RECOMMENDED PRACTICES MANUAL

A
GUIDELINE
FOR
MAINTENANCE AND SERVICE
OF
UNPAVED ROADS

CHOCTAWHATCHEE, PEA and YELLOW RIVERS
WATERSHED MANAGEMENT AUTHORITY
FEBRUARY 2000

ACKNOWLEDGMENTS

This manual is the realization of the vision and effort of a group of men and women committed to preserving and enhancing the quality of our water resources, and the environment in general, while improving the methods of maintaining our unpaved public road infrastructure. Their endeavor has been to incorporate a new way of thinking. This is being done by introducing new ideas and innovations to effect positive changes from traditional approaches to unique and even revolutionary approaches toward maintaining our unpaved roads and ditches. Paramount to this has been educating our society of the need for enhanced environmental sensitivity.

While many have been pro-active in this endeavor, special recognition is given to Mr. Joe K. Parker, Chairman, Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority for his tenaciousness in addressing unpaved roadway problems and in energizing the CPYRWMA to be pro-active in taking the initiative to help solve these problems. Acknowledgment is also due Mr. H. Estus Walker, former Executive Director, in his active leadership and skill spearheading the initiative, consolidating the necessary resources, and putting into motion events which led to the publishing of this manual.

A special thanks to all those professionals and laymen who gave of their time, shared their knowledge and experience, and shared their ideas to help make this a manual a reality.

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DISCLAIMER

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INTRODUCTION

Funding Source

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Participants

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Purpose

To provide a written manual of standard procedures which describe and illustrate cost effective techniques and practices which can be used to enhance stability and maintenance of unpaved roadways while reducing sedimentation and improving the quality of surface waters in the Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority (CPYRWMA) counties in south Alabama and northwest Florida. County and City Engineers, road maintenance crews, private companies, lake associations, select Boards and Authorities, and the citizenry of Alabama can effectively use this manual.

Need

The costs involved in maintenance of unpaved roads is one of the most significant items in the budgets of most southeast Alabama counties. Erosion of unpaved roads and their drainage systems is the single most significant factor affecting maintenance needs and costs involved with these roadway systems. The costs to the counties and local municipalities, due to roadway erosion, is not limited to direct costs associated with keeping these unpaved roads passable, but also include additional costs due to increased flooding, impaired waterway navigation, loss or impairment of stream or lakeside recreational areas, loss of fisheries and other riparian zone natural resources, adverse effects on the natural food chain, and loss of aesthetics which can have profound effects on tourism and general business growth. Most of the latter-mentioned effects are considered in today's social climate to be *environmental* issues, and they are; but rest assured, they are very real economic concerns as well.

Erosion of unpaved roadways occurs when soil particles are loosened and carried away from the roadway base, ditch, or road bank by water, wind, traffic, or other transport means. Exposed soils, high runoff velocities and volumes, sandy or silty soil types, and poor compaction increase the potential for erosion. Loosened soil particles are carried from the road bed and into the roadway drainage system. Some of these particles settle out satisfactorily in the road ditches, but most often they settle out where they diminished the carrying capacity of the ditch, and in turn cause roadway flooding, which subsequently leads to more roadway erosion. Most of the eroded soil, however, ultimately ends up in streams and rivers where it diminishes channel capacity causing more frequent and severe flooding, destroys aquatic and riparian habitat, and has other adverse effects on water quality and water-related activities.

Aggravating causes of erosion on unpaved roadways include erosive road-fill soil types, shape and size of coarse surface aggregate (if any), poor subsurface and/or surface drainage, wet and dry road fill moisture extremes due to atmospheric conditions, freeze/thaw cycles, poor roadbed construction (poor graded material, inadequate compaction), roadway shape, roadway shading/sunlight exposure, traffic parameters such as speed, volume, vehicular weight, and lane patterns, exposed soils, untimely road and drainage system maintenance, excessive off-site runoff, and lack of adequate numbers of runoff discharge outlets (turn-outs) from the roadway. This is not an all-inclusive list of causative factors of erosion; however, it should be enough to make apparent the scope of the problem and the need for a comprehensive, wide-spread, maintenance guideline which incorporates the knowledge and experience of pertinent professionals and skilled laymen from throughout the concerned areas in an effort to reduce roadway maintenance needs and costs through erosion control on unpaved roads. The result will be money freed from maintenance and repair expenditures becoming available for more productive projects such as more substantial roadway improvements, etc., and subsequently, an improvement in the overall economy of the Choctawhatchee, Pea, and Yellow River basins.

Chapter 1
ROAD SURFACE

Description

Unpaved roads carry local traffic between rural lands and communities, and provide connecting links between paved collector roads. More than 25% of the roads in the Choctawhatchee, Pea, and Yellow River watersheds have an unpaved or gravel surface. Most of these roadways consist of sandy to sandy clay loam soil material. These roadway surfaces and ditches are subject to erosion and degradation which lead to sedimentation within watercourses, streams, and rivers.

Importance to Maintenance & Water Quality

Disturbances to unpaved roadway surfaces and ditches, and poor road surface drainage always result in deterioration of the road surface. This deterioration is the erosion which accounts for a large percentage of unpaved road maintenance costs and stream sedimentation. Frequent, excessive, and unnecessary disturbances to the roadways are all too common because of political pressure from the public to continually blade roads, and the common practice of wholesale blading adopted by administrators and operators over the years. Proper and timely surface maintenance, selectively performed, will help reduce the amount of roadway being disturbed, and will reduce the amount and frequency of disturbance to the section of roadway requiring maintenance.

Proper, timely, and selective surface maintenance, which includes water disposal, prevents and minimizes erosion problems, thereby lengthening the life of the road surface which in turn lessens frequency and cost of maintenance. This will also decrease the amount of sediment carried into surface waters. Frequent and excessive disturbance of the roadway surface and ditches, and failure to direct surface water from the road surface to a drainage channel results in deterioration of the road surface, which leads to other roadway problems which may impair traffic flow and traffic safety, among other things.

Surface Profile, Grading, and Drainage Characteristics

General

Do not disturb roadway sections which *do not* need maintenance while repairing, blading, or grading those sections which do. When routine maintenance is being performed, limit the amount of disturbed areas to that which can be re-established to the desired final shape by the end of the work day. To minimize opportunity for degradation of the roadway, it is best not to blade, grade, or drag if rain or freezing temperatures are favorable within the 48 hour forecast. As much as possible, avoid non-essential or non-emergency work near streams or stream crossings during the "wet" months of the year. Save this work for drier seasons.

It is best to limit roadway blading to times when there is enough moisture content to allow for immediate re-compaction. Often, an optimum time for this is soon after a rain while the surface materials are still moist but not too wet. Blading with little moisture content in the soil is futile, and is often a causative factor in road surface degradation such as "washboarding" and other problems associated with loss of fines.

As shown in figure 1-1, crown roads 3/4 to 1 inch for each foot of road width, measured from the center of the roadway to the outside edge, to ensure good drainage. Roads in deep loose sands may be crowned 1/4 inch or less for each foot of road width from center of the roadway to the back of ditch. In this instance, there is no defined ditch front slope due to the excessively erosive nature of the sand. Rather, the extra road width provides drainage at the outer edges of the roadway. Proper crowning and compacting of the road surface quickens the removal of runoff, thus protecting the road surface from degradation.

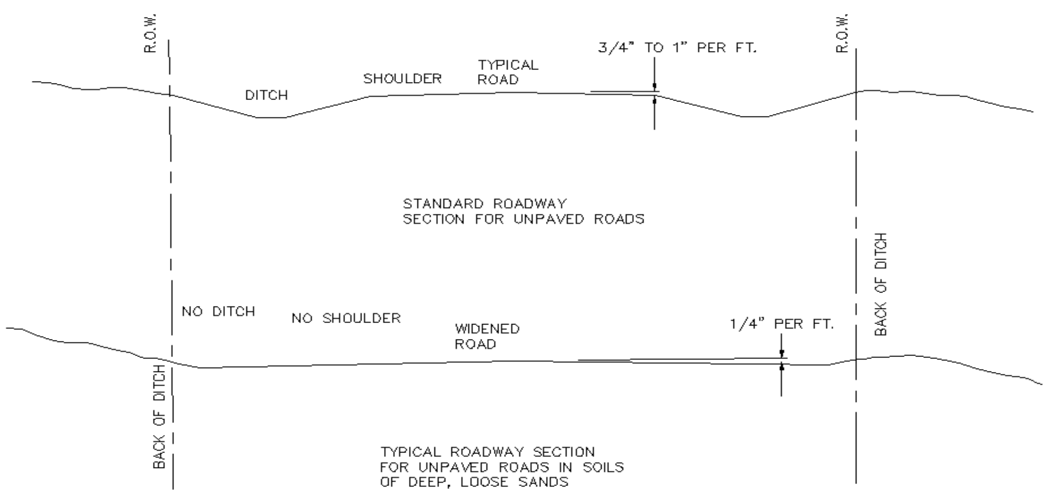


Figure 1-1. Typical Sections - Unpaved Roadway

Exhibit 1.1a - Examples of 3/4" to 1' crown with road ditches in place. Water sheds readily off the crowned road surface and into the ditches. Proper drainage off the roadway surface helps to maintain a good "crust" which stabilizes the roadway and helps provide a good riding surface.

Exhibit 1.1b - Examples of 0" to 1/4" crown with no road ditches in place. Water infiltrates the soil of the sandy and flat road surface minimizing runoff from the roadway. The water that sheds from the roadway is readily removed from the road surface into the roadway edges allowing a passable lane in the center of the roadway.

Exhibit 1.1 - Typical Crowns and Sections Of Unpaved Roadways

Proper moldboard forward tilt for blading.

Proper blade angle and wheel lean.

Unnecessary Blading. Road is adequate.

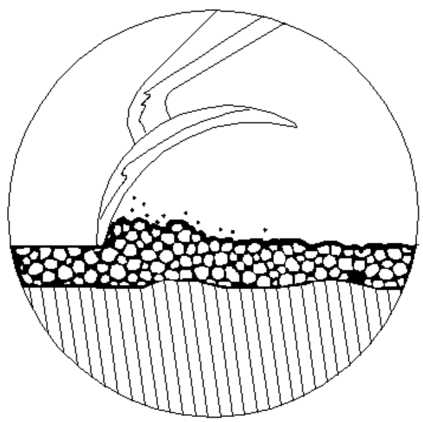
Rutted, weathered, and rough surfaces require blading. Blading shaves high spots and fills low spots.

Exhibit 1.2 - Blading

Performance

Blading and Dragging

Blading and dragging is a smoothing operation which pulls loose material from the side of the road or spreads wind-rowed aggregate to fill surface irregularities and restore the road crown. It is performed with the moldboard tilted forward with light down pressure on the motorgrader blade as shown in figure 1-2. The angle of the moldboard is adjusted to between 30 and 45 degrees, and in most cases, the front wheels are tilted slightly 10 to 15 degrees toward the direction the aggregate should roll.



TILT MOLDBOARD
FOR DRAGGING ACTION

Figure 1-2. Blading

The following should be adhered to when blading:

a. Avoid blading during extended dry periods to minimize the loss of fine aggregates and minimize "washboarding".

b. Blading/dragging speed depends on the operator's skill, type and condition of machine (grader), tire pressure, and road surface condition. Normally, **three miles per hour in second gear is advised**.

c. Periodically blade the road surface against traffic flow to prevent aggregate from drifting onto ends of bridges, culverts, intersections, and railroad crossings. This is commonly referred to as "back dragging".

d. On hill crests, avoid cutting into the road surface, gradually adjusting the blade up as the front wheels pass over the crest and then down as the rear wheels follow (figure 1-3a).

e. In valleys or swags, gradually adjust the blade down as the front wheels pass the lowest point and then adjust the blade up as the rear wheels follow. This will prevent loose, easily erodible materials from piling up where runoff and concentrated flows frequently occur, thus preventing loss of valuable road fill, and preventing massive sedimentation to local streams and waterways (figure 1-3b).

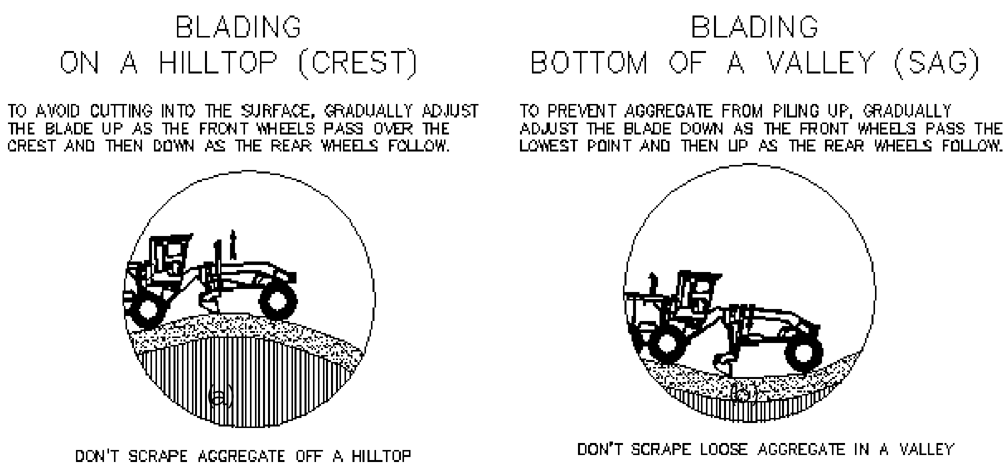


Figure 1-3. Blading on Hill Crests and in Valleys or Swags

Reconstructive Grading

Reconstructive grading consists of cutting through, redistributing, and re-compacting the road surface crust, and/or adding new road fill material to obtain the desired roadway shape and profile. This method is used when reshaping the roadway or when the correction of major surface defects such as deep ruts, soft spots, severe erosion, etc. is necessary. Figure 1-4a shows motor grader cutting operations performed with the moldboard tilted backward with sufficient down pressure on the blade to produce a cutting action. Breaking the crust with a scarifying rake may be required before moldboard work can be performed (see figure 1-4b).

Deep rutting often requires grading work. Such ruts are frequently caused by heavy machinery such as farm equipment and feed trucks.

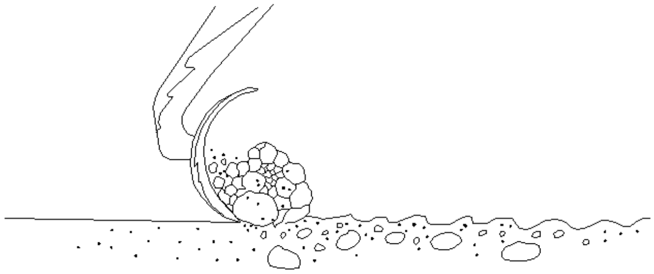
Exhibit 1.3 - Grading

Clay surface layer placed over sandy roadway surface

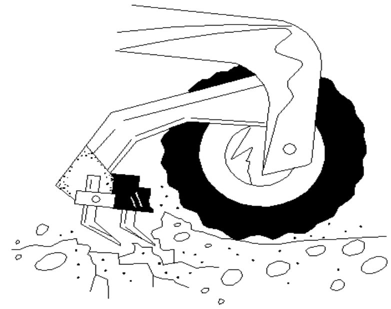
Clay blended into roadway surface with scarifier and blade

Aggregate blended into clay surface layer with scarifier

Exhibit 1.4 - Grading Using Scarifier and Blade



(a)



(b)

Figure 1-4. Grading Tools

The following should be adhered to when grading:

a. Perform grading cutting operations with the outer edge of the moldboard at the road surface's edge.

b. If the road ditch is not to be re-worked along with road grading operations, keep a minimum of one foot from the ditch line so that vegetation or rock stabilization is not disturbed. In this case, grading work must always bring the road surface back up to and slightly above the ditch line elevation to allow road surface runoff to flow into the ditch and not create a *false ditch* down the roadway (figure 1-5).

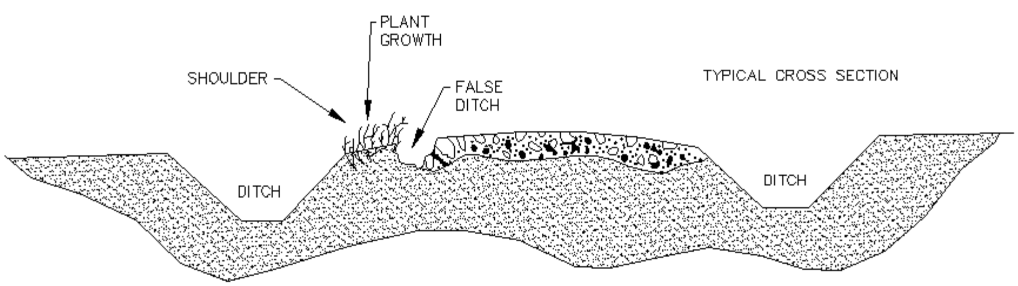


Figure 1-5. False Ditch

c. Lightly scarify the existing road surface before adding new material. This blends the soils and improves cohesion.

d. Adding new material should be done by running the dump truck down the center of the roadway and dumping as it travels. The new material should then be blended with the scarified old material using a grader, and compacted.

e. To reduce potential roadway degradation, the entire width of the of the roadway disturbed by grading should be compacted by the end of the day.

f. Positive drainage to road ditches or other outlets must be established throughout the entire finished road surface.

Distress Conditions

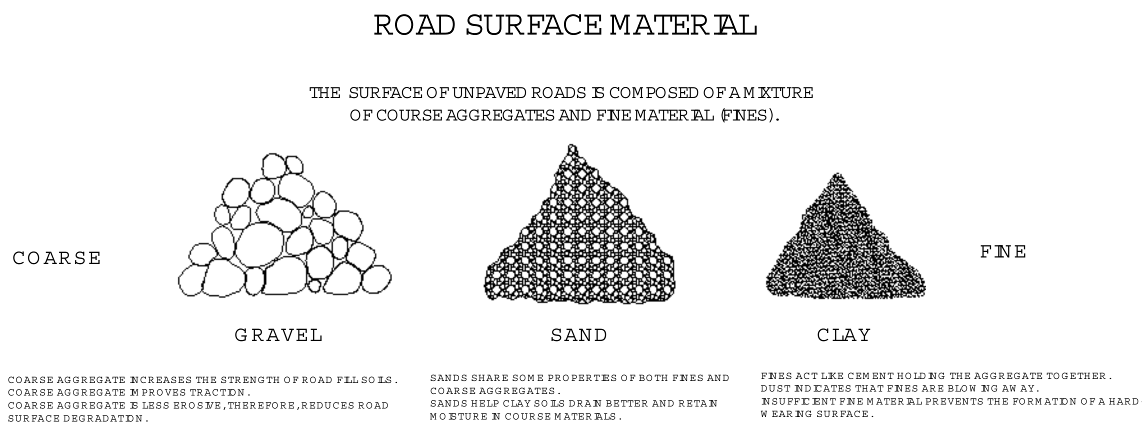


Figure 1-6. Aggregate Comparison

Surface Deteriorations

Dust

Dust in the air is a loss of fine, binder aggregates from road surfaces. Loss of these fines leads to other types of road distresses such as loss of cohesion and compaction of the road fill material, and reduced capacity to maintain moisture in the road fill. These deficiencies also tend to feed on themselves, compounding the problems - especially the lack of moisture within the road fill. Mechanically adding water to the road surface for dust control is a very short-term, expensive, and infeasible solution. In some cases, dust can be reduced by applying chemical additives which draw moisture from the air to improve fine aggregate cohesion, however, this also can be an expensive solution and may be feasible only in the most severe cases.

Ravelling

Ravelling is the loss of coarser aggregates. This is brought about when the coarser aggregates are worn away by traffic after fine, binder aggregates have been lost due to dust or erosion. Correct by grading or blading with the addition of fines or other binder to improve surface gradation and composition.

Slipperiness

Slipperiness is caused when the road surface contains excessive fine aggregates in proportion to coarser aggregates, especially within the crust. Traffic wear can reduce coarse aggregates to finer aggregates, thus dis-proportioning the original road fill aggregate mix. During wet weather, the road surface becomes slippery and may become impassible. This problem can be corrected by mixing the surface fines with coarser aggregate by grading and/or blading the road surface and compacting back in place. Occasionally, coarser aggregate will need to be hauled in and added to the roadway.

Surface Deformations

Surface deformation problems are almost solely the end result of excessive moisture in the road fill and thus can be reduced with proper road surface and road ditch maintenance.

Rutting

Ruts are longitudinal depressions in the wheel paths caused by high moisture content in the subsurface soil or base, inadequate surface course thickness, and /or heavy traffic loads. Rutting can be corrected by adding suitable material, grading, crowning, and rolling the road surface. Do not simply fill ruts with stone or soil. Filing ruts with stone can lead to new ruts being generated beside the original ones and thus would be an expensive and temporary "fix" which can also interfere with grading. The surface must be re-mixed and properly bladed or graded in more severe cases.

Areas of sustained and repeated rutting may require more severe measures. An elaborate drain system and/or geotextile fabric foundation with a crushed stone road fill may be used to correct severe rutting problems.

Corrugating/"Washboarding"

Corrugating/"washboarding" is a series of ridges and depressions across the road surface caused by the lack of surface cohesion. This lack of cohesion is a result of the loss of fines in the road surface which, in turn, is usually a result of very dry conditions within the road surface. These conditions are aggravated and enhanced by excessive vehicle speeds and high traffic volumes.

Where surface fines are segregated from coarser aggregates, blading with sufficient moisture content can repair the road surface. When the causative problem is of loss of fines, blading alone is not recommended. The problem will only recur shortly thereafter. The problem is best corrected by scarifying the road surface while damp, thereby re-mixing the road surface with a good percentage of fines, regrading, re-establishing the crown, and compacting the surface.

Depressions

Depressions are localized low areas one or more inches below the surrounding road surfaces caused by settlement, excessive moisture content, and improper drainage. These are larger areas not to be confused with potholes.

Depressions should be corrected by filling them with a well-graded aggregate, then grading the effected road surface, and compacting. Underdrains or cross drains may be necessary to improve drainage and prevent recurrence.

Potholes

Potholes are small depressions or voids in the road surface one or more inches deep which are caused by excessive moisture content, poor drainage, poorly graded aggregate, or a combination of these factors. Potholes may be corrected by patching with well-graded materials and compacting, and/or spot grading. Large areas of potholed road surface indicate a poor road fill condition over an extended section of roadway, and thus may require the re-grading, re-crowning, and re-compacting of the affected roadway section to mix aggregates into a well-graded road fill and improve road surface drainage. Underdrains may also be necessary in these areas to drain the sub-grade.

Softspots

Softspots are areas of the road surface and/or sub-grade made weak by poor drainage. These areas depress under vehicular weight and almost always develop one or more of the other types of surface deformations. These areas can be corrected by improving drainage conditions or

False ditch created by vegetal impediments

False ditch created by shoulder traffic and rutting

Washboarding

Slipperiness

Rutting

Exhibit 1.5 - Roadway Surface Problems

Soil stockpile located on the crest of a hill where runoff is minimal

Soil stockpiles located on a well vegetated hillcrest and away from concentrated flow channels

Exhibit 1.6 - Storing and Stockpiling Soil Materials

replacing the soft spot with more drainable materials. Depending on the cost effectiveness and feasibility of each, the following methods may be used to correct soft spots:

a. Improving the drainage of the road fill and/or sub-grade with underdrain. This method is outlet dependent.

b. Improving the drainage of the road fill and/or sub-grade by grading road ditches low enough to remove water from beneath the problem area. This may involve piping to move water from one side of the road to the other. This method is outlet dependent.

c. Patching the soft spot area with a suitable material such as well-graded stone or gravel.

d. A combination of the above.

Storing and Stockpiling Soil Materials

Improper storing or stockpiling of soil material can increase the amount of sediment that enters streams and damage sensitive areas, particularly wetlands. Soil materials should not be placed in or along wetlands, drainage ditches, swales, stream banks, areas within 50 feet of (and drain into) a waterway, and against slopes that are more than 2 horizontal to 1 vertical. Always ensure the area down slope of the storage area has an adequate vegetated filter strip to trap sediments, or use a properly installed and maintained silt fence or other barrier. Seed or vegetate any fill or spoil disposal areas as soon as possible.

Plan erosion-safe storage and stockpiling areas ahead of time, especially in the winter and early spring when rainfall can be high and vegetative cover minimal. Level to gently sloping, grassed areas usually provide good storage sites. Hilltops, ridges, and inactive or active borrow pits also often provide good sites. These planned storage areas will help reduce sedimentation and will also provide the opportunity to utilize these materials later when needed for roadway repairs. This can reduce overall maintenance costs by saving fill material and making it conveniently and readily available. Figure 1-7 illustrates proper stockpiling techniques of soil materials.

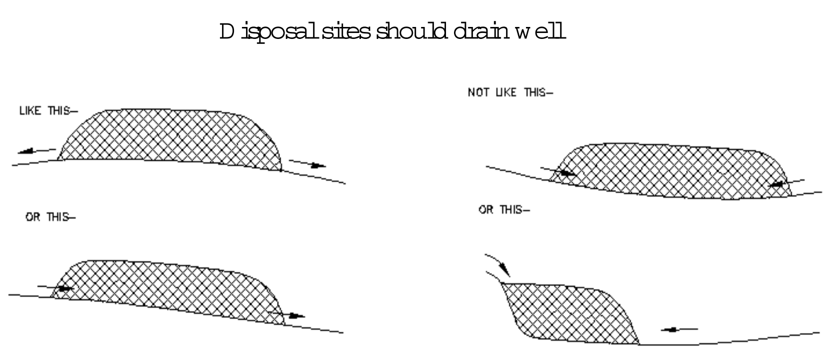


Figure 1-7. Soil Material Storage Site Configuration

Chapter 2

DITCHES

Description

Ditches are constructed to convey water from storm runoff to an adequate outlet. A good ditch is shaped and lined using the appropriate vegetative or structural material and does not cause flooding, erosion, or sedimentation. Energy dissipating structures to reduce velocity, dissipate turbulence, or to flatten flow grades in ditches are often necessary.

Importance to Maintenance & Water Quality

Efficient disposal of runoff from the road will help preserve the road bed and banks. Well vegetated ditches slow, control, and filter runoff providing an opportunity for sediments to be removed from the runoff water before it enters surface waters. In addition, a stable ditch will not become an erosion problem itself. Ideally, "turn-outs" (intermittent discharge points also called "tail ditches") will help maintain a stable velocity and the proper flow capacity within the road ditches by timely outleting water from them. This will help alleviate roadway flooding, reduce erosion, and thus reduce maintenance problems. In addition, properly placed "turn-outs" help distribute roadway runoff and sediments over a larger vegetative filtering area, helping to reduce the amount of road ditch maintenance required to remove caught-up sediment.

Ditch Profile and Grading

General

Roadway ditch location, profile, shape, lining and outlets effect how efficiently water will be removed from the roadway. Ideally ditches should resist erosion, be self cleaning, and discharge onto nearly level vegetated areas, thus maximizing the length of time between regrading, thereby reducing maintenance costs. As shown in figure 2-1, ditches should be located on the uphill side of the roadway to prevent runoff water from flowing onto and over the road surface.

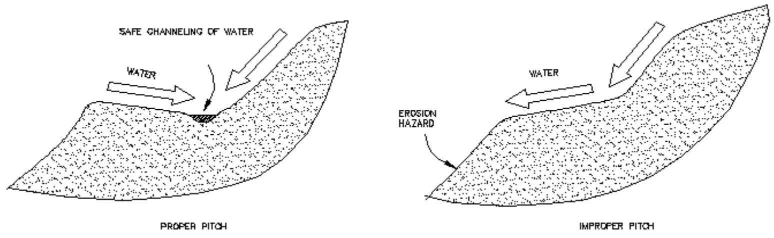


Figure 2-1. Hillside Pitch of Roadway and Proper Ditch Location

Excavate roadway ditches at a bottom elevation 1 to 2 feet below the road base. The ditch bottom should be rounded-V shaped (preferred), parabolic, or flat, as shown in figure 2-2, and at least 2 feet wide to disperse the flow and slow the velocity. Do not construct U-shaped ditches. U-shaped ditches actually have up to 30 percent less drainage capacity than other shapes and they tend to look messy. Their steep sides make maintenance difficult and the sides tend to cave in, compounding maintenance problems and adding to erosion and sedimentation.

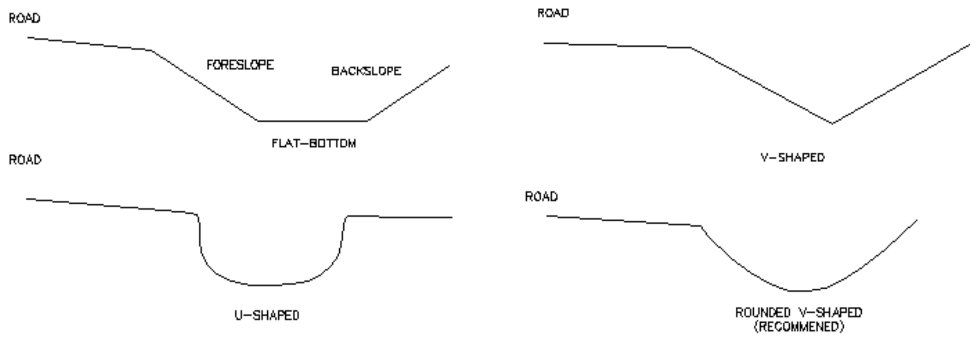


Figure 2-2. Common Ditch Shapes

Where possible, install "turn-outs" ("tail-ditches") to help maintain a stable velocity and the proper flow capacity within the road ditches by timely outleting water from them. See Figure 2-3 below. These structures are critical elements in establishing and maintaining a stable unpaved roadway drainage system. It is imperative that landowners adjacent to these roadways allow water to be discharged in this manner at crucial points. Correspondingly, these turn-out points must be stabilized to prevent creating worse erosion problems such as gullies. In many cases, the discharged runoff can be spread to reduce the erosive energy of concentrated flows.

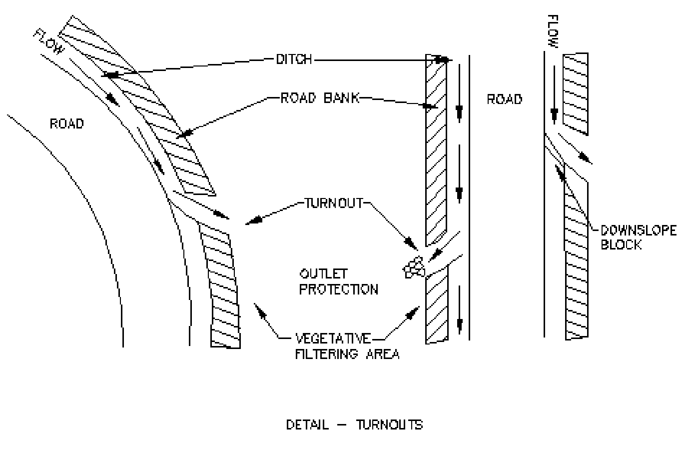


Figure 2-3. Typical Locations for "Turnouts" ("Tail Ditches")

No ditch on the uphill side of the roadway can allow runoff to overflow the roadway. This leads to surface erosion of the roadway, such as these corrugating rills, and often to complete washouts. Road surface overflow is a significant contributor to sedimentation, especially during high runoff events.

Exhibit 2.1 - Proper Ditch Location

Flat Bottom (Trapezoidal) Shaped Ditch

V-Shaped Ditch

U-Shaped Ditch

Rounded V-Shaped Ditch

Exhibit 2.2 - Common Ditch Shape Examples

Motorgraders can be used to create and maintain tail ditches, however, backhoes and dozers can be more efficient and leave much less loose and disturbed soil which is easily and readily washed out.

Exhibit 2.3 - Tail Ditch/Turn-Out Construction with a Motor Grader

Turn-out to a drop inlet.

Turn-out at gradient changes.

Turn-out before bridges.


Turn-outs into filtering areas.

Turn-outs/Tail ditches outlet water from roadway ditches to maintain a stable flow volume and velocity within the ditches. They can be placed at specific and selected sites to protect down gradient structures such as bridges and culverts, or to utilize specific erosion control or storm water discharge facilities.

Exhibit 2.4 - Turn-outs/Tail Ditches

Line ditches which have a channel slope less than 5% with grass, and line those which have a 5% or greater channel slope with geo-fabric or aggregate filter underlain riprap or other material *(Concrete lining is not recommended on unpaved roads in the CPYRWMA area due to the highly erosive sandy soils and the potentially volatile nature of unpaved road degradation during intense storms common to this area).* Line ditches as soon as possible to prevent erosion and to maintain the ditch profile. Whenever possible, excavate ditch only as far as lining can catch up before the next expected or potential rainfall event.

All ditches should have appropriate outlets which allow water to completely drain from them. Standing water in ditches against road fill weakens the roadway. The preferred equipment for creating ditches is a rubber-tired excavator with an articulated bucket. A well designed and constructed road ditch can be cleaned with a grader or excavator making maintenance quicker, easier, and less costly.

Other Applications

Diversion ditches and berms may be used as structures to intercept, consolidate, and direct or redirect runoff at the top of a slope to prevent gullies and rills on slopes, or across the slope to break up the slope length or redirect water flow. These ditches and berms should be located where the outlet will empty onto a stable disposal area. Ditches and berms may be used in combination where runoff is significant and/or hard to control.

Cleaning & Maintenance

Check all ditches, including "tail-ditches" and "turn-outs", after major storm events, as the storms may have caused obstructions, erosion, or bank collapse. Have a post-storm plan for checking for damage and determining maintenance needs.

Clean out ditches, when they become clogged with sediments or debris, to prevent ponding, bank overflows, and road washouts. Re-grade ditches <u>only when absolutely necessary</u> and line with vegetation or stone as necessary. Re-grading of ditches should be limited to late spring or summer, after spring rains have diminished and drier weather has set in, and when vegetation can re-establish itself. Other times may be suitable depending on weather patterns, work to be performed, and exigency of work to be done. The main concern is to limit disturbance to the ditches during times of high erosion potential.