UNPAVED SURFACES

07.01 SCOPE

07.01.01 MILEAGE OF UNPAVED ROADS

This manual is intended for internal guidance only and is not intended to create a legal or moral duty. Supervisors have discretion, based upon their expertise and the particular circumstances, to deviate from this manual and to conduct additional research or receive input from experts in other areas, as needed.

The greatest number of road miles in the United States is unpaved. Maintenance of these roads is very important because they must carry local traffic back and forth between farms, small mills, and villages. These roads must also serve as links connecting the paved arteries that carry the main streams of traffic.

The West Virginia Highway System consists of approximately 35,000 miles. Of this total mileage about 17,000 miles or 47 percent, have unpaved surfaces. This high percentage gives some idea of the relative importance of the maintenance of these surfaces to the entire State. As a result of the increasing number and length of school bus routes, and of the ever-growing movement of people out of towns and cities, it has become necessary for the West Virginia Division of Highways to maintain a large percentage of the unpaved roads as year-round roads.

The objectives of the maintenance program for unpaved surfaces are to provide greater safety and comfort for the traveling public, to reduce the cost of vehicle operation, and to preserve the State's investment in roads. This chapter is written with these basic aims in mind. Experience and unusual local conditions will sometimes dictate the need for some minor modifications in the procedures that are described and recommended in the following sections. However, these procedures are to be used as the basic guides for performing maintenance operations on unpaved surfaces.

07.01.02 TYPES OF UNPAVED SURFACES

07.01.02.01 MATERIALS

The surfaces of some unpaved roads consist of natural soil or earth. Other surfacings for unpaved roads are mixtures of granular material and clay. The granular material may be sand, stone, gravel, crushed slag, chert or shale.

Sometimes these materials are used without clay as a binder. However, a small percentage of clay added to these materials will aid in compaction and provide a more stable roadway surface.

07.01.02.02 NATURAL SURFACES

A road with a surface of natural soil or earth is the lowest type of road. Such a road is constructed by performing simple grading and shaping operations with the minimum necessary provisions for drainage. Satisfactory drainage is absolutely essential to obtain good service from any road or highway, regardless of the surface type.

07.01.02.03 SURFACING MIXTURES

A sand-clay road is constructed by mixing sand and clay in proper proportions. This type of surface is considered superior to a natural earth road, because a sand-clay road is more resistant to rutting and softening under traffic during periods of wet weather. Even better than a sand-clay road for carrying traffic satisfactorily during all kinds of weather is a road surface that consists of a mixture of soil, sand and larger mineral aggregate, such as gravel, crushed stone, crushed slag, or shale.

07.01.03 THICKNESS OF SURFACING

The compacted thickness of the surface material of an unpaved road must be at least 4 inches. As the volume of traffic and the vehicle weight increases, the required thickness for an adequate maintainable unpaved surface must also increase. Eventually, economic factors may dictate that paving be considered.

07.01.04 SHAPE OF SURFACE

07.01.04.01 CROWNED AND SUPERELEVATED SECTIONS

Satisfactory typical sections for unpaved road l8 feet wide are shown in Figure 07-1.

In each case, the portion of the road on one side of the center line is shown on an embankment or fill. A crowned section is shaped like a flattened inverted letter "V". A crowned section is not suitable on a curved portion of a road for two important reasons. There is the danger that a vehicle will slide off the road if its wheels cross the centerline of the roadway. Even if the vehicle stays on the road, the sliding will result in increased loss of surface material.

To overcome these objections to a crowned section, a superelevated section is used wherever the curve of the road is appreciable. A superelevated section slopes upward uniformly from the inner edge of the roadway to the outer edge.

The rate of slope on a crowned section depends on the type of the road surface and should be sufficient to permit water to flow rapidly off the roadway. This rate should not be less than l/2 inch per foot of width nor more than 3/4 inch per foot. If the road were constructed with a rounded crown, the slope in the middle portion of the roadway would be so flat that surface water would tend to collect there. Such water

could cause soft spots and potholes in the surface. The inverted "V" section has the additional advantage that the average grader operator can shape and maintain the surface much more easily than when a section with a curved or parabolic crown is used. The rate of superelevation on a curved portion of the road depends on the degree of curve and the allowable speed of the traffic.

07.01.04.02 SHOULDERS AND DITCHES

Where the roadway has a crowned section, the slope of the shoulder is 1 in. per ft. (25mm per 300mm) of width, as shown in Figure 07-1. On a superelevated portion of a road, each shoulder has a different slope. The rate of such a slope depends on the superelevation, as stated in the note on Figure 07-1.

The side of an embankment usually has a slope of l-l/2 to l. This means there is a horizontal distance of l-l/2 ft. (450mm) for each vertical distance of l ft. (300mm). In a cut, there must be a drainage ditch alongside the road. The slope of the side of the ditch next to the shoulder should be 4:1 or flatter. The slope of the other side depends on the character of the natural ground. It is 1/4 to 1 to l/2 to l in rock and may be 3/4 to l to l to 1 in other firm material. The edge of the excavation near the natural ground surface should be rounded as shown in Figure 07-1.

07.01.04.03 HEIGHT OF CROWN

The crown height of a road or the difference in elevation between the center line of a crowned roadway and the nearer edge of either shoulder, depends on the width of the roadway and the rate of slope of the surface. In Figure 07-2, "X" represents half the width of the travelway and "Y" represents the height of crown. Limited values of "Y" corresponding to several values of "X" are shown in the table. For each value of "X", the smaller value of "Y" applies to a slope of 1/2 in. per ft. (13mm per 300mm) of width and larger value of "Y" applies to a slope of 3/4 in. per ft. (19mm per 300mm).

07.01.04.04 CROWN TO SUPERELEVATION TRANSITION

At the beginning or end of a curve where a superelevated section is used, it is necessary to provide a gradual transition from one type of section to the other. On the higher side of the road centerline, the downward slope from the centerline to the shoulder which exists on a crowned section must be changed to an upward slope on each end of the curve to provide transition.

When the road surface on a curve is being shaped by blading, the operator of the machine must make sure that the established rate of superelevation is maintained. There is a tendency for the rate of superelevation to become too great because of the action of traffic. This tendency will be overcome and a serious drainage problem will be prevented if special care is taken to maintain the proper ditch section on the low side, or inside, of a superelevated curve.

07.02 ROUTINE MAINTENANCE SCHEDULE

07.02.01 PURPOSE

The County Maintenance Superintendent will plan routine maintenance of unpaved roads in accordance with a detailed seasonal schedule. The following listing of work to be performed during each season of the year will be used as a basis or guide in the development of a schedule.

07.02.02 SPRING OPERATIONS

l) Make a field inspection of each road to determine:

a) Priority of work

b) Immediate maintenance needs, covering type of maintenance equipment and material required

c) Future maintenance needs, covering type of maintenance and equipment and material required

2) Blade and recompact surface:

a) Dry the surface material

b) Smooth the surface so that it will be more satisfactory for the traveling public and will shed surface water better.

3) Reshape all roads and make repairs to badly damaged roadway sections; restore proper roadway crown or slope.

4) Check drainage conditions and make immediate corrections where necessary.

07.02.03 SUMMER OPERATIONS

l) Blade road surfaces as required by traffic and weather conditions

2) Make continual field inspections of road surfaces and drainage structures

3) Apply dust palliatives as required

4) Clean ditches as required

5) Repair and stabilize soft and unstable roadway sections, giving special attention to the sections marked during the preceding winter inspection.

6) Make major improvements and corrections to drainage

7) Mow, trim and cut brush from right-of-way

07.02.04 FALL OPERATIONS

l) Blade to maintain the proper crown and a smooth surface.

2) Make frequent field inspections of road surfaces, drainage, and drainage structures.

3) Repair potholes and soft spots before the start of bad weather.

4) Complete scheduled ditch cleaning.

07.02.05 WINTER OPERATIONS

l) Make frequent field inspections of road surfaces, drainage and drainage structures

2) Remove all obstructions to surface drainage

3) Add good material to roadway sections as needed and as weather and road conditions permits

4) Mark spots and sections of roadway that will require major repairs during the coming construction season

5) Cut brush from right of way.

07.03 MAINTENANCE METHODS

07.03.01 INSPECTION

Frequent inspection of unpaved roads is required for good maintenance. When it is found that any road or section needs repairs, the necessary information will be placed on a work order. This matter will be brought to the attention of the proper person. The County Maintenance Superintendent, Assistant County Superintendent, or Maintenance Crew Supervisor should make a careful inspection at least once a month, and sections that are causing problems should be inspected more frequently and scheduled for repair.

The surface of an unpaved road must be kept smooth and firm. The surface must be shaped so that surface water will move quickly from the roadway to established waterways. Culverts and bridges must be provided to permit water on the ground surface to pass through an embankment and the ditches must be maintained so that they will carry the water. A smooth, firm road surface means comfort and

economy to the road user. Since rapid surface drainage is dependent on smoothness and stability, the maintenance of a proper crown or proper superelevation is an essential and continuing operation. Each drainage structure must be inspected to determine if it needs cleaning or repair.

07.03.02 MAINTENANCE OPERATIONS

There are four principal operations in maintaining smoothness and surface drainage: a) blading and compacting, b) scarifying and reshaping the surface to remove corrugations or ruts, or adding new material to replace material removed by wind and water erosion; c) patching soft and unstable areas; d) improving and maintaining firmness or stability by adding chemicals, bituminous materials and compacting.

07.03.02.01 BLADING

07.03.02.01.01 POWER GRADER USE

Blading is done to keep the road surface smooth and to provide the proper crown or superelevation. The operation is performed with power graders. A modern grader is a powerful and versatile machine which is able to perform a variety of tasks, such as; cleaning side ditches that are parallel to the roadway or lead-off ditches that run at an angle to the roadway; trimming side slopes of cuts; trimming shoulders; scarifying a surface that has become so rough that blading is ineffective; scraping out soft spots; and mixing soil and granular material.

07.03.02.01.02 BLADING PROCEDURE

Blading will be done as soon as possible after a rain and while the surface materials are still moist but not too wet. Blading when the road surface is dry may actually do more harm than good.

It is usually best to begin blading at the outer edge of the road and to work only to the centerline. The loose material is deposited in ruts, holes and other low places after first scarifying the road surface. The other half of the road is then bladed in a similar way. After the loose material has been brought across the surface from both edges to the center, it will be carried back to both edges in such a manner that all the material is spread over the surface and no surplus material is left to form a windrow at the edge of the road. If a windrow of excess surfacing material, that has been loosened by blading, is left at the edge of a road for any length of time, it will be a hazard to traffic and will also form a dam that would tend to cause ponds of water to collect on the roadway surface. Also, if objectionable material such as weeds or trash is pulled from a shoulder or ditch onto the roadway surface, it must be removed so it will not become mixed with good loosened surfacing material.

If large rocks are present in the natural soil near the surface of an unpaved road, they tend to work their way to the surface during the blading operation. If such a rock appears, it should be removed and the hole filled with soil of good quality.

On a heavily traveled stabilized road where the formation of potholes is a continuous problem, it may be desirable to scarify, add stone and recompact the surface after it has been bladed. If the moisture content of the surfacing material is suitable for good compaction, the surface should be compacted with a roller equipped with pneumatic tires.

When a grader is used for blading, its speed normally will not be greater than 4 miles per hour. At a higher speed "chattering" may result and corrugations may be formed in the road surface.

07.03.02.02 CORRUGATIONS REMOVAL

07.03.02.02.01 REMOVAL STEPS

Corrugated or "washboard" surfaces are a common defect of many unpaved roads. Although the exact cause of this defect may not be known, some factors that are suspected of contributing to the formation of corrugations are poor gradation of the soil and aggregate particles, lack of moisture over a long period of time, and the "chattering" of wheels of fast moving traffic. If the corrugations are too deep to be effectively removed by cutting with a grader, the method of corrections is as follows: the material near the surface must be cut or scarified to at least the full depth of the corrugations, the surface must be reshaped by blading, and the loosened material must be recompacted. Scarifying, reshaping, proper moisture content and compaction is the key to correcting the problem.

07.03.02.02.02 PROCEDURE DETAILS

A scarifier is usually attached to a motor grader. An unpaved road is preferably scarified at a time when the surface material is damp. The old and new materials will be thoroughly mixed by blading or harrowing before compaction of the ingredients is begun. After the surfacing materials have been properly mixed, the surface should be shaped to the correct crown or superelevation. The material may be compacted to some extent by blading while traffic is permitted on the surface. Desired compaction is obtained by rolling with rubber tired rollers. If necessary, water may be added to aid compaction. A roller for compacting an unpaved road should have rubber tires. It must be heavy enough to produce the required density but not of such weight that ruts will be formed in the surface.

07.03.02.02.03 CROWN SHAPE CHECK

To establish the proper crown of the roadway, it is necessary to use a template or a stringline level and ruler. The Crew Leader will determine the proper height of crown based on a slope of l/2 to 3/4 inch per foot of half-width of roadway, as shown in

Figure 07-2. He should check the crown every 50 feet while the grader is shaping the surface. The best way to insure that the road being graded has the proper crown is to use a crown gauge (slope meter) on the grader, thus giving the operator a constant reading of the amount of crown being established on the road. When rollers are used, the crown will be checked frequently during blading and compacting operations. When proper crown has been established the compaction operation will begin on the low side and progress toward the center.

07.03.02.03 RUTS REMOVAL

07.03.02.03.01 FORMATION OF RUTS

During the winter months, the surface of an unpaved road is likely to become rutted. The freeze-thaw cycles in that season of the year make the road surface unstable and it is easily damaged by traffic. The thaw in the early spring also is conducive to damage.

Many roads are severely damaged by the use of heavy working equipment while they are still unstable. However, light blading should start as early in the spring as practical. Blading with light equipment will smooth and dry the material near the surface.

07.03.02.03.02 FILLING RUTS

The first time a blade passes over a rutted surface, the ruts should be filled with the material that is already on the surface of the road, because such material will usually compact better with the grader. The only sections of ditches that will be cleaned are those which are blocked by material from small slides, erosion, or debris, and in which water tends to stand.

Filling ruts with large stones is not a good practice because these stones interfere with subsequent grading operations. Traffic will usually slip from these narrow strips of stone and will form new ruts alongside the stones. The loose stones become dislodged and could cause damage to vehicles using the road. At best, the use of stones is only a temporary expedient and is usually not worth the expense involved. Draining the ruts by hand tools, if necessary, and filling them with material from the roadbed may be less costly and more effective. It may become necessary to take some type of corrective action at a time when road conditions make the use of heavy equipment impractical and suitable local material is not available. In such a case, a light truckload of good surface material will be brought to the site, placed in the ruts by hand tools and tamped. Water standing in ruts must be drained before the material can be placed. Suitable equipment will be used to spread and compact the material in the ruts on a frozen road.

07.03.02.04 ELIMINATING SOFT SPOTS

07.03.02.04.01 CAUSES

Very often, most portions of an unpaved road will remain firm and smooth for the greater part of the year but "soft spots" will occur. An area becomes "soft" for one of three reasons: 1) lack of proper drainage, 2) poor soil 3) poor exposure. Maintenance employees should be alert to detect and determine the cause of such an area as soon as it appears. If one of these areas is found, but conditions make immediate repairs impractical, each end of the area will be marked by a stake or some other means of identification and repairs made as soon as weather conditions permit.

07.03.02.04.02 CORRECTIVE MEASURES

The cause of improper drainage may be a plugged pipe, an improperly placed pipe, or the absence of a pipe. Another possible cause is that the side ditches may not be deep enough to lower the water table to the proper level. The faulty condition must be corrected immediately.

When the soil is of poor quality, the remedy is either to replace with a good soil or add a suitable stabilizing agent in sufficient amount to provide the required stabilization. Gravel, crushed stone, slag, reddog, or sand will provide good results.

Poor exposure of the surface may be corrected by clearing the right-of-way of overhanging trees or bushes to allow sunlight to dry the soil.

If a soft spot persists in spite of the corrective measures just mentioned, it will be necessary to stabilize the soil by adding gravel, hard shale, crushed stone or other suitable material. Particles of limestone, gravel or slag should be of sufficient size to stabilize and bridge the soft area. It may be necessary to place a layer of fine aggregate over the larger stabilizing material to aid in grading and shaping the roadway surface.

07.03.02.04.03 PRECAUTIONS

One should not attempt to improve conditions at a soft spot by hauling a heavy load of additional material over the road during a period of wet weather or thawing. The number of good sections of unpaved roads that have suffered major damage from trucks hauling material over them in an attempt to make repairs is greater than the number damaged by normal traffic. As long as traffic can move through or around a soft spot in the travelway, it is best to only mark the spot and delay making the necessary repairs until soil and weather conditions are good. If it becomes impossible to postpone repairs because traffic cannot move through or around a soft spot, then the truck hauling material to the location will "tailgate" the material over the spot. The truck should not be stopped and started on the soft spot. Spreading of the material will then be completed with hand tools and when weather permits, permanent repairs should be scheduled.

07.03.02.05 DUST CONTROL

07.03.02.05.01 DUST FORMATION

Dust accumulates on the surface of any untreated, unpaved road during a period of dry weather. When the formation of dust is allowed to continue unabated, the dust may become a nuisance to the public. Substantial loss of surfacing material results when the dust is removed from the road, regardless of whether that material is natural soil or a mixture of soil and aggregate.

The Department has no formal dust control program because the expense of an effective program would be prohibitive. The following procedures for dust control will generally be used for emergency conditions only.

07.03.02.05.02 USE OF ADDITIVES

Although the formation of dust may be reduced temporarily by sprinkling the road surface with water, a more efficient control method consists of applying an additive as a preventative measure. Many additives used mainly to prevent the formation of dust also serve to provide additional bonding or cementing effect to the particles of soil and aggregate on the surface of the road. Such an additive thus serves as a stabilizing agent as well as a dust palliative.

Bituminous material, calcium chloride, or sodium chloride has all been used successfully as dust retardants.

Treatment of a surface with moisture retentive or adhesive materials will not prevent failure of the surface if the surface has improper gradation of the soil and aggregate particles in the mixture composing the surfacing.

07.03.02.05.03 CALCIUM CHLORIDE APPLICATION

Since calcium chloride has the ability to absorb moisture, it is used as a dust palliative. After the spring rains is the best time to apply the initial treatment, since moisture will already be present on the road.

The amount of chemical used per square yard of road surface will be about 1.5 pounds of Type 1 flake calcium chloride or 1.2 pounds of Type 2 material. Later in the summer, lighter treatments may be applied as required. Caution should always be exercised to assure proper application because over application may produce adverse effects.

Normally each treatment will consist of about 1/2 pound per square yard and if possible will also be applied when the road surface is damp. If a needed treatment cannot be postponed until after a rain, satisfactory results may be obtained by applying calcium chloride late in the afternoon or in the early hours of the morning when the humidity is highest. When the road surface is dry, the use of a solution of calcium chloride and water has proven very satisfactory. For the application of this solution, a truck-mounted-gravity-flow sprinkler is adequate.

The number of retreatments will depend on the rainfall and on other factors such as the volume of traffic and the type of surfacing material. A "dense graded," compact surface requires less calcium chloride than does a loose, porous surface. Roads carrying light traffic require an average of about 4 tons a mile per year. Roads carrying heavier traffic may require as much as 10 tons per mile per year.

07.03.02.05.04 SODIUM CHLORIDE APPLICATION

When sodium chloride is used as a dust palliative, the only moisture it can retain is that which is already in the road or which is applied to the road with or before the application of the salt. For this reason, it is often applied to the road in solution as brine by means of a truck-mounted-gravity-flow sprinkler.

When used in the solid state, sodium chloride is mixed into the top 1-1/2 to 2 inches of surfacing material at a rate of 2-1/2 to 3 pounds of salt per square yard of road surface. Additional water may be required during mixing.

07.03.02.05.05 BITUMINOUS MATERIAL USE

Bituminous materials of light consistency have been used with good results as a dust palliative. Any of the bituminous materials commonly used as a prime material in new construction will give satisfactory results.

When a County Maintenance Superintendent or District Maintenance Assistant plans to use any bituminous material as a dust palliative, he should obtain guidance from the District Maintenance Engineer. In general, the rate of application ranges from 0.25 gallon per square yard for a more open textured surface, to as high as 0.5 gallon per square yard on a surface with very low density.

07.03.02.05.06 DUST PALLIATIVE DISTRIBUTION

When it is necessary to use a dust palliative in front of a home or business building, the palliative must be applied at the proper rate with a suitable spreader. If the palliative is a dry type, such as calcium chloride, the spreader will be the type used to apply chemicals for snow removal and ice control. If the palliative is a liquid type, such as asphaltic oil, it will be distributed with a pressure spray applicator such as an asphalt distributor. The palliative will be applied while the surface is still in smooth condition immediately after the road has been bladed and most of the loose material has been removed from the surface or recompacted.

In the vicinity of a building, a dust palliative must be spread over the full width of the road surface for a distance of approximately 500 feet along the road. After the palliative has been applied to a section of road that section should not be bladed until another application of palliative is required or the surface becomes so rough it must be bladed. At that time the same procedure will be followed. If a pothole develops in a section that has been treated with a palliative, the hole must be filled by hand tools and the patch must be given a suitable treatment with a palliative, since cutting or

scarifying the road surface will destroy the bond properties of the palliative previously applied.

07.03.02.06 BOULDERS AND ROCK LEDGES

Rock ledges and boulders are often present in the roadbed of an unpaved road where the surface consists of natural soil. Efforts should be made to remove ledges and boulders, since they not only impede traffic and cause inconvenience to the public, but also make proper maintenance of the adjacent roadway difficult. If it is not practical to remove a ledge or boulders and to substitute good surfacing material, then thought should be given to raising the grade of the road enough to cover the ledge or boulders. A covering of at least 10 inches of compacted material will be required to permit proper maintenance of the road.

07.03.02.07 STABILIZATION

When the amount of traffic on a natural earth road exceeds about 25 vehicles per day or when a natural earth road contains a high amount of clay which tends to soften and become rutted during wet weather, some type of stabilizing treatment is desirable. Even on a somewhat higher class of surfacing, such as sand-clay or a mixture of soil and gravel or stone, instability may develop. The cause may be an excessively high proportion of clay, poor gradation of the coarser sand or gravel portions of the combination, a heavier volume of traffic than originally expected, or some other unforeseen condition.

07.03.02.07.01 METHODS

Stabilization of a natural soil, sand-clay mixture or a combination of soil and coarser aggregate may be satisfactorily accomplished by adding suitable material. Among the materials used in stabilization are hydrated lime, portland cement, asphaltic products and granular material such as natural sand, manufactured sand (stone or slag screenings) and crushed gravel, stone, slag or shale.

Stabilizing an entire road or a long section of a road with any of the first three materials named is usually a major reconstruction or rehabilitation operation. This work is not ordinarily performed solely by maintenance forces. If such a project is attempted, the work will be done under the direction of the District Engineer in accordance with Standard Specifications.

Consequently, only the stabilizing operations in which granular material is employed will be described here. Stabilization of this type, commonly called mechanical stabilization, is very effectively used to correct either local or general weakness in the road surface. This work can be done with a minimum of equipment.

07.03.02.07.02 CLAY IN MECHANICAL STABILIZATION

In a granular type of stabilized road surface, the particles of silt, sand and

coarse aggregate are cemented with clay binder. It is most important that the proper proportion of clay be used in the mixture. If too little is used, the particles of aggregate in the surfacing will loosen and shift under the wheels of traffic. Too much clay can cause softness and rutting during wet weather. Gradations of combined materials that can be used as guides are given in the following sections. However, a little experimentation with the materials that are likely to be used can be extremely valuable in setting up trial mixtures of aggregate and clay binder.

If the proportions of the ingredients are correct, it will be possible to form a moist sample of the mixture into a ball with the hands. This ball will retain its shape when light pressure is applied with the fingers. If not enough clay is present, the ball will crumble. If too much clay is present, the ball will have a plastic putty-like feel.

07.03.02.07.03 NATURAL SOIL SURFACES

Some soils contain enough granular particles to give a sufficient degree of stability to serve a limited volume of traffic. When additional material is needed in routine maintenance, an effort should be made to select material from nearby sources with a good combination of sandy particles, silt and clay. This will help the repaired surface to sustain light traffic with the least amount of potholing, corrugating and rutting. When maintenance costs are excessive or traffic using the road is too heavy to be served by this type of surfacing, the quality of the road surface should be upgraded by stabilizing with coarser materials.

When a layer of new material must be added to a road surface to raise the grade or to replace material lost as a result of erosion and wear, the procedure will be as follows: before the new material is placed, the material in the old surface is loosened by scarifying to a depth of about 1 inch. This assists in making a bond possible. The new material is then mixed with the loosened material and the surfacing is reshaped and compacted.

07.03.02.07.04 SAND-CLAY-GRAVEL SURFACES

07.03.02.07.04.01 MATERIALS REQUIREMENTS

By adding graded mineral aggregate, such as gravel, shale, crushed stone, crushed slag or red dog, to an existing natural soil or sand-clay road surface, a high degree of stability can be obtained. The sieve analysis of the combination of materials selected for the stabilization operation will conform to one of the gradings shown in Table 07-1.

If it is planned that a road with a soil-aggregate surface course is to remain unpaved for several years, the liquid limit of the fraction passing the No. 40 sieve must not be greater than 35 and the plasticity index must not be less than 4 nor more than 9. In any event, the weight passing the No. 200 sieve must not be less than 8 percent, or greater than 67 percent of the weight passing the No. 40 sieve.

However, if it is likely that the road will be paved with some type of impervious surface course within a short time, (6 months) the liquid limit of the fraction passing the No. 40 sieve must not be greater than 25 and the plasticity index must not be greater than 6.

07.03.02.07.04.02 AGGREGATES SOURCES

Several possible sources and types of coarse aggregates are stated below:

1) **River gravel includes coarse aggregate and sand but is lacking in silt and clay.**

2) **Bank or pit gravel is found in certain areas in the Ohio River Bottoms. The gradation of this gravel varies greatly but it usually is inclined to be sandy. In many cases it is necessary to add both coarse gravel and clay to provide proper gradation.**

3) **Creek gravel is sometimes lacking clay and frequently contains oversize gravel and boulders. Oversize gravel should be either removed or broken. Clay should be added to provide the required amount of binder. There is an abundance of creek gravel in the many streams throughout the State and the removal and use of this gravel is desirable for two reasons. First, since many of the defective areas on unpaved roads are caused by the presence of natural material that has too much clay in it, the addition of proper amounts of this native stream gravel will produce a good surface material at low cost. The second reason is to clean a stream channel, to get rid of a bar or, where necessary, to shift a channel which will often aid in the reduction of damage to public and private property at times of heavy rain or melting snow. Proper permission and permits must be obtained before entering streams to remove material.**

4) **Crushed stone and slag must generally be obtained from commercial sources.**

5) **Hard shale can be found in large supply in many areas statewide. In some cases the shale requires drilling and shooting. This type of material usually has enough fines in it for good stability and compaction as well as being economical.**

In general, the material must meet the requirements of the West Virginia Department of Highways Standard Specifications in regard to soundness and hardness.

07.03.02.07.04.03 STABILIZATION PROCEDURE

The first step in stabilizing an existing road is to shape the existing surface to

the proper crown and grade. The surface is then scarified to the proper depth, which depends on the character of the material in the existing road, the character of the clay and aggregate to be added and the desired thickness of the finished stabilized surface layer.

The materials must then be mixed by use of power graders or by use of a special mixing apparatus, such as a "pulvamixer." It is important that all lumps consisting of clay and aggregate particles be broken down as much as practicable. The mixing operations are ordinarily performed while the materials are in a fairly dry condition.

07.03.02.07.04.04 <u>CONSTRUCTION DETAILS</u>

If it is desired to add calcium chloride or sodium chloride to soil and aggregate to help the mixture retain moisture, provide better compaction, and reduce dusting of the road surface to a minimum, the best method of mixing is as follows: The materials to be mixed are dampened by sprinkling with water, and the chemical is added separately to the soil and aggregate either in solution or in dry form. The treated soil and aggregate are then mixed again until the chemical and moisture have been uniformly distributed throughout the mass.

After the loose materials have been mixed, the next operation is to blade the mixed material into a continuous windrow at one side of the road. The material from the windrow is then distributed across the road in thin layers, each 4 to 6 inches thick, with the motor grader. As the distribution progresses, each layer should be compacted by a rubber tired roller. When all the stabilized mixture has been placed, the surface should be carefully shaped to the proper crown and graded by the motor grader, and then compacted with a rubber tired roller.

When additional materials must be incorporated into an existing road surface to improve the stability of the surface, the best procedure is as outlined below:

l) The area that requires stabilizing must be determined and care must be taken to include the entire unstable roadway at the location.

2) Samples of the material in place will be taken by a technician from a Materials Control, Soil and Testing Laboratory or by some other qualified person.

3) From the results of tests and other information, the proper material for stabilizing this spot or section will be determined. It is necessary, of course, to take into consideration the availability and cost of the stabilizing material and the anticipated type and amount of traffic.

4) The correct amount of stabilizing agent to be added per square yard of road surface will be reported to the Maintenance Supervisor, who will then determine the total amount required for the entire job.

5) After the necessary material is available either at the job site or at some convenient location, the job will be scheduled. The Maintenance Supervisor must determine that the necessary personnel and equipment will be available and observe weather predictions for the estimated duration of the job. Knowing what kind of weather to expect may prevent delay of the work or damage to the treated road.

6) The original surface will be shaped to the correct crown before it is scarified to eliminate the possibility that some of the stabilizing material will be used to fill low places during the mixing operations.

7) The existing material must be scarified to the desired predetermined depth and care must be taken not to go beyond that depth.

8) After the surface is well scarified, the mixer will run through the loosened material. If no mixer is available, the material will be bladed back and forth until the larger particles have been broken up. The surface will then be reshaped to the proper section and compacted with a rubber tired roller.

07.03.03. DRAINAGE IMPORTANCE

A complete discussion of Highway Drainage and Drainage Structures is contained in Chapter 4 of this Manual. The importance of drainage merits special emphasis in connection with unpaved surfaces. A puddle of water is a menace to any type of highway surface. It is a particularly serious threat to the performance of an unpaved surface. In the case of a high type surface, particular attention is given to the design and planning of adequate drainage facilities. On an unpaved surface, however, too little attention is paid to this essential feature of design.

Adequate side ditches must be constructed and maintained to carry water from the road to regular watercourses. The side ditches parallel to the roadway will be as low as practicable. The water table must be positioned well below the road surface and preferably will be below the top of the subgrade. Culverts and bridges must be provided to permit surface water to pass under the road as well as through an embankment.

07.03.04 DANGERS OF CAPILLARY ACTION

A soil-aggregate mixture that is good for surfacing of a road maintained with an unpaved surface IS NOT a good mixture for soil-aggregate base on which a bituminous treated surfacing course is to be placed. Moisture is carried to the top of the soil-aggregate mixture by capillary action. In the case of an unpaved surface, the moisture is normally removed by evaporation. Placing a moisture tight seal on the mixture in the form of a bituminous treated surface course prevents the normal evaporation process.

As a result, the capillary moisture collects just beneath the surfacing course and causes softening and instability of the soil-aggregate mixture and eventually of the underlying subgrade. The final effect of this condition will be a failure of both the surfacing course and the soil-aggregate course beneath.

An aggregate base upon which a bituminous resurfacing course is to be placed within a short time must contain sufficient fine material for compaction but these fines must be non-plastic. Stability of the course will depend on the angularity and mechanical bond of the aggregate, rather than on the presence of plastic binder soil.

FOOTNOTE

As more fully set forth in Section 01.01.01, nothing in this manual is intended to create a legal or moral duty and has been created for internal guidance only.