations is most effective if implemented during the time of year when PM_{10} is most likely to be produced.

- Applying fertilizer and herbicide in a single pass.
- Cultivating and fertilizing in a single pass.
- Using specialized machinery to bury stalks and make new furrows in a single pass.
- Combining multiple heavy tillage operations in a single pass, for example, pulling a ring roller behind a disc.

Equipment Modification

Practice Definition

"Equipment modification" means modifying agricultural equipment to prevent or reduce particulate matter generation from cropland.

Purpose

Modifying and maintaining an existing piece of agricultural equipment or purchasing new equipment to prevent PM_{10} from becoming airborne during tillage and harvest operations, which helps reduce PM_{10} and soil erosion.

Examples of Equipment Modification

- Shields or deflectors that redirect fan or vehicle exhaust sideways or upward. This can prevent PM_{10} from becoming airborne because exhaust is not blowing downward on the soil surface.
- Dust shrouds around tillage implements and harvesters.
- Spray bars that emit a mist to knock down PM_{10}.

Limited Activity During a High-Wind Event

Practice Definition

"Limited activity during a high-wind event" means performing no tillage or soil preparation activity when the measured wind speed at 6-feet above the ground is more than 25-mph at the farm site.

Purpose

Because this management strategy falls within the tillage, planting, and harvest category, it also applies during harvest time. Wind speed, temperature and relative humidity affect the distance that PM_{10} travels and the ability for PM_{10} to be suspended in the air. Limiting activity during a high-wind event will reduce the transport of PM_{10}. Reducing farm operations during a high wind event, as well as when the wind speed is less than 25-mph, can significantly help reduce PM_{10} emissions.

Suggestions for Implementation

- A device to measure wind speed should be available at the commercial farm site.
- An individual farm policy should be developed to ensure that no tillage or soil preparation activities occur when the wind speed reaches 25-mph. Employees and family members should receive training in implementing the farm policy.

Dust being generated from a tillage operation during a high-wind event

Planting Based on Soil Moisture

Irrigation Water Management (Code 449)

Practice Definition

"Planting based on soil moisture" means applying water to soil before performing planting operations.

Purpose

Planting based on soil moisture reduces PM_{10} during the planting operation and is effective from the time of planting until crop establishment. Planting based on soil moisture is one of the most efficient practices to reduce PM_{10} between planting and crop emergence. Moisture causes soil to crust and therefore PM_{10} is not easily transported into the air.

Suggestions for Implementation

- Care should be taken to avoid over compaction of the soil, which could result in additional tillage operations.
- Irrigation should be applied as soon after soil preparation for planting as possible. After watering, a thin crust develops on the soil surface, which stabilizes the soil until planting
- The time between bed lifting, irrigation and planting should be minimized as much as possible.
- Use the soil moisture "feel method" to determine adequate soil moisture. See the NRCS publication No.1619 "Estimating Soil Moisture by Feel and Appearance". This publication is available at most NRCS offices.
- See **"Tillage Based on Soil Moisture"** management practice listed on page 10.

Reduced Tillage System

Reference to NRCS Conservation Practice:
Residue and Tillage Management, No-Till/Strip-Till/Direct Seed (Code 329)
Residue and Tillage Management, Mulch-Till (Code 345)
Residue and Tillage Management, Ridge-Till (Code 346)

Practice Definition

"Reduced tillage system" means reducing the number of tillage operations used to produce a crop.

Purpose

Any tillage operation in a field can modify the soil structure and possibly release PM_{10} into the air. Reducing the number of tillage activities can maintain the soil structure and help reduce PM_{10}.

Suggestions for Implementation

- Minimum tillage system
- Mulch tillage system
- Reduced tillage system
- No-till seeding

No-Till Drill allows reduced seedbed preparation and soil disturbance

Surface Roughening

Reference to NRCS Conservation Practice:
Surface Roughening (Code 609)

Practice Definition

"Surface roughening" means manipulating a soil surface to produce or maintain clods.

Field left rough and cloddy

Purpose

The formation of clods helps disrupt the erosive force of the wind over an unprotected soil surface. Soil clods can be formed by tillage implements under appropriate soil moisture conditions.

Suggestions for Implementation

- Not all soils are able to form clods. Review the local soil survey or contact the NRCS office to help determine a specific field's soil type.
- Caution should be used to determine the most opportune time to roughen the soil surface while considering the tillage needed prior to planting, crop to be grown and irrigation water management needs (surface roughening can dry the upper soil profile more rapidly than not disturbing the soil).

Tillage Based on Soil Moisture

Reference to NRCS Conservation Practice:
Irrigation Water Management (Code 449)

Practice Definition

"Tillage based on soil moisture" means applying water to soil before or during tillage, or delaying tillage to coincide with precipitation.

Checking soil moisture by feel and appearance

Use the soil moisture "feel method" to determine adequate soil moisture. See the NRCS publication No.1619 "Estimating Soil Moisture by Feel and Appearance". This publication is available at most NRCS offices.

Purpose

Moisture binds soil particles and helps reduce the amount of PM_{10} released into the air. Fine dry soil can easily erode with increased wind speeds. Sufficient moisture levels can be achieved by irrigating before tillage or tilling after rain. Moisture can also allow large soil clods to form, after tillage, which reduces wind erosion.

Suggestions for Implementation

- Fields should be irrigated to the depth of proposed cut prior to soil disruption, or tillage should be conducted to coincide with precipitation.
- The application of moisture or the date of tillage that coincided with precipitation should be documented.
- The soil moisture "feel method" should be used as a way to determine adequate soil moisture.

Timing of a Tillage Operation

Practice Definition

"Timing of a tillage operation" means performing tillage operations at a time that will minimize the soil's susceptibility to generate PM_{10}.

Purpose

Adjusting the time of tillage operations can minimize the amount of time the soil surface is susceptible to wind erosion and generation of PM_{10}. When a field's surface is smooth, dry, and consists of finer grained soil particles, the field is most susceptible to wind erosion, resulting in PM_{10}.

Some examples of timing of tillage operations to reduce PM_{10} generation include:

- Reducing the amount of time between seedbed preparation and planting.
- Leaving the field surface with large soil clods for as long as possible prior to preparation of seedbeds.
- Performing tillage operations when wind speeds are low.

Perform tillage operations when wind speeds are low or the type of tillage does not create significant levels of windblown dust

Crop Production

Artificial Wind Barrier

Practice Definition

"Artificial wind barrier" means a physical barrier to the wind.

Purpose

Artificial wind barriers disrupt the erosive flow of wind over unprotected cropland fields thus helping to reduce PM_{10}.

Suggestions for Implementation

- Continuous board fences, burlap fences, crate walls, bales of hay and similar material can be used to control air currents and blowing soil.
- Barriers should be aligned across the prevailing wind direction. While 90 degrees or perpendicular is preferred, benefits can still be realized when barriers are aligned as close to perpendicular as possible.
- The distance of 10 times the barrier height is considered the protected area downwind of the barrier.

Cover Crop

Reference to NRCS Conservation Practice:
Cover Crop (Code 340)

Practice Definition

"Cover crop" means plants or a green manure crop grown for seasonal soil protection or soil improvement.

Purpose

Cover crops help control soil movement and protect the soil surface between crops. Cover crop reduces wind erosion by shielding the soil with vegetation and anchoring the soil with roots.

To be effective for most purposes, cover crops should provide a combined surface and canopy cover of 90 percent and produce at least 4,000-lbs/ac.

Cover crop protecting the soil from wind erosion

Suggestions for Implementation

It is recommended that:

- Cover crops consist of any vegetative cover that maintains more than 80 percent combined surface and canopy cover.
- Short-term cover can be grown between major crops. Plants are then tilled into the soil prior to or during major crop planting.
- Longer-term cover may be maintained by periodic mowing to maintain at least 80 percent cover.

Cross-Wind Ridges

Reference to NRCS Conservation Practice:
Cross-Wind Ridges (Code 589A)

Practice Definition

"Cross-wind ridges" means soil ridges formed by a tillage operation.

Purpose

Ridges formed by tillage operations create protective windbreaks that disrupt the erosive forces of high winds.

Cross-wind ridges

Suggestions for Implementation

It is recommended that:

- Ridges formed by tillage or planting should be aligned across the prevailing wind direction. While 90 degrees or perpendicular is preferred, benefits can still be realized with ridges as close to perpendicular as possible.
- If ridges deteriorate and become ineffective due to weathering or erosion, they should be reestablished, unless doing so would damage a growing crop.
- This practice is best adapted on soils which are stable enough to sustain effective ridges, such as clayey, silty and sandy loam soils. It is not well adapted on unstable soils, such as sands, loamy sands and certain organic soils.

Cross-Wind Stripcropping

Reference to NRCS Conservation Practice:
Stripcropping (Code 585)
Conservation Crop Rotation (Code 328)

Practice Definition

"Cross-wind strip-cropping" means planting strips of alternating crops within the same field.

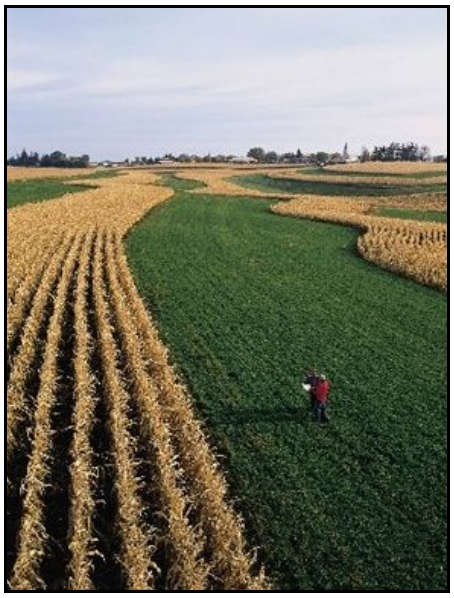
Purpose

Growing crops or managing residue as a protective cover in strips across the prevailing wind direction can break the effects of high wind events.

Suggestions for Implementation

It is recommended that:

- A cross-wind stripcropping system consist of at least two crop or residue cover alternating strips.
- Strip widths be at least 25-feet but no more than 330-feet.
- Strips are aligned parallel to each other and oriented as close to perpendicular to the prevailing wind direction as practical.
- Protective cover includes, but is not limited to a growing crop, grasses, legumes, grass-legume mixtures, standing stubble or tilled residue with enough surface cover to provide protection.



Cross-wind stripcropping

Cross-Wind Vegetative Strips

Reference to NRCS Conservation Practice:
Cross Wind Trap Strips (Code 589C)
Herbaceous Wind Barriers (Code 603)

Practice Definition

"Cross-wind vegetative strips" means herbaceous cover established in one or more strips within the same field.

Purpose

Herbaceous cover creates a protective windbreak that disrupts the erosive forces of high winds, especially during critical wind erosion periods.

Herbaceous wind barrier

Suggestions for Implementation

It is recommended that:

- Herbaceous cover should be composed of perennial or annual vegetation, growing or dead.
- Strips consist of at least one row of plants, providing the minimum porosity required can be achieved with a single row that contains no gaps.
- When two or more rows are required to achieve the required porosity and to avoid gaps, the rows should be spaced no more than 36-inches apart.
- Annual vegetation strips be composed of more than one row.
- Strips designed for this purpose have a minimum expected height of two feet.
- Strips designed for this purpose achieve a minimum porosity of 40 to 50 percent.
- Spacing between strips (not within row) not exceed 12 times the expected height of the herbaceous cover.
- Spacing between strips be adjusted to accommodate widths of farm equipment to minimize partial or incomplete passes.

Manure Application

Reference to NRCS Conservation Practice:
Nutrient Management (Code 590)
Waste Utilization (Code 633)
Manure Transfer (Code 634)

Practice Definition

"Manure application" means applying animal waste or biosolids to a soil surface.

Purpose

Applying manure to maintain or improve chemical and biological condition of the soil can help reduce wind erosion and PM_{10}.

Suggestions for Implementation

- If the application or storage of manure is near a water source, precautions should be taken to prevent accidental leakage, spillage or runoff that will result in undesirable effects on soil, water and plants.
- Caution should be used when applying manure to ensure that state and local regulations are not violated.
- Caution should be used when certain manures are applied as they can volatilize and contribute to odor and ammonia emissions.
- Manures should be incorporated as quickly as possible to reduce odor and ammonia emissions, and to preserve nutrient value if the area is to be cropped in the future.

Manure spreading operation

Mulching

Reference to NRCS Conservation Practice:
Mulching (Code 484)

Practice Definition

"Mulching" means applying plant residue or other material that is not produced on site to a soil surface.

Purpose

Adding a protective layer to the soil surface reduces soil movement in high wind events. This practice also conserves soil moisture, which can reduce surface movement of soil.

Suggestions for Implementation

It is recommended that:

- This practice can be used after low residue producing crops, like cotton, are harvested.
- Materials for mulching be acquired as waste products from other enterprises. These include, but are not limited to, wood bark, chips, shavings, and saw dust; food processing wastes; and small grain straw/chaff.
- Mulches be applied by blowers, hydro applicators, disk type straw punchers and spreaders.
- When small grain straw is used, spread at least 4,000-pounds straw per acre, distribute evenly and partially incorporate into the soil.
- When wood fibers are used, spread at least 2,000-pounds per acre or achieve 80% cover.

Multi-Year Crop

Reference to NRCS Conservation Practice:
Pasture and Hayland Planting (Code 512)
Forage Harvest Management (Code 511)
Prescribed Grazing (Code 528)
Conservation Crop Rotation (328)
Contour Orchards and Other Fruit Areas (Code 331)

Practice Definition

"Multi-year crop" means a crop, pasture, or orchard that is grown, or will be grown, on a continuous basis for more than one year.

Purpose

Surface covers, such as crops, pasture and orchards, that are grown and maintained for a long duration, protect the soil surface from erosive winds. The longer a crop or cover is protecting the soil surface, the less time the surface is susceptible to wind erosion.

Examples of multi-year crops are:

- ♦ Alfalfa
- ♦ Livestock pastures
- ♦ Orchards
- ♦ Sod

Multi-year alfalfa crop being cut for hay

Permanent Cover

Reference to NRCS Conservation Practice:
Conservation Cover (Code 327)
Field Border (Code 386)
Range Planting (550)

Practice Definition

"Permanent cover" means a perennial vegetative cover on cropland.

Purpose

Maintaining a long-term (perennial) vegetative cover on cropland that is temporarily not producing a major crop protects the soil surface from erosive winds. This practice can also apply to center pivot corners.

Suggestions for Implementation

It is recommended that:

- ♦ Perennial species of grasses and/or legumes be used to establish at least 60 percent cover.
- ♦ When perennial species are used, maintenance by periodic mowing or swathing/baling is encouraged.

Residue Management

Reference to NRCS Conservation Practice:
Residue and Tillage Management, No-Till/Strip-Till/Direct Seed (Code 329)
Residue and Tillage Management, Mulch-Till (Code 345)
Residue and Tillage Management, Ridge-Till (Code 346)
Residue Management, Seasonal (Code 344)

Practice Definition

"Residue management" means managing the amount and distribution of crop and other plant residues on a soil surface.

Purpose

Leaving crop and other plant residues on the soil surface can protect the soil between the time of harvest of one crop and emergence of a new crop, thus helping reduce wind erosion and the generation of PM_{10}.

Suggestions for Implementation

Many different residue management systems have been developed. Some examples include:

- Reduced tillage systems, such as mulch-till, which partially incorporates surface residues and involves no plowing.
- No-till, which involves planting directly into the soil without any alteration to the seedbed. One example is planting a new crop directly into the grain stubble.
- Soil protection by crop residues can be increased by leaving residues on the soil surface as long as possible (e.g. by delaying tillage operations until just before planting).

It is recommended that:

- Stubble height to be left standing is six-inches or more.
- Tillage be limited during this period to undercutting tools, such as blades, sweeps or deep tillage implements, such as a ripper or subsoiler.
- Loose residue be uniformly distributed on the soil surface.
- Residues from previous crops be left to maintain 60 percent ground cover.

Crop residue left on field for wind erosion protection

Sequential Cropping

Reference to NRCS Conservation Practice:
Cover Crop (340)
Conservation Crop Rotation (328)

Practice Definition

"Sequential cropping" means growing crops in a sequence that minimizes the amount of time bare soil is exposed on a field.

Purpose

By reducing the amount of time bare soil is exposed, sequential cropping helps reduce the window of time that the cropland is susceptible to PM_{10} erosion.

Some examples of sequential cropping include:

- Planting a winter grain crop between alfalfa rotations.
- Close rotations of vegetable crops.

Suggestions for Implementation

It is recommended that:

- The amount of time bare soil is exposed be limited to 30-days or less.
- Rotations be provided for acceptable substitute crops in case of crop failure or shift in planting intentions for weather related or economic reasons.

Tree, Shrub, or Windbreak Planting

Reference to NRCS Conservation Practice:
Windbreak/Shelterbelt Establishment (Code 380)
Tree and Shrub Establishment (Code 612)
Hedgerow Planting (Code 422)

Practice Definition

"Tree, shrub, or windbreak planting" means providing a woody vegetative barrier to the wind.

Purpose

Barriers placed perpendicular to the wind direction can reduce wind speeds by changing the pattern of airflow over the land surface, which helps to reduce wind erosion and PM_{10}.

Field windbreak

Suggestions for Implementation

- The distance of 10 times the barrier height is considered the protected area downwind of the barrier.
- Single row plantings are most popular in field windbreaks because they use less water and occupy the least amount of land area for the amount of protection derived.
- Recommended species for planting can be obtained at all NRCS or University of Nevada Cooperative Extension offices.
- The planting should be done at a time and manner to insure survival and growth of selected species.
- Moisture conservation or supplemental watering should be provided for plant establishment and growth, as well as the use of drought tolerant species.
- Windbreaks should be aligned across the prevailing wind direction. While 90 degrees or perpendicular is preferred, benefits can still be realized when windbreaks are aligned as close to perpendicular as possible.
- The interval between windbreaks should be determined using current approved wind erosion technology available at all NRCS or University of Nevada Cooperative Extension offices.

Non-Cropland

Access Restriction

Reference to NRCS Conservation Practice:
Use Exclusion (Code 472)
Fencing (382)

Practice Definition

"Access restriction" means restricting or eliminating public access to non-cropland with signs or physical obstruction.

Purpose

Reducing the number of trips driven on agricultural aprons and access roads can reduce that area's susceptibility to PM_{10}.

Examples of methods to restrict access include, but are not limited to:

- Installing physical barriers such as gates, fencing, posts, signs, shrubs, trees or other physical obstructions to prevent or control access to the area.
- Installing "no trespassing" or "limited use area" signs.

Field access restriction

Aggregate Cover

Reference to NRCS Conservation Practice:
Heavy Use Area Protection (Code 329)

Practice Definition

"Aggregate cover" means gravel, concrete, recycled road base, caliche or other similar material applied to non-cropland.

Gravel cover

Purpose

Applying an aggregate cover to unpaved farm roads, parking areas and canal banks helps reduce the amount of soil particles exposed to the surface, thus helping to reduce the generation of PM_{10}. Aggregate cover acts as a surface barrier to erosive forces like wind or vehicle traffic.

Suggestions for Implementation

- The aggregate should be one inch or larger in diameter.
- The aggregate should be applied a minimum of four inches deep.
- The aggregate material should be clean, hard and durable.

Artificial Wind Barrier

Practice Definition

"Artificial wind barrier" means a physical barrier to the wind.

Purpose

Artificial wind barriers disrupt the erosive flow of wind over unprotected areas thus helping to reduce PM_{10}.

Suggestions for Implementation

- Continuous board fences, burlap fences, crate walls, bales of hay and similar material can be used to control air currents and blowing soil.
- Barriers should be aligned across the prevailing wind direction. While 90 degrees or perpendicular is preferred, benefits can still be realized when barriers are aligned as close to perpendicular as possible.
- The distance of 10 times the barrier height is considered the protected area downwind of the barrier.

A haystack used as an artificial wind barrier

Critical Area Planting

Reference to NRCS Conservation Practice:
Critical Area Planting (Code 342)
Mulching (Code 484)
Herbaceous Wind Barriers (Code 603)
Tree and Shrub Establishment (Code 612)

Practice Definition

"Critical area planting" means using trees, shrubs, vines, grasses, or other vegetative cover on non-cropland.

Purpose

Critical area plantings helps control soil movement and protect the soil surface when adequate cover does not exist. Ground covers reduce dust and wind erosion by shielding the soil with vegetation and anchoring the soil with roots. This practice applies to field aprons, equipment parking areas, turn rows, canal or ditch banks, canal excavation spoil piles and bare areas where vegetation is difficult to establish by usual planting methods.

Suggestions for Implementation

- Critical area planting consists of any vegetative cover that maintains more than 60 percent ground cover.

Manure Application

Reference to NRCS Conservation Practice:
Nutrient Management (Code 590)
Waste Utilization (Code 633)
Manure transfer (Code 634)

Practice Definition

"Manure application" means applying animal waste or biosolids to a soil surface.

Purpose

Applying manure to maintain or improve chemical and biological condition of the soil can help reduce wind erosion and PM_{10} emissions.

Suggestions for Implementation

- If the application or storage of manure is near a water source, precautions should be taken to prevent accidental leakage, spillage or runoff that will result in undesirable effects on soil, water and plants.
- Caution should be used when applying manure to ensure that state and local regulations are not violated.
- Caution should be used when certain manures are applied as they can volatilize and contribute to odor and ammonia emissions.
- Manures should be incorporated as quickly as possible to reduce odor and ammonia emissions, and to preserve nutrient value if the area is to be cropped in the future.

Reduced Vehicle Speed

Practice Definition

"Reduced vehicle speed" means operating farm vehicles or farm equipment on unpaved private farm roads at speeds not to exceed 20-mph.

Purpose

Reduced speeds can decrease the amount of PM_{10} generated by vehicles or equipment on unpaved farm roads.

Examples of methods to reduce vehicle speed include, but are not limited to:

- ♦ Posting speed limit signs.
- ♦ Informing all employees, contractors and sub-contractors of speed limits.
- ♦ Placing signs in all farm vehicles stating the speed limits on farm roads.
- ♦ Installing speed bumps.

Synthetic Particulate Suppressant

Reference to NRCS Conservation Practice:
Heavy Use Area Protection (Code 561)

Practice Definition

"Synthetic particulate suppressant" means a manufactured product such as lignosulfate, calcium chloride, magnesium chloride, an emulsion of a petroleum product, an enzyme product, and polyacrylamide that is used to control particulate matter.

Purpose

Synthetic particulate suppressants provide a surface barrier or bind soil particles together to retard PM_{10} on unprotected areas, such as unpaved roads, rights-of-way and abandoned fields.

Synthetic particulate suppressant being applied to an unpaved road

Examples of synthetic particulate suppressant include, but are not limited to:

- ♦ Calcium chloride (CaCl)
- ♦ Soybean feedstock (SBF) processing byproducts
- ♦ Calcium lignosulfonate (lignin)
- ♦ Polyvinyl acrylic polymer emulsion (PVA)
- ♦ Polyacrymide (PAM)
- ♦ Emulsified petroleum resin

Differences in traffic type and volume, soil types, roadway surface characteristics and topography between sites requiring dust control can cause product performance to vary.

Track-Out Control System

Practice Definition

"Track-out control system" means a device to remove mud or soil from a vehicle before the vehicle enters a paved public road.

Purpose

Using a track-out control system helps remove mud and soil from the tires of farm equipment and vehicles before they enter a paved public road, where the mud or soil can be crushed into fine particles and easily suspended in the air by passing vehicles.

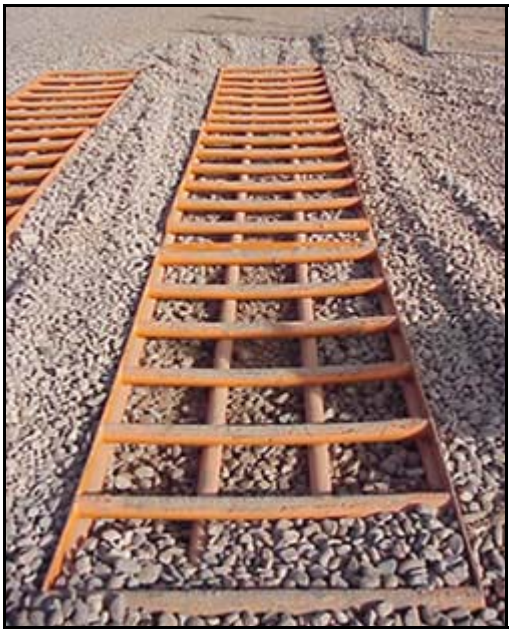
Suggestions for Implementation

Some examples of track-out control systems are:

- Grizzly - a device similar to a cattle guard, which is used to dislodge mud, dirt or debris from the tires and undercarriage of equipment and vehicles prior to leaving a farm.
- Gravel pad - a pad of crushed stone, coarse gravel or recycled road base located at the point of intersection of a paved public roadway and a farm entrance. It is recommended that:
  a. The stone or gravel is one-inch or larger in diameter.
  b. The gravel pad is applied a minimum of four-inches deep.
  c. The gravel pad is the full width of the farm entrance.
  d. The gravel pad is a minimum of 50-feet long.
- Pavement – an area of asphalt, concrete or similar material applied to a farm road at the intersection of a paved public roadway and a farm entrance. It is recommended that:
  a. The pavement is the width of the farm road.
  b. The pavement is a minimum of 100-feet long from the point of intersection with a paved public roadway.

The farm entrance should be maintained in a condition that will prevent tracking of mud and soil onto paved public roads. The farmer should conduct periodic inspections, maintenance, re-application of gravel and cleaning of paved access road surfaces to accomplish track-out control.

Track-out control device



Portable track-out control device

Tree, Shrub, or Windbreak planting

Reference to NRCS Conservation Practice:
Windbreak/Shelterbelt Establishment (Code 380)
Tree and Shrub Establishment (Code 612)
Hedgerow Planting (Code 422)

Practice Definition

"Tree, shrub, or windbreak planting" means providing a woody vegetative barrier to the wind.

Purpose

Barriers placed perpendicular to the wind direction can reduce wind speeds by changing the pattern of airflow over the land surface, which helps reduce wind erosion and PM_{10}.

Suggestions for Implementation

- The distance of 10 times the barrier height is considered the protected area downwind of the barrier.
- Single row plantings are most popular in field windbreaks because they use less water and occupy the least amount of land area for the amount of protection derived.
- Recommended species for planting can be obtained at all NRCS or University of Nevada Cooperative Extension offices.
- The planting should be done at a time and manner to ensure survival and growth of selected species.
- Moisture conservation or supplemental watering should be provided for plant establishment and growth, as well as the use of drought tolerant species.
- Windbreaks should be aligned across the prevailing wind direction during erosive wind events. While 90 degrees or perpendicular is preferred, benefits can still be realized when windbreaks are aligned as close to perpendicular as possible.
- The interval between windbreaks should be determined using current approved wind erosion technology, available at all NRCS or University of Nevada Cooperative Extension offices.

Windbreaks protecting farmland

Watering

Practice Definition

"Watering" means applying water to non-cropland.

Purpose

Applying water from a truck, tractor or other portable spray system to bare soil surfaces, such as unpaved roadways and equipment yards where high traffic areas exist, can help reduce PM_{10}. Watering the soil surface tends to compact the soil so that it is not dispersed into the air.

Suggestions for Implementation

Watering can be effective during peak usage times, such as silage harvest time.

- Apply water so that the surface is visibly moist.

Applying water to control dust

APPENDIX I

Elements of a Dust Control Plan

General Information

Company Name:
Address:
Phone Number:
Responsible Person:
Address of site that plan is prepared for *(if different than business address above)*:

Introduction

Narrative describing the purpose of the Dust Control Plan

Example: This dust control plan is prepared for [*Company Name*]. The purpose is to minimize particulate emissions and meet the intent of regulation for dust control during and following operations that disturb soil surface areas.

Site Description

Type of operation: (*i.e. dairy and hay farm)*
Scale of operation: _____ acres
Site Map: Draw diagram of area/site that plan is prepared for and attach as a supplement

Sources of Fugitive Dust

Tillage and Harvest:	List and describe any mechanical practices you undertake that disturb crop soils *(or remove or alter crop cover)* and can contribute to fugitive dust.
Crop Production	For land in agricultural production, describe *(in general terms*) agricultural operations that contribute to fugitive dust generation.
Non-Cropland Areas:	Describe *(in general terms)* areas/sites and activities not directly related to producing an agricultural crop or commodity such as: unpaved roads (number of miles); storage sites for materials subject to dust production (number and size); sites/areas with disturbed surface soils or with bare ground that can produce dust (number and size); areas/sites that are in native, or non-farmed, vegetation that can produce dust (number and size).

Dust Control Procedures

Tillage and Harvest:	List and describe management strategies and conservation practices that are planned, or in-place, to control fugitive dust.
Crop Production:	For land in agricultural production, list and describe management strategies and conservation practices that are planned, or in-place, to control fugitive dust.
Non-Cropland Areas:	List and describe management strategies and conservation practices that are planned, or in-place, to control fugitive dust.

Certification

Signature of Owner and Date
Signature of Operator and Date

APPENDIX II

MANAGEMENT AND CONSERVATION PRACTICES TO CONTROL FUGITIVE DUST

Adapted from: San Joaquin Air Pollution Control District - *List of Conservation Management Practices, May 2004*

CROPLAND

PRACTICE/ MANAGEMENT	DESCRIPTION	BENEFITS	EXAMPLES
Alternate Till	Rotate tillage leaving residue on soil	Tilling alternate rows for weed management allows for approximately 50% reduction in field activity. Stabilizes soil surface, reduces soil compaction	Tillage of alternate rows, of vineyard and orchards, thereby reducing passes across field.
Application Efficiencies	Use compact, low volume, or concentrate quantity with spray equipment, aerial applications	Reduces soil compaction, number of passes, and chemical usage	Low volume sprayer heads, photosynthetic i.d heads, hand-spot spraying, variable rate applicators & shielded sprayers, to reduce spray emissions and apply spray to desired pest.
Baling/Large Balers	Using balers to harvest crop	Reduce PM_{10} emissions from chopping, truck passes, residue burning	Bale forage, grain stubble, or crop residue
Bulk Materials Control	Minimize visible dust emissions from bulk materials	Reduces entrainment of fugitive dust	To apply water or suitable chemical/organic , or cover the bulk materials with tarps, plastic or suitable material, or construct wind barriers surrounding the bulk materials
Chemigation/ Fertigation	Application of chemicals thru an irrigation system	Each application reduces the need to travel in-field for application purposes. Reduces the number of passes and soil disturbance, increases efficiency for application	During irrigation, add herbicide or fertilizer through water application; also includes aerial application
Combined Operations	To combine equipment, to perform several operations during one pass	Reduction in the number of passes necessary to cultivate the land and harvest crop will result in fewer disturbances to the soil. Other benefits are reduction of soil compaction and time to prepare fields, both of which can be precursors to additional tillage requirements	Use of one- pass till equipment in ground preparation or crop tillage; cultivation and fertilization of field crop in a single pass; combining cane cutting, disking and flat-furrowing in a single pass for vineyards; bulk movement of commodity from field, gondolas, combined shredding and incorporation.
Conservation Irrigation	To conserve the quantity of water use, e.g.: drip, sprinkler, buried/underground line	Conserves water, reduces weed population, which in turn reduces the need for tillage and reduces soil compaction. Applying a light amount of water or stabilizing material to soil prior to harvest (when possible)	Use drip, or buried line (including permanent or semi-permanent line) in crop production, use of pressure bombs, water flow meters or soil monitoring devices to avoid over-irrigation, adopting the use of evapo-transpiration factors
Conservation Tillage *(e.g., no tillage, minimum tillage*)	Types of tillage that reduce loss of soil and water in comparison to conventional tillage	Reduces the number of passes, soil disturbance. Improves soil because it retains plant residue and increases organic matter.	Converting to no- or low-till operations, implement reduced till activities, adding soil/ water amendments to improve resource and reduce tillage needs
Cover Crops	Use seeding or natural vegetation/regrowth of plants to cover soil surface	Reduces soil disturbance due to wind erosion and entrainment.	Plant or allow volunteer vegetation to grow in crop without tilling under thereby reducing tillage and increasing stabilizing of that portion of soil
Equipment Changes or Technological Improvements	To modify the equipment such as combines, tilling and harvesting equipment, increase equipment size, modify land planes and land leveling, matching the equipment to row spacing, grafting to new varieties or technological improvements	Reduces the number of passes during an operation, therefore reducing soil disturbance.	Increase harvester head size to reduce passes; increase tillage equipment size to reduce passes; grafting to new varieties

CROPLAND

PRACTICE/ MANAGEMENT	DESCRIPTION	BENEFITS	EXAMPLES
Green Chop	The harvesting of a forage crop without allowing it to dry in the field.	Reduces multiple equipment passes in-field, reduces soil disturbance, reduces soil compaction, reduces dust emissions from dry materials.	Alfalfa, winter forage, silage corn.
Irrigation Power Units	Use cleaner burning engines, electric motors (CMP only applicable if engines are cleaner than current rule requirements)	Reduces PM_{10} and NOx emissions.	New Tier II engines, electric motor, other alternative fuels.
Mulching	Applying or leaving plant residue or other material to soil surface	Reduces entrainment of PM_{10} due to winds, reduces weed competition thereby reducing tillage passes & compaction.	May include organic material, gypsum, lime, humus, pre-plant ground covers or plastic mulches for vegetables
Night Farming/Harvest	Operate at night where practical when moisture levels are higher and winds are lighter	Decreases the concentration of PM_{10} emissions during daytime, increased ambient humidity reduces PM_{10} during high emissions periods	Increased humidity increases soil surface moisture thereby helping contain PM_{10} emissions from tillage.
No Burning	Switching to a crop/system that would not require waste burning	Reduces practices associated with pruning and chipping	Non- burning may include; pesticide and seed containers, weeds, prunings, other residual crop residues.
Non Tillage/ Chemical Tillage	Use flail mower, low volume sprayers, use heat delivery system (as harvest pre-conditioner)	Reduces soil compaction, stabilizes soil through elimination or reduction of soil tillage passes	Leaving residue on surface after mowing, using pre-emergent or contact herbicides, scorching of weeds or foliage, mulch to smother weed competition. Semi-permanent crops e.g.: alfalfa will require no tillage.
Organic Practices	Use biological control methods, use non-chemical control methods	Reduces chemical use	Organic certification, biological controls mulches, humus.
Permanent Crops	Having an established permanent crop	Reduces incidence of wind blown dust	Trees, vines or certain semi-permanent field crops, pasture
Precision Farming (GPS)	e.g.: GPS, using satellite navigation to calculate position in the field, therefore manage/treat selective area	Reduces overlap, allows operations during inclement weather conditions and at night.	Install overlap reduction technology, pass markers, variable rate application technology, use petiole and soil sampling to reduce unnecessary applications
Pre-Harvest Soil Preparation	Applying a light amount of water or stabilizing material to soil prior to harvest (when possible)	Reduces PM_{10} emissions at harvest	A light application of water to soil prior to garlic harvest, to help control dust.
Soil Amendments	Organic or chemical materials applied to the soil for improvement	Increase moisture retention, reduce soil compaction, stabilize soil.	May include Organic material, gypsum, polyacrilamide, humus, pre-plant ground covers
Surface Roughening	Leaving soil surface with clods of soil when fallow, preparing planting surface perpendicular to wind direction	Reduces entrainment of PM_{10} due to winds	Till perpendicular to predominate wind direction. Can be used during high wind period such as March -June to reduce geologic emissions.
Timing of Tillage and Planting	Tillage/planting based on soil moisture and at times when soil not susceptible to wind erosion.	Adequate soil moisture binds soil particles and reduces PM_{10} emissions; harvest and tillage operations timed when wind erosion potential is low.	Plant/till early in early AM when wind velocities are low; irrigate fields and allow minimum time for dry out prior to tillage/planting.
Transgenic Crops	Use of GMO or Transgenic crops	Reduces need for tillage or cultivation operations, reduces soil disturbance.	Round Up-ready alfalfa or corn
Wind Barrier	Artificial or vegetative wall/fence that disrupts the erosive flow of wind over unprotected land	Reduces entrainment of PM_{10} due to winds	Plant various wind breaks around farmstead with plants such as, oleanders, populars, juniper, native grass.

NON-CROPLAND

PRACTICE/ MANAGEMENT	DESCRIPTION	BENEFITS	EXAMPLES
Chips / Mulches	Application of any non-toxic chemical or organic dust suppressant which meets any specification required by any federal, state, or local water agency and is not prohibited for use by any applicable regulations. See Regulation VIII for additional requirements and see Agriculture Improving Resources (AIR) Partner's list of products available	Reduces entrainment of fugitive dust	Application of suppressant to areas meeting the vehicle trips per day threshold
Gravel	Placing a layer of gravel with enough depth to minimize dust generated from vehicle movement and to dislodge any excess debris which can become entrained	Reduces entrainment of fugitive dust	To add a layer of washed gravel, rock, or crushed rock
Mechanical Pruning	Using a machine instead of hand labor to prune	Reduced vehicle trips, thereby reducing P.M. emissions	Pruning style can include tree hedging, topping, summer pruning, trimming, vineyard hedging or other mechanical pruning operations
Paving	To pave currently unpaved roads	Prevent dust from vehicle traffic	To pave unpaved roads
Restricted Access	To restrict public access to private roads	Reduces vehicle traffic and thus reduces associated fugitive dust	To install a device which will limit use of road on or surrounding an operation
Speed Limits	Enforcement of speeds that reduce visible dust emissions	Dust emissions from unpaved roads are a function of speed meaning reducing speed reduces dust	Posting speed limits on or surround the operation
Track Out Control	Minimize any and all material that adheres to and agglomerates on all vehicles and equipment from unpaved roads and falls onto a paved public road or the paved shoulder of a paved public road	Reduces entrainment of fugitive dust	Accomplished by maintaining sufficient length of paved/ graveled interior roads to allow mud and dirt to drop off vehicles before exiting the site; or use of a grizzly to dislodge debris from tires and undercarriage of vehicles leaving site.
Water	Application of water to unpaved roads and traffic areas	Reduces entrainment of fugitive dust	Application of water to areas meeting a vehicle trip threshold
Wind Barrier	Artificial or vegetative wall/fence that disrupts the erosive flow of wind over unprotected land	Reduces entrainment of fugitive dust due to winds	Plant various wind breaks around farmstead with plants such as, oleanders, eucalyptus, juniper native grass or tillage perpendicular to field till, etc

References

The following publications were reviewed and/or utilized to prepare this guide.

Agency/University/Organization	Publication Date/Reference Date	Publication	Author(s)/Reference
Agriculture Improving Resources (A.I.R.) Partners	May 2004	Agricultural Air Quality Conservation Management Practices for San Joaquin Valley Farms	
Arizona Department of Environmental Quality	August 2004	Revised PM_{10} State Implementation Plan for the Salt River Area	
Arizona Department of Environmental Quality	June 2001	Technical Support Document For Quantification of Agricultural Best Management Practices	URS Corporation
Arizona Governor's Agricultural BMP Committee	February 2001	Guide to Agricultural PM_{10} Best Management Practices (Maricopa County, Arizona PM_{10} Non-Attainment Area)	First Edition
Clark County Dept. of Air Quality and Environmental Mgmt.	2006	The Clark County Department of Air Quality and Environmental Management, 2005 Performance Report	
Clark County Dept. of Air Quality and Environmental Mgmt.	2004	Air Quality Questions & Answers - Particulate Matter	
Conservation District of Southern Nevada	June 2004	A Resident's Guide To Improving Our Air Quality, Help Keep Our Air Clean	
Montana State University	2005	Soil & Water Management Module 3, Managing For Soil Erosion	A. McCauley, C. Jones
Nevada Division of Environmental Protection	2001	Nevada Resource Guide To Agricultural Dust Control Practices	
San Joaquin Air Pollution Control District	May 2004	List of Conservation Management Practices	
South Coast Air Quality Management District	August 2003	2003 Coachella Valley PM_{10} State Implementation Plan	J.C. Lester, Ph.D, M. Laybourn, A.I.C.P.
State of Nevada	Last Verified on October 2006	Nevada Administrative Code, Emissions of particulate matter: Fugitive Dust.	Nevada Revised Statutes

References *continued*

Agency/University/Organization	Publication Date/Reference Date	Publication	Author(s)/Reference
USDA Agricultural Research Service	2001	Wind Erosion and Air Quality Research in the Northwest U.S. Columbia Plateau: Organization and Progress	K. Saxton, D. Chandler, et al.
USDA Natural Resources Conservation Service	October 2002	National Agronomy Manual	(190-V-NAM, 3rd Ed.)
USDA Natural Resources Conservation Service	August 1999	CORE4 Conservation Practices Training Guide	
USDA Natural Resources Conservation Service	May 2001	Soil Quality Information Sheet, Rangeland Soil Quality--Wind Erosion	Rangeland Sheet 10
USDA Natural Resources Conservation Service	October 2003	National Environmental Compliance Handbook, 610.81 Air Quality and the Clean Air Act	(190-VI-NECH, First Ed.)
USDA Natural Resources Conservation Service	February 2006	Conservation Resource Brief, Air Quality	(Number 0605)
USDA Natural Resources Conservation Service	Last Verified on July 2006	Soil Quality Management	http://soils.usda.gov/sqi/management/index.html
USDA Soil Conservation Service	January 1994	Soil Erosion by Wind	Agriculture Information Bulletin Number 555
USDA-ARS National Soil Erosion Research Laboratory (Purdue University)	Last Verified on July 2006		http://topsoil.nserl.purdue.edu/nserlweb/weppmain/overview/wndersn.html
Washington State University	February 2004	Farming with the Wind II, Wind Erosion and Air Quality Control on the Columbia Plateau and Columbia Basin	R. Papendick (XB1042)
Western Governors' Association	November 2004	WRAP Fugitive Dust Handbook	(WGA Contract No. 30204-83)

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