Environmentally Sensitive Maintenance for Dirt, Gravel, and Low-Volume Roads

PennState
Center for Dirt and Gravel Road Studies

Pennsylvania SCC
PA State Conservation Commission

DCNR
PA Dept. of Conservation and Natural Resources
Forestry

Surface Maintenance and Drainage

ESM Modules

Introduction
Orientation
Low Volume Roads
ESMP Intro
Off ROW
Geosynthetics
Road Base
Entrenched Roads
Road Banks
Stream Crossings
Stream Stabilization
Surface Maintenance
Ditches
Ditch Outlets
Infiltration
Road Surface

Road Surface Drainage

Introduction

Traditional Road Maintenance Practices

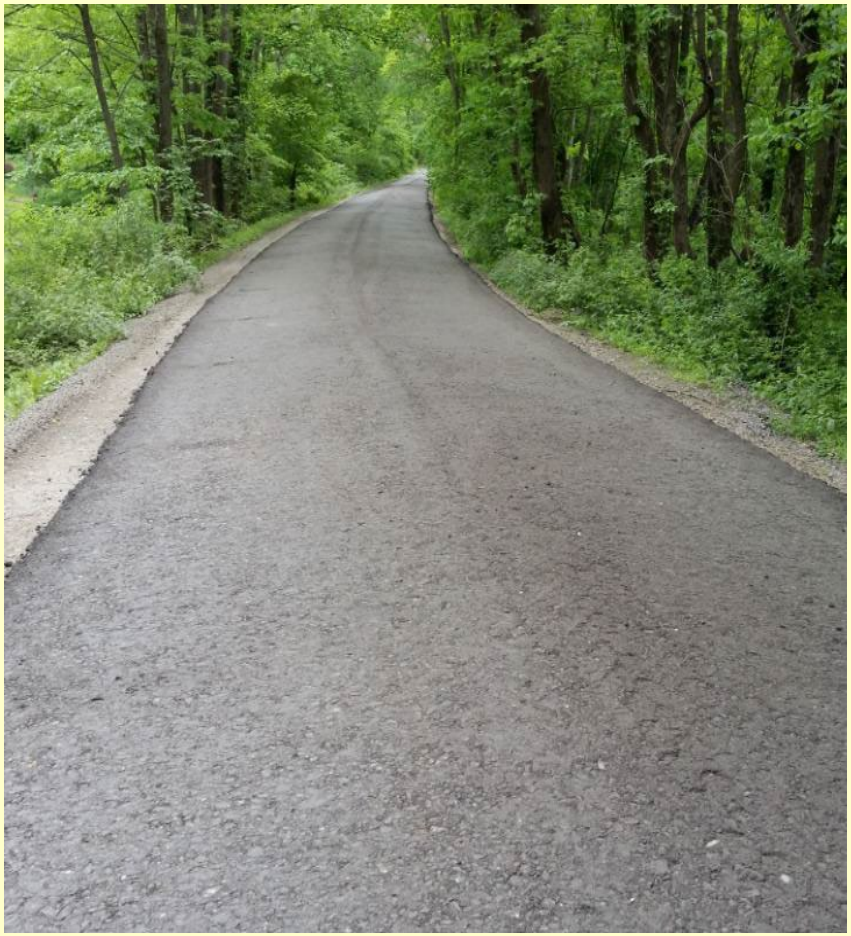
Environmentally Sensitive Maintenance Practices

This module focuses on Maintaining the unpaved road surface and proper road surface Drainage

Surface Drainage & Maintenance of Gravel Roads:

End Goals:

- Improved drivability
- Effective drainage
- Less material loss
- Less maintenance
- Lower environmental impact
- Happy Residents



Insufficient surface drainage is a result of:

- Lack of effective crown or side-slope
- Artificial berms
- Poor transitions
- Problems in the road base

(discussed in Road Base module)

Surface Maintenance of Gravel Roads:

Includes:

- Grading
- Blading
- Re-graveling
- Dust Control

Road Surface Drainage

Introduction

Traditional Road Maintenance Practices

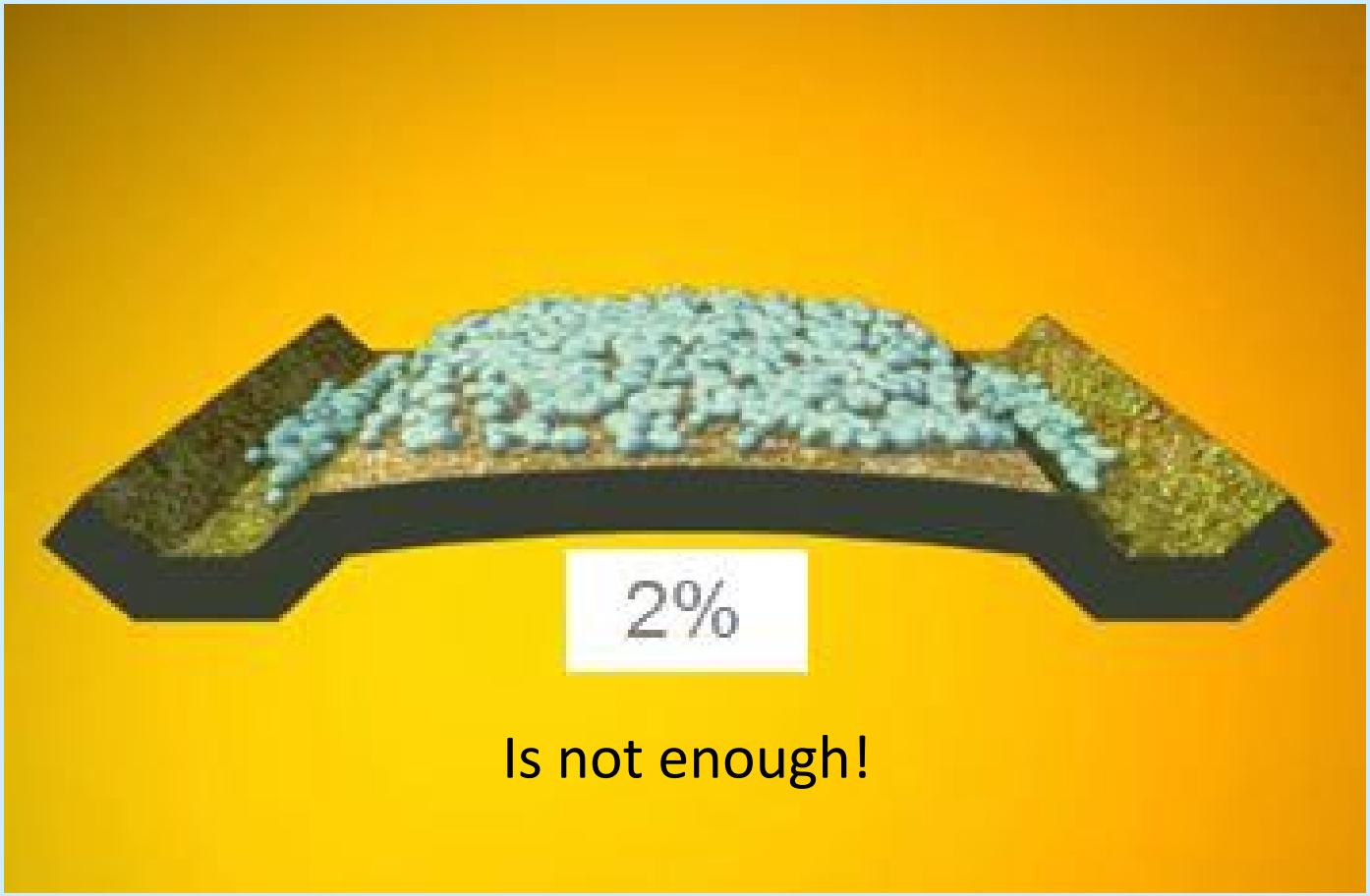
Environmentally Sensitive Maintenance Practices

Insufficient surface drainage:

- **Lack of effective crown or side-slope**
- Artificial berms
- Poor transitions

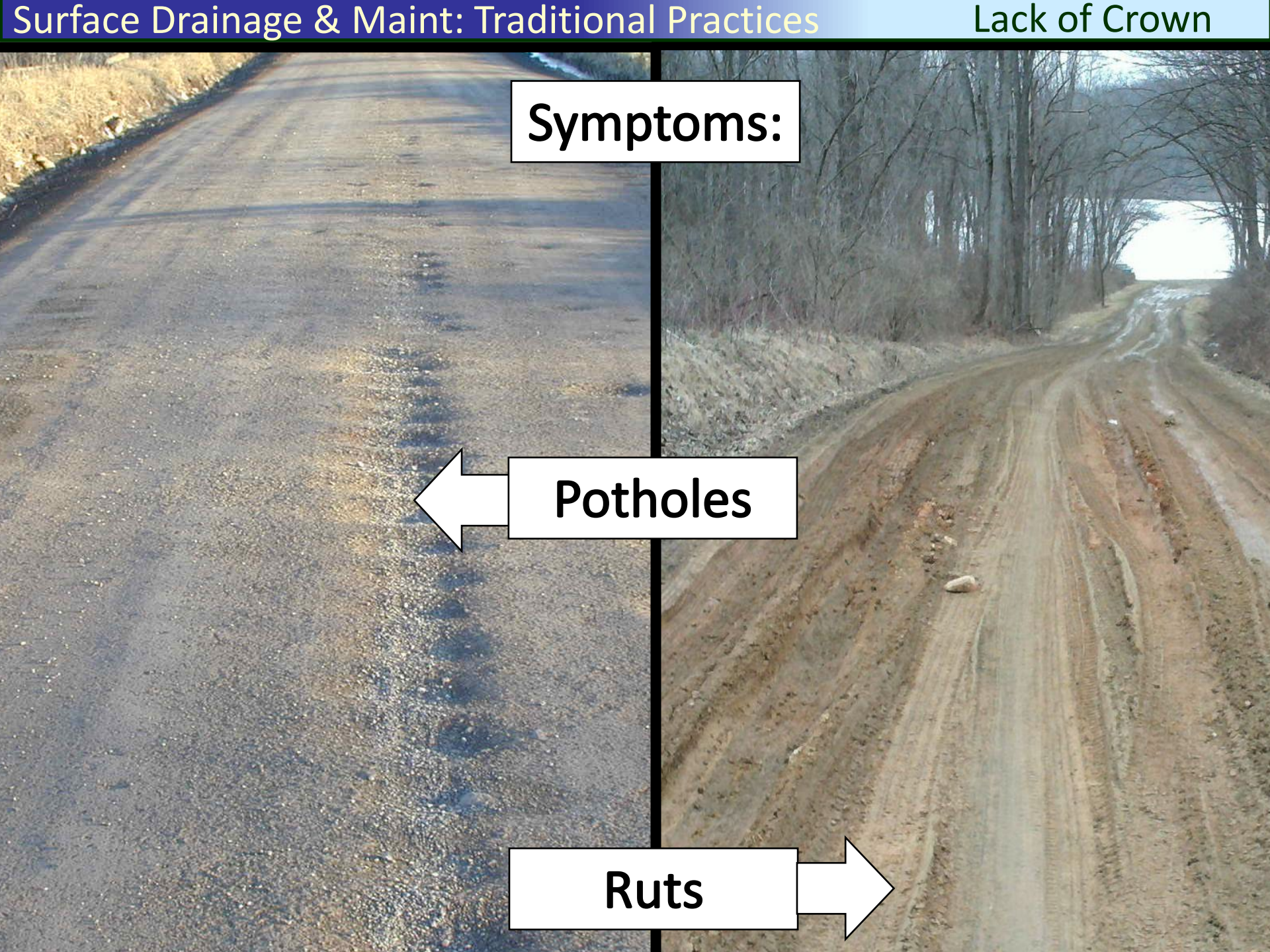
Why roads lack effective crown:

- Modeled after paved roads
- Crown lost between grading cycles



Problems with lack of Crown:

- Water runs on the road – not off the road
- Road base saturates and softens
- Potholes, ruts, and stone loss
- More maintenance, pollution, and complaints

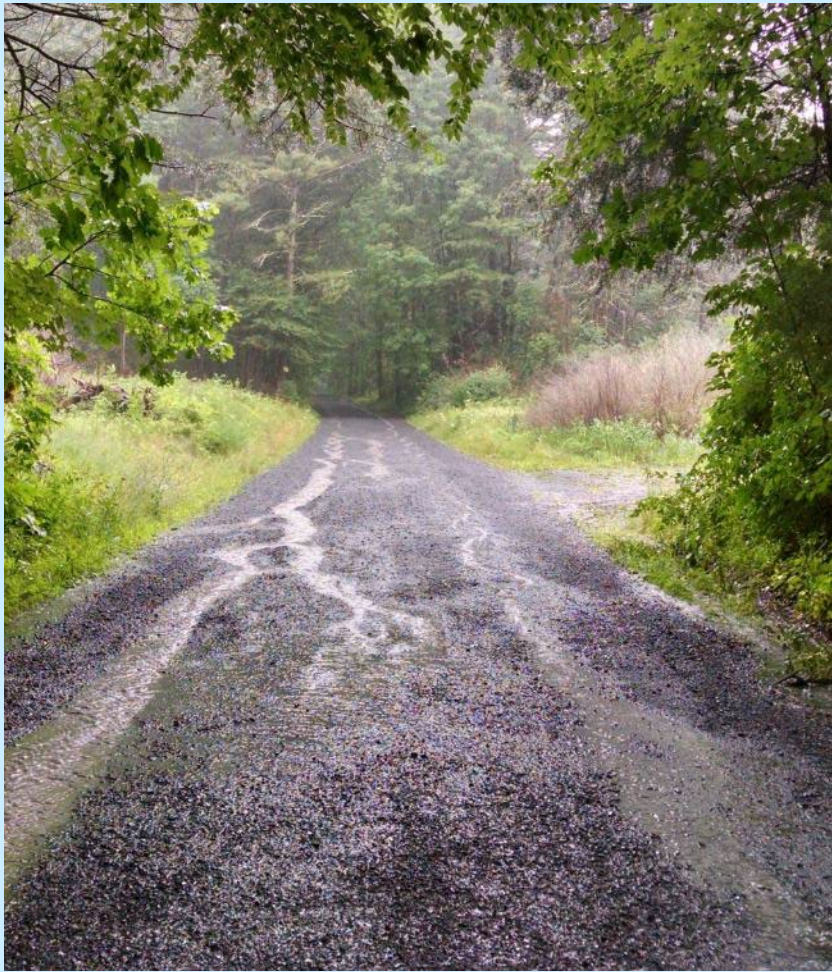

Lack of Crown
Symptoms:
Potholes
Ruts

Insufficient Surface Drainage:

- Gravel Roads modeled after paved roads
- Crown lost between grading cycles
- Artificial berms form

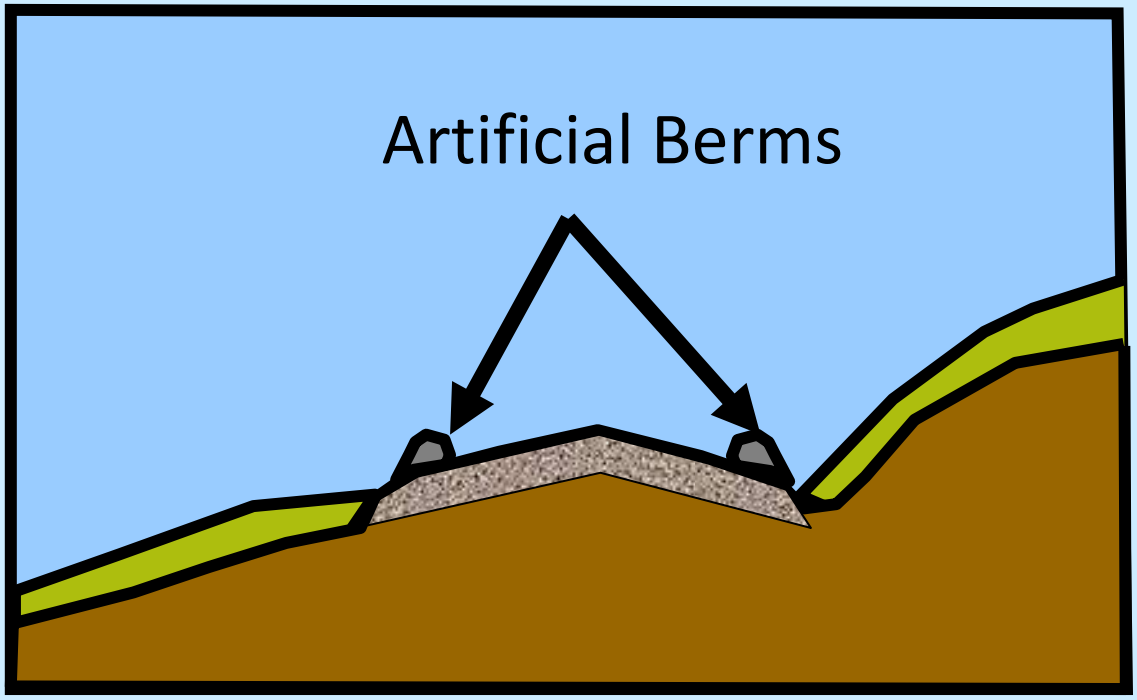
Problems

- Water lays on road
- Water runs on road



Insufficient surface drainage:

- Lack of effective crown or side-slope
- **Artificial berms**
- Poor transitions



Artificial berms keep water on the road surface, causing erosion and secondary ditches

Artificial berms

Insufficient surface drainage:

- Lack of effective crown or side-slope
- Artificial berms
- **Poor transitions**

Surface transitions become trouble spots due to a lack of attention and proper maintenance to enhance drainage and reduce traffic impacts.

Poor transitions

Poor transitions

Traditional maintenance deficiencies:

Insufficient:

- Surface material
- Grading frequency
- Surface drainage
- Compaction

Insufficient Surface Material:

- Stone often not replenished as needed
- “Cosmetic” re-graveling

Problems

- Can’t maintain crown
- Won’t compact

Insufficient Grading Frequency:

Grading occurs by the calendar, rather than as needed.

Problems

- Not often enough = crown is lost between cycles
- Too often = packed surface disturbed and fines are lost

Insufficient compaction after grading:

Problems

- Surface deforms more quickly
- Gravel and fines are lost
- Road saturates easily
- Need to re-grade sooner

Insufficient Compaction:

- Undersized or incorrect equipment
- No compaction at all

Road Surface Drainage

Introduction

Traditional Road Maintenance Practices

Environmentally Sensitive Maintenance Practices

Remember these…

ESMP Principals:

1. Avoid Concentrated Drainage
2. Minimize Flow Volumes
3. Reduce Effects of Concentrated Drainage
4. Prevent Surface Erosion
5. Reduce Cost and Frequency of Road Maintenance

These principals apply to ALL of the Practices we will discuss

are important to maintaining the road surface

Road Surface and Drainage ESM Practices:

1. **Establish and Maintain Effective Crown**
2. Maintain Surface As Needed
3. Adjust Transitions
4. Add Surface Drainage Controls
5. Winter Maintenance
6. Surface Stabilization
7. Maintaining Quality Aggregate

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CROWN

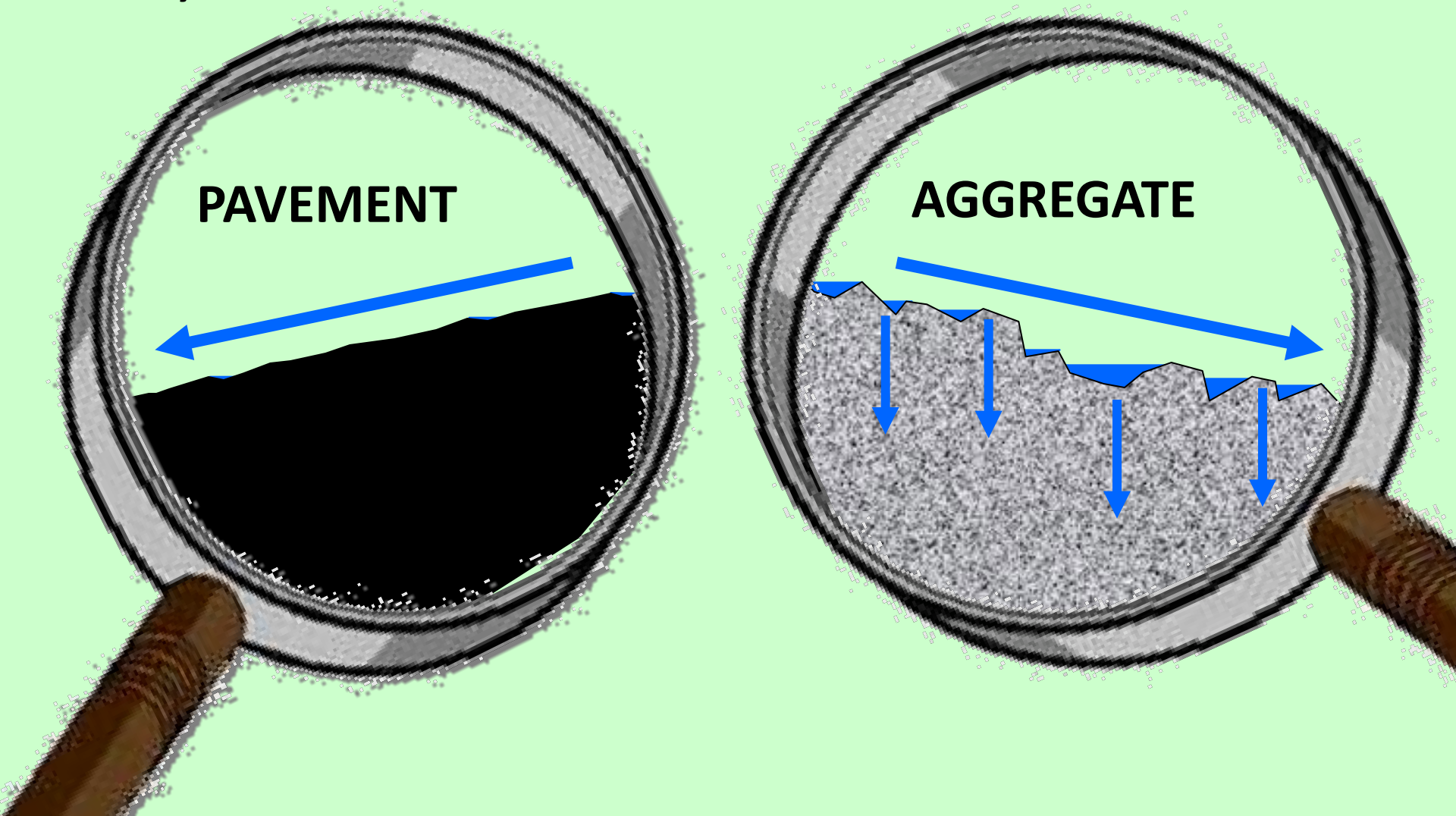
is your road's first line of defense!

How Much Crown?

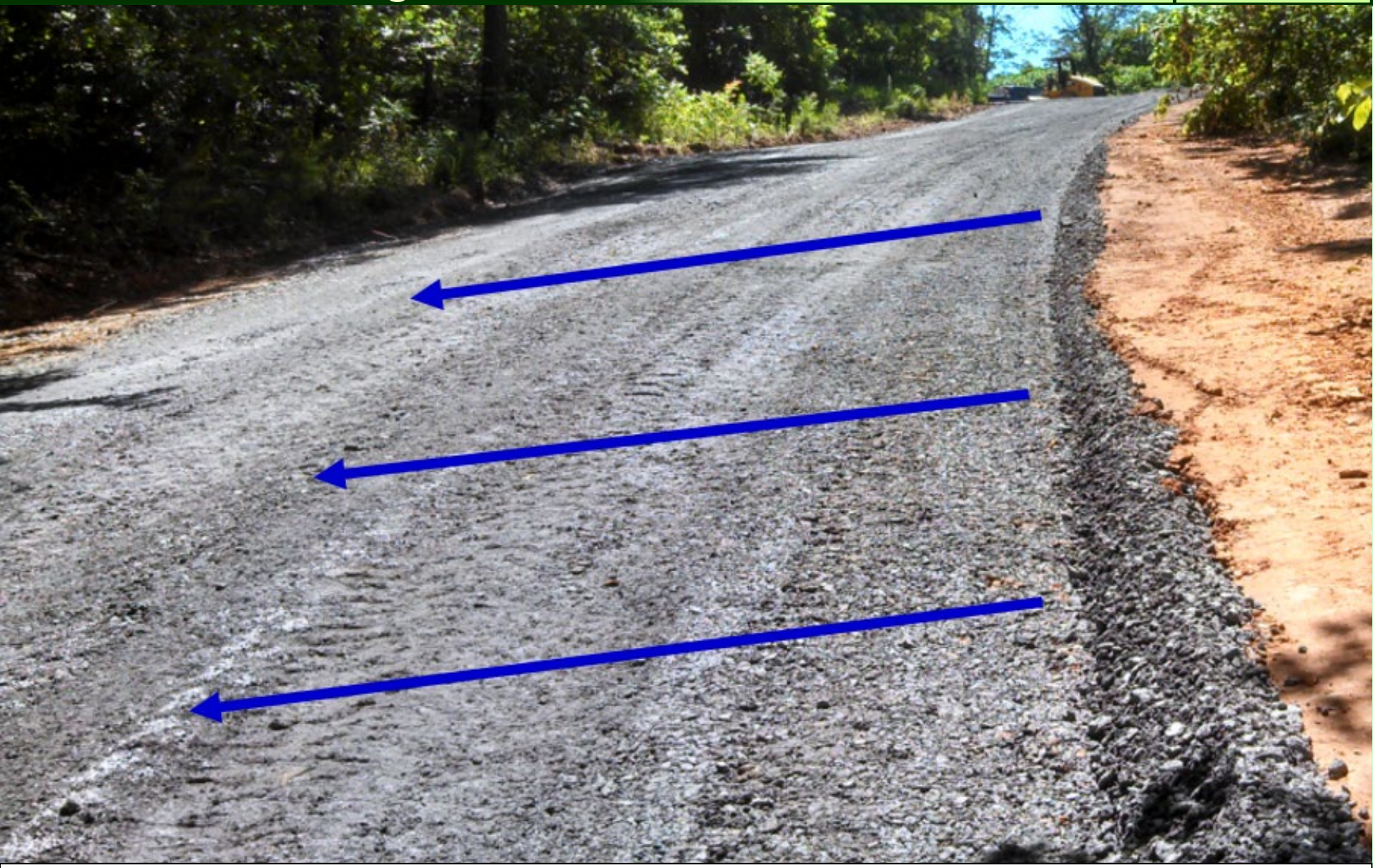
4% to 6% slope

Effective Side-slope

Unpaved roads require <u>more crown</u> than asphalt roads, because…



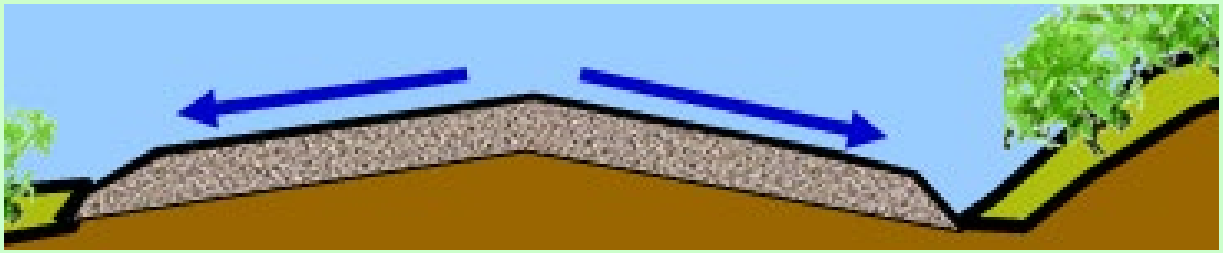
Effective Side-slope



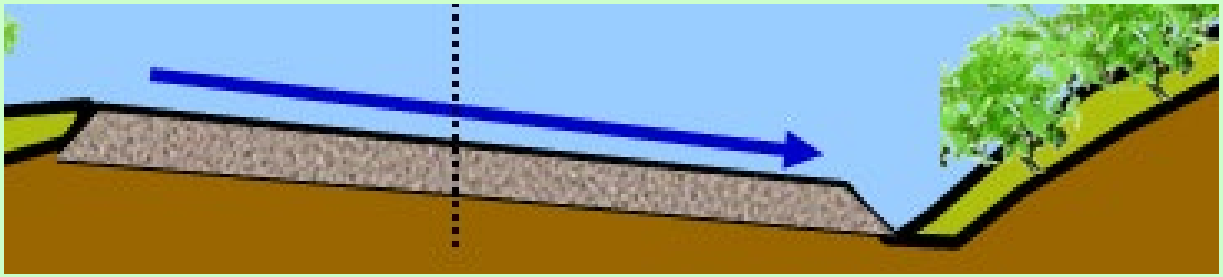
Aggressive and continuous side-slope is key to proper drainage

Shape for Drainage and Traffic:

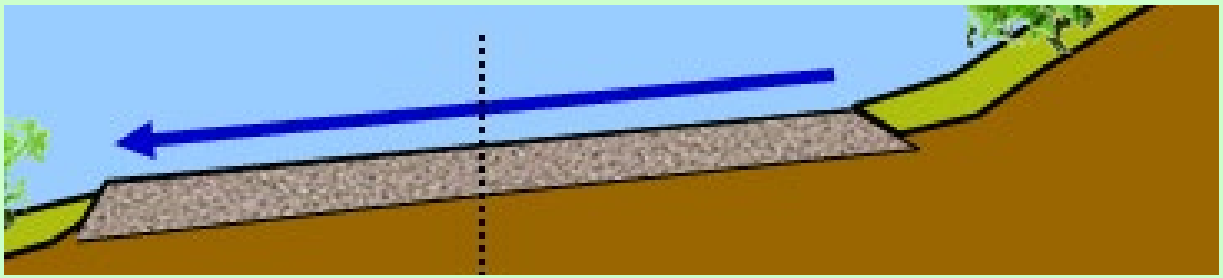
- Establish Side-Slope of 4% to 6% for unpaved roads and 2% for paved roads
- Chose Center-crown, In-slope or Out-slope



Center-crown

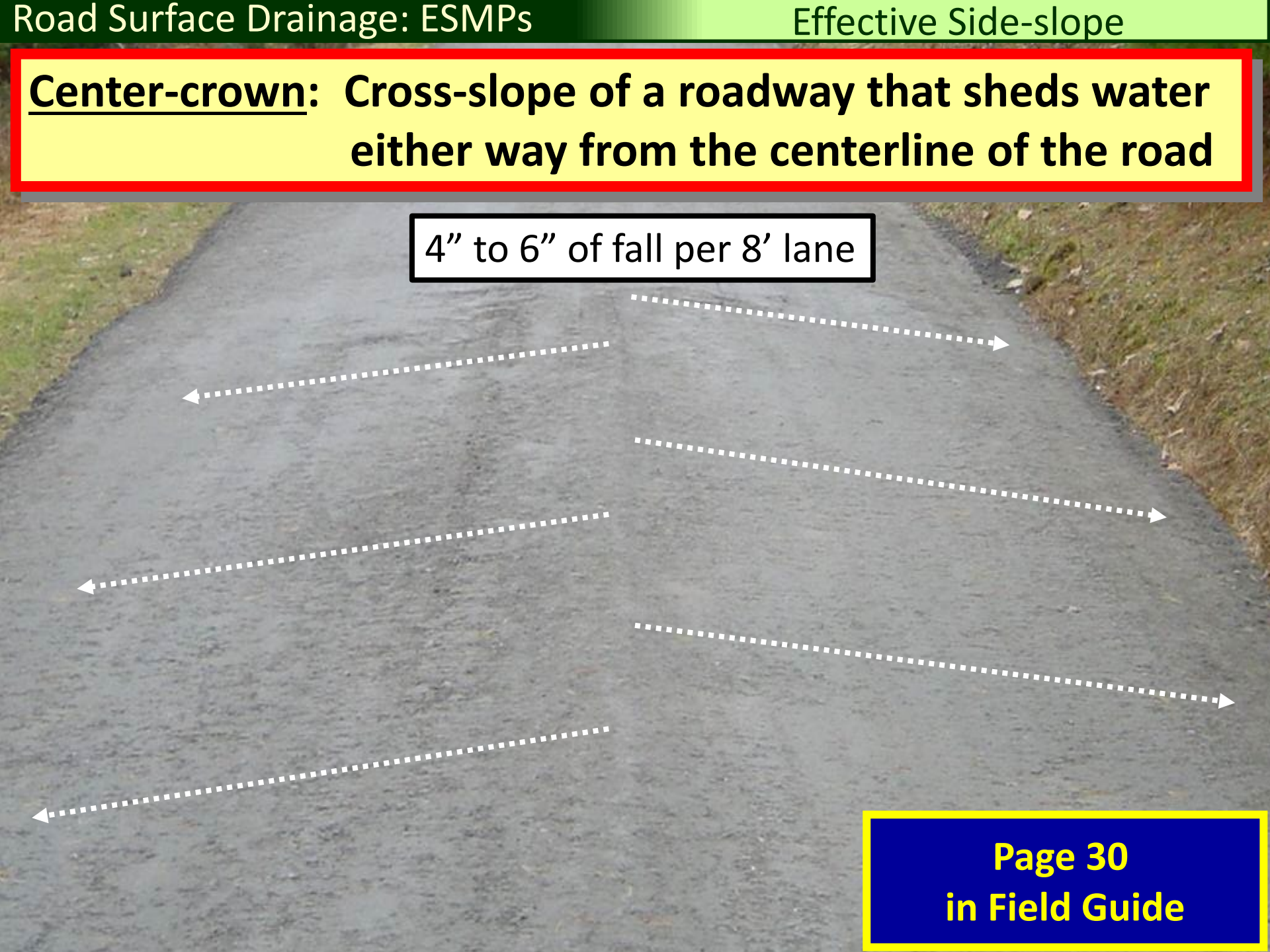


In-slope



Out-slope

<u>Center-crown</u>: Cross-slope of a roadway that sheds water either way from the centerline of the road



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<u>Center-crown</u>: Cross-slope of a roadway that sheds water either way from the centerline of the road

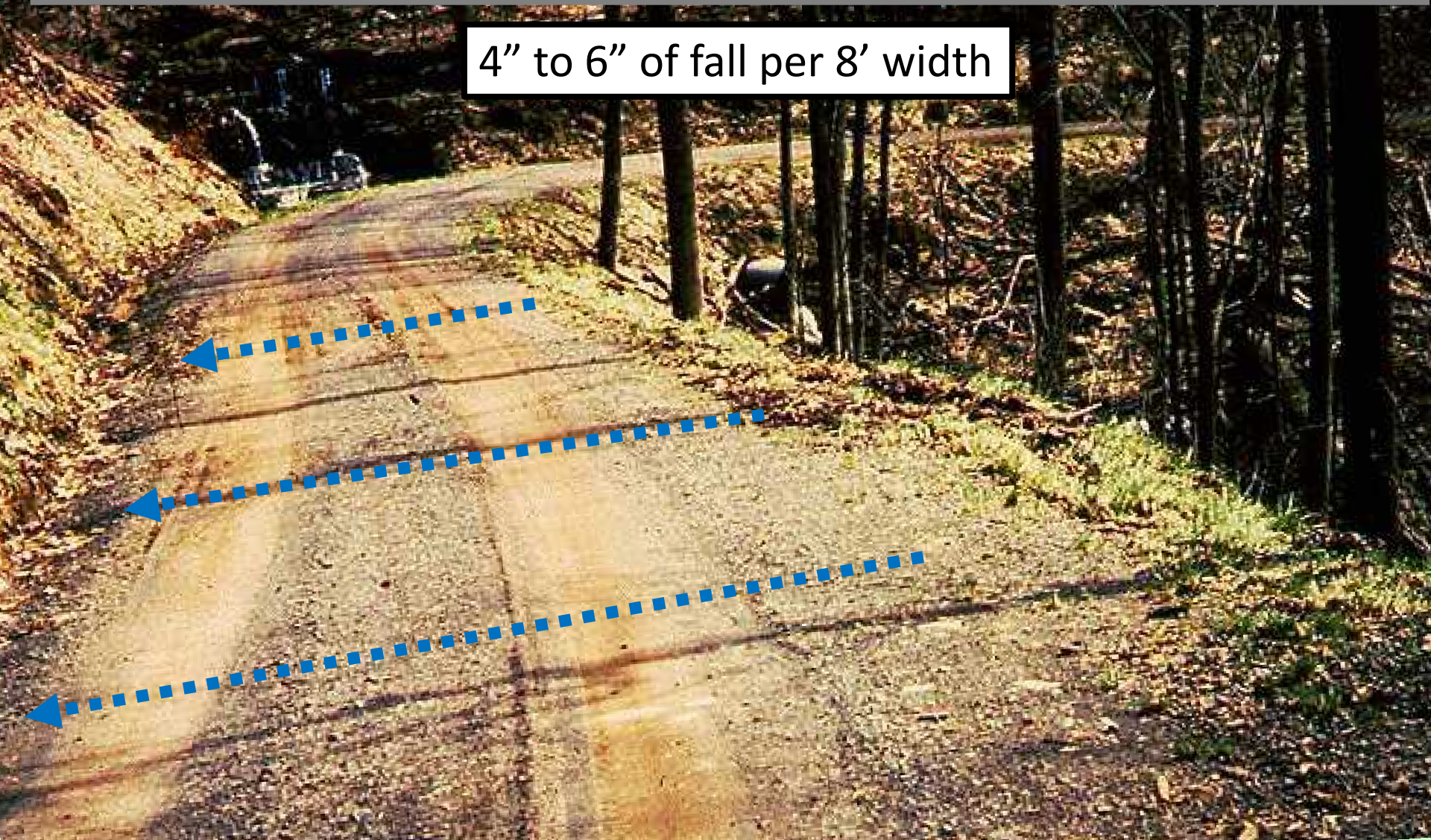
Considerations:

- Most popular road shape
- Divides flow to each side
- Angles oncoming vehicles away from each other

Challenges:

- Easy to plow out
- Can be difficult to maintain on narrow roads
- May not be suitable for sharp turns and steep banks

<u>In-sloping</u>: Cross-slope of a roadway that sheds water from the entire road surface <u>towards the uphill bank</u>



In-sloping: Cross-slope of a roadway that sheds water from the entire road surface towards the uphill bank

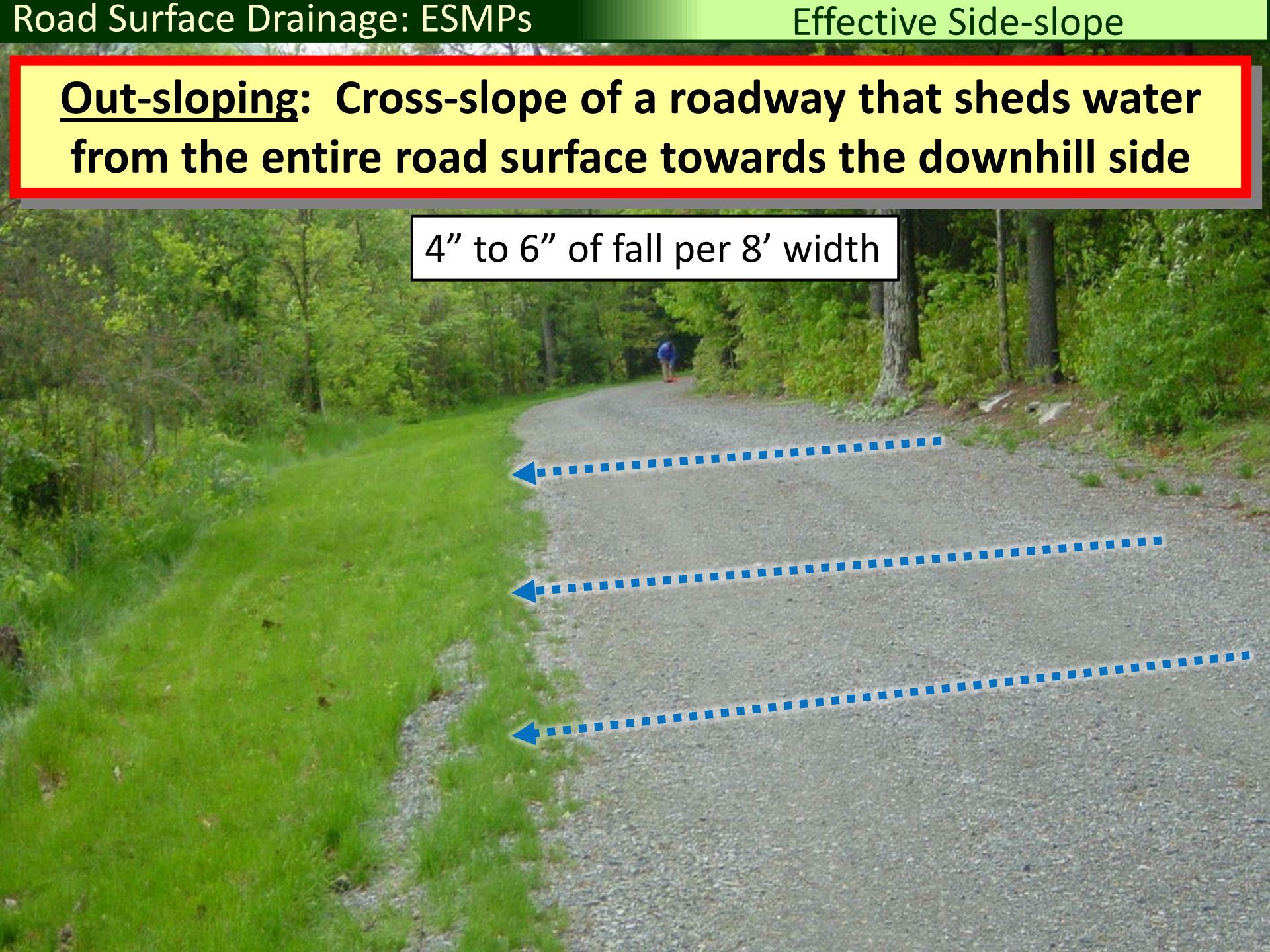
Considerations:

- Super-elevation on curves to support traffic & drainage
- Used where steep downslope banks exist
- Less gravel loss from plowing

Challenges:

- Likely requires more crosspipes
- Traffic angled toward opposite lane

<u>Out-sloping</u>: Cross-slope of a roadway that sheds water from the entire road surface towards the downhill side



Effective Side-slope

<u>Out-sloping</u>: Cross-slope of a roadway that sheds water from the entire road surface towards the downhill side

Considerations:

- Eliminates roadside ditches
- Eliminates concentrated outlets and promotes sheet flow
- Less gravel loss from plowing

Challenges:

- Typically, only suitable for low volume roads
- May not be suitable for sharp turns and steep drop-offs
- Crosspipes are still required for concentrated run-on flows

Effective Side-slope

How do you check your side-slope?

4% or ½” of fall per foot
to
6% or ¾” of fall per foot

Road Surface and Drainage ESM Practices:

1. Establish and Maintain Effective Crown
2. **Maintain Surface As Needed**
3. Adjust Transitions
4. Add Surface Drainage Controls
5. Winter Maintenance
6. Surface Stabilization
7. Maintaining Quality Aggregate

Maintain Surface As Needed

"Read the Road" to determine maintenance needs

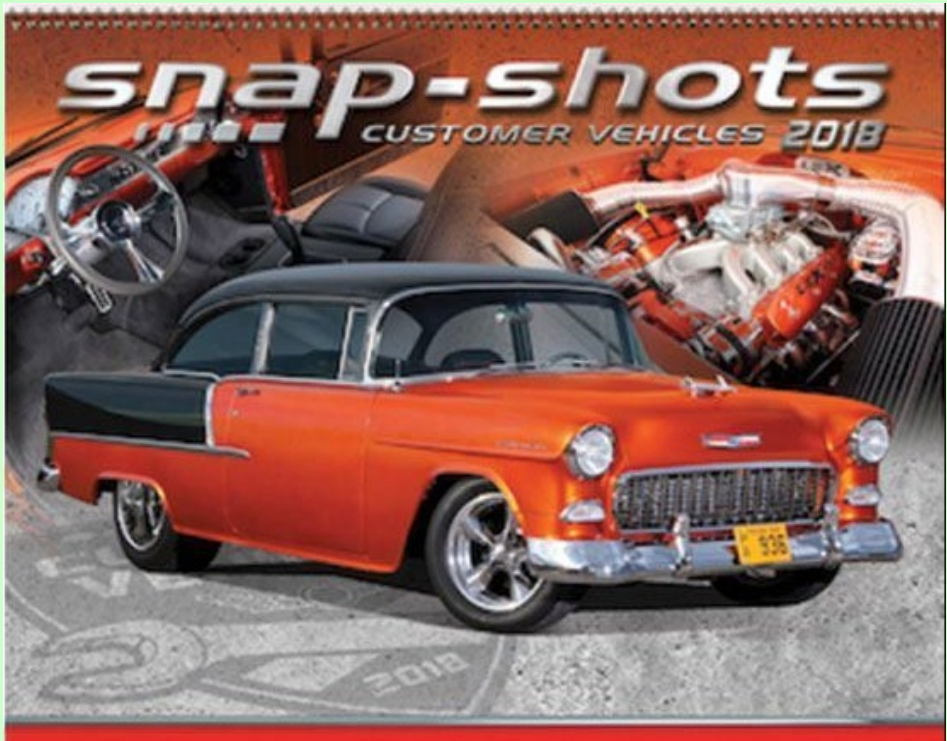
Use these visual indicators:

- Potholes / washboards
- Ruts & secondary ditches
- Flow on road surface
- Artificial berms
- Excessive dust

Maintain Surface As Needed

Grade the road when one or a combination of the indicators are observed. Otherwise, avoid a smooth and free-draining road.

Forget the calendar!



Unlike paved roads, unpaved roads continuously change shape
CROWN MUST BE MAINTAINED!

Surface Maintenance: ESMPs

Maintain Surface as Needed

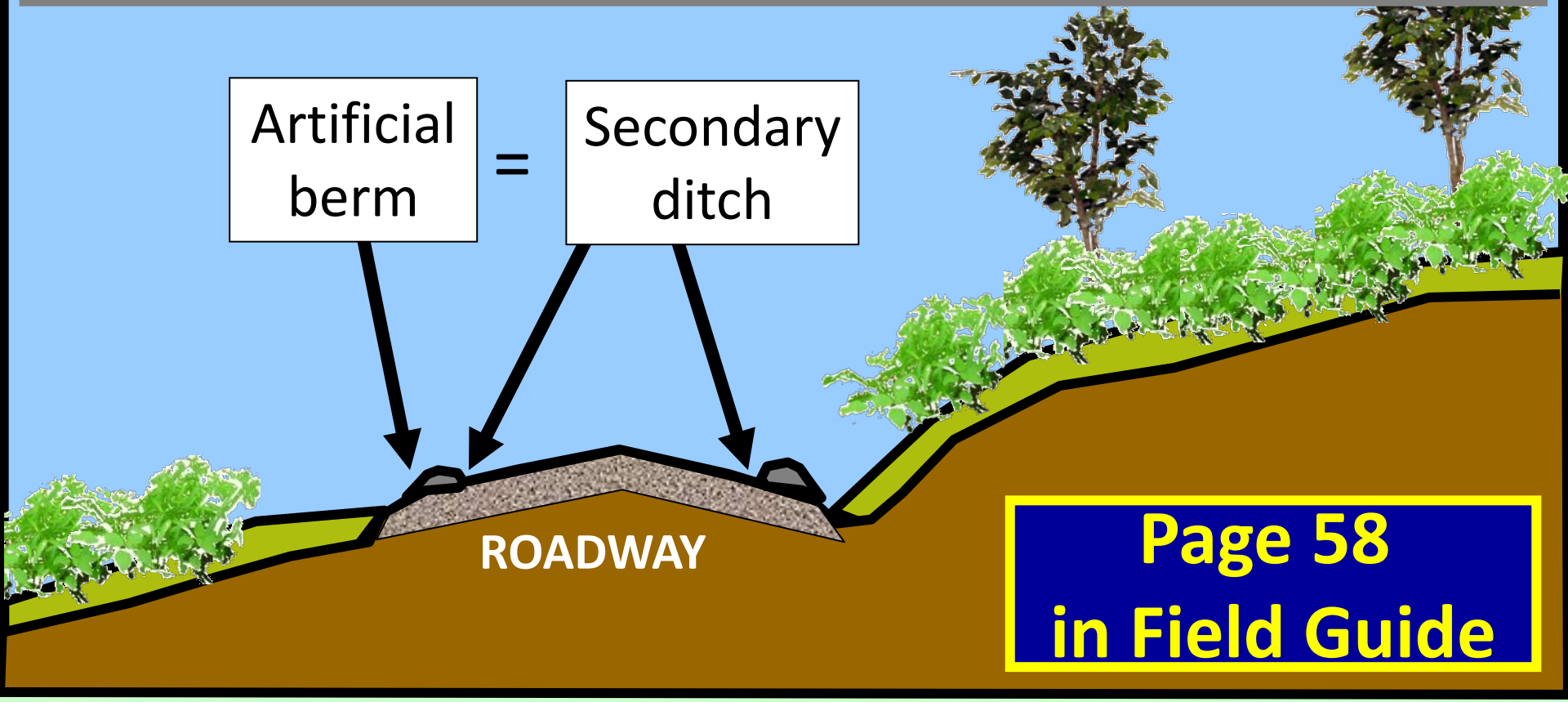
Surface unraveling and losing shape

It's time to grade this road

SAME ROAD 1 YEAR LATER

Maintain Surface as Needed

<u>Artificial Berm</u>: Unnecessary high spot on edge of road that traps water on the road



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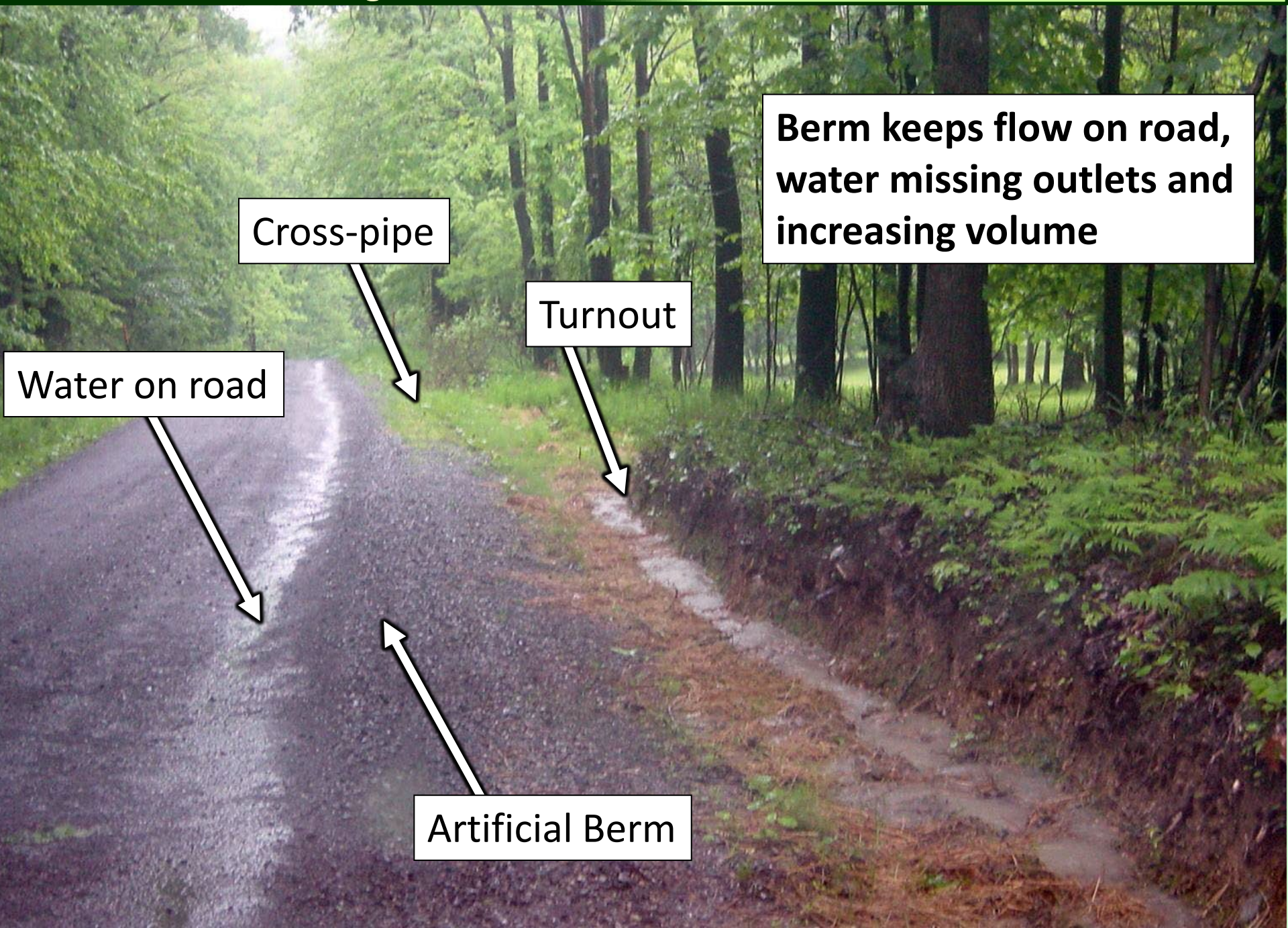
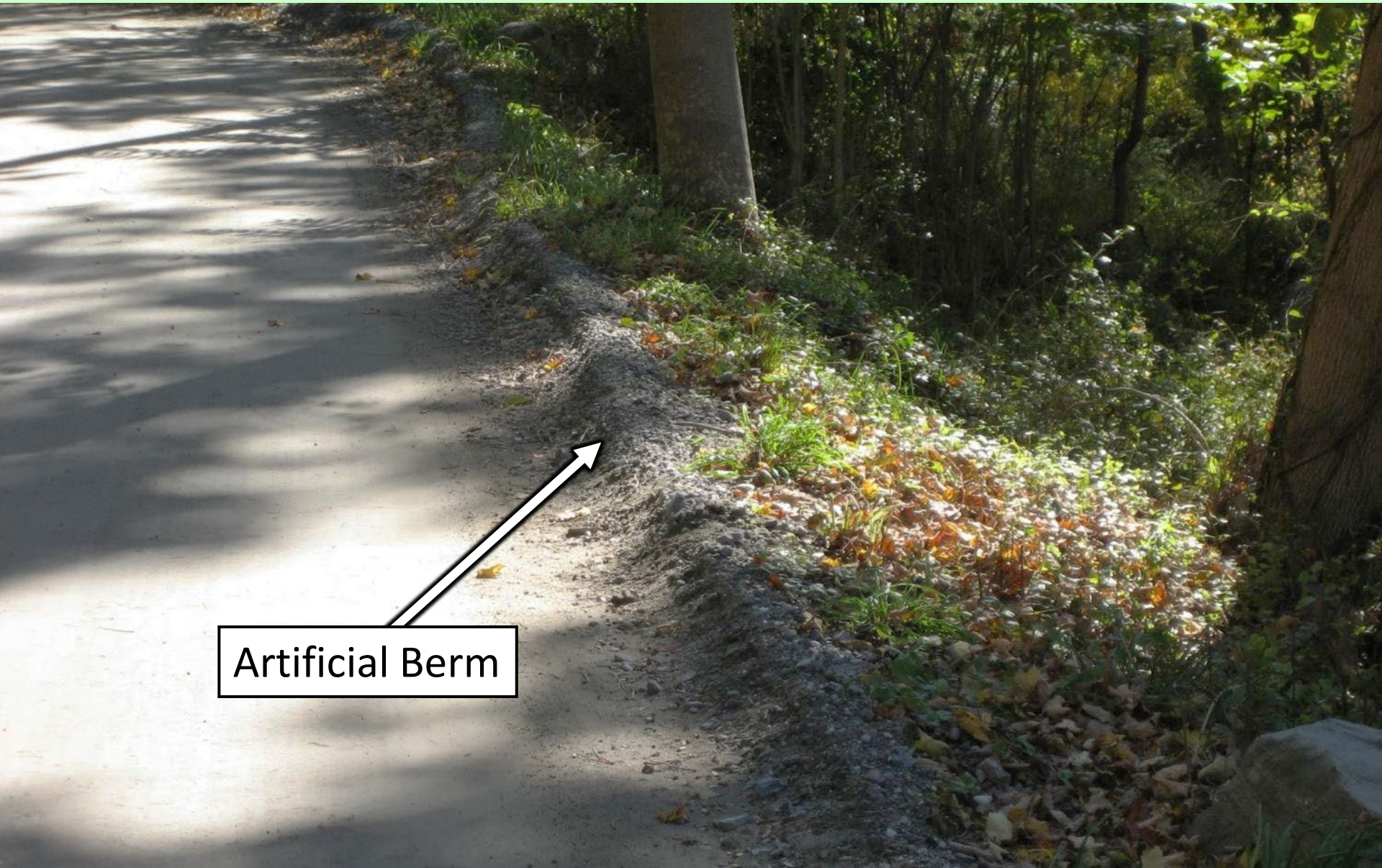
Remove Berms



Remove artificial berms with grader to drain road surface



Remove artificial berms with grader to drain road surface

Remove Large artificial berms with skid steer or bulldozer to drain road surface

Maintain Surface as Needed

Pay close attention to:

- **Steep slopes**
- **Sharp curves**
- **Transitions**

Road Surface and Drainage ESM Practices:

1. Establish and Maintain Effective Crown
2. Maintain Surface As Needed
3. **Adjust Transitions**
4. Add Surface Drainage Controls
5. Winter Maintenance
6. Surface Stabilization
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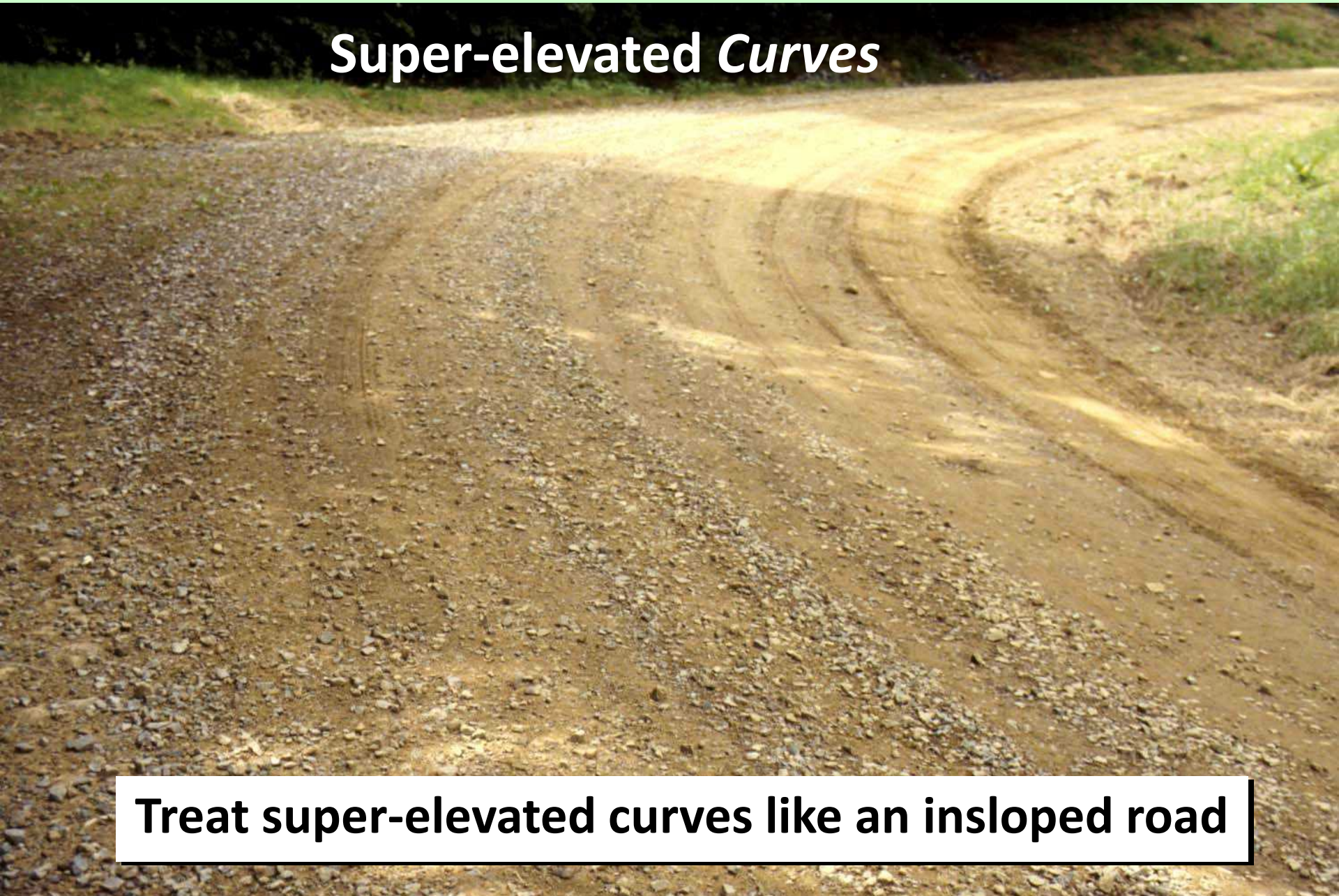
Adjust Transitions:

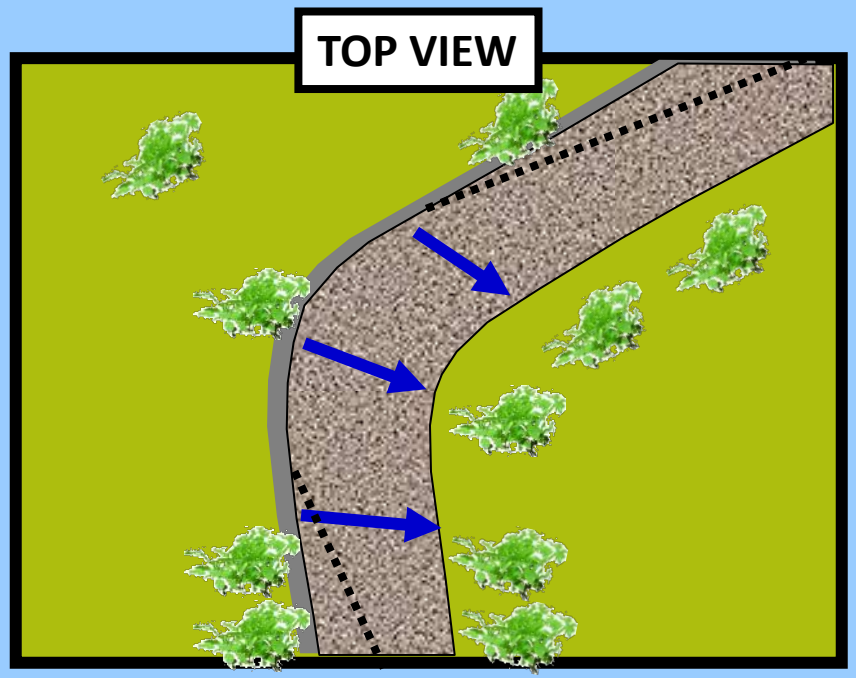
- **Curves**
- Other Transitions
  - Bridges
  - RR Crossings
  - Intersections
  - Transitions from Gravel to Paving/Concrete

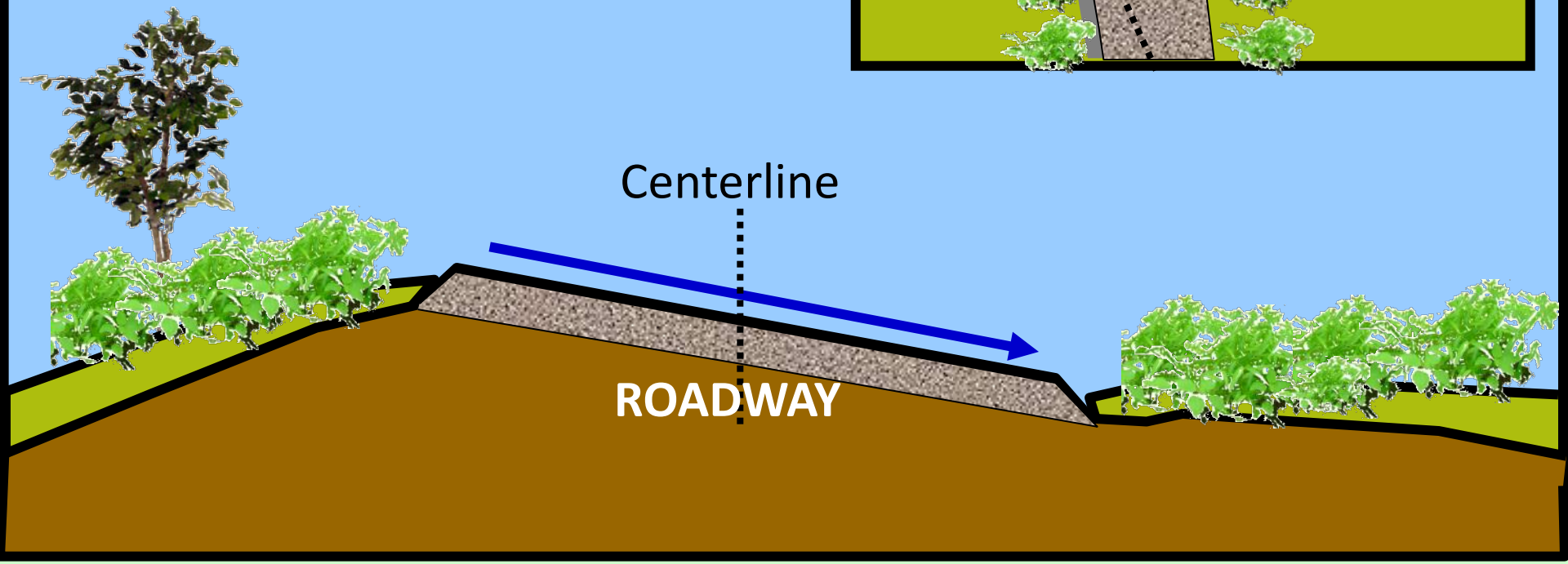

Super-elevated *Curves*
Treat super-elevated curves like an insloped road

Super-elevated Roadway

(banked curves)

Keep same 4% to 6% side-slope as crown and gradually transition out of and back into center-crown





Adjust Transitions:

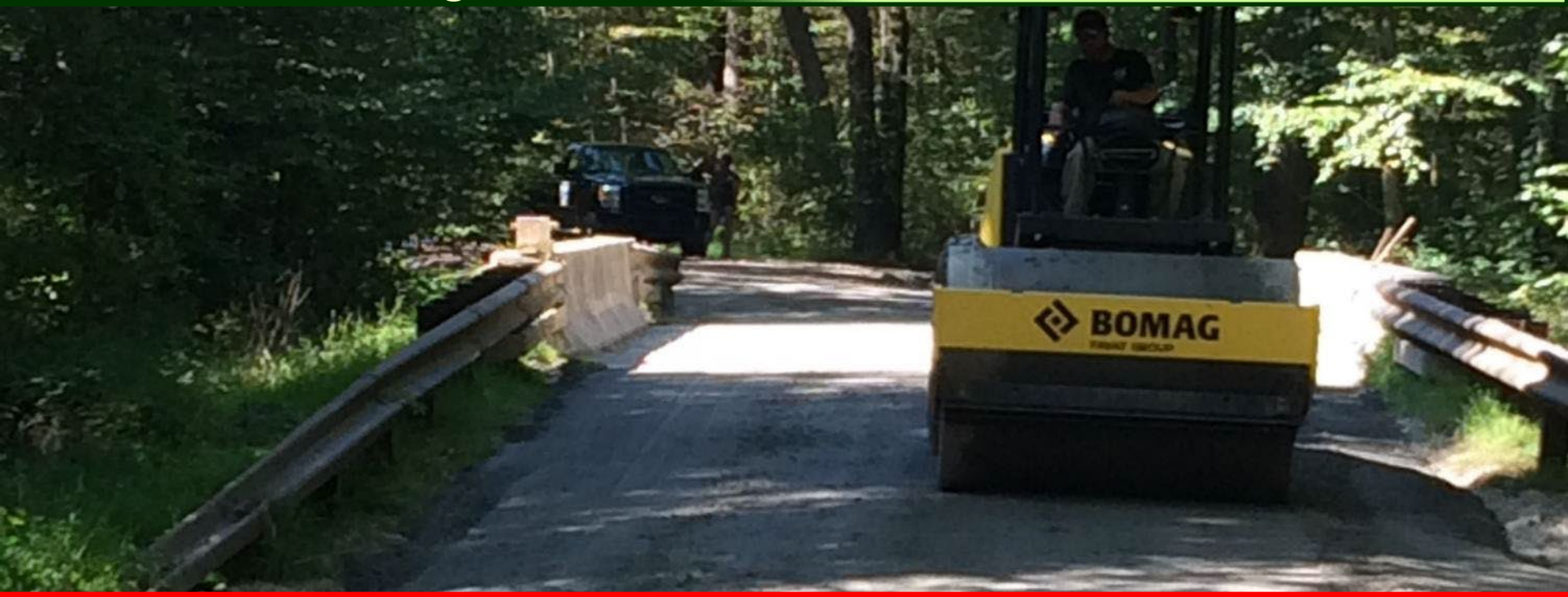
- Curves
- **Other Transitions**
  - **Bridges and RR Crossings**
  - **Intersections**
  - **Transitions from Gravel to Paving/Concrete**

Adjust Transitions

Bridges and RR Crossings

Gradually eliminate crown to match bridge deck/RR crossing. Start 50 - 100 feet back

Adjust Transitions



Match compacted road height and shape to bridge deck

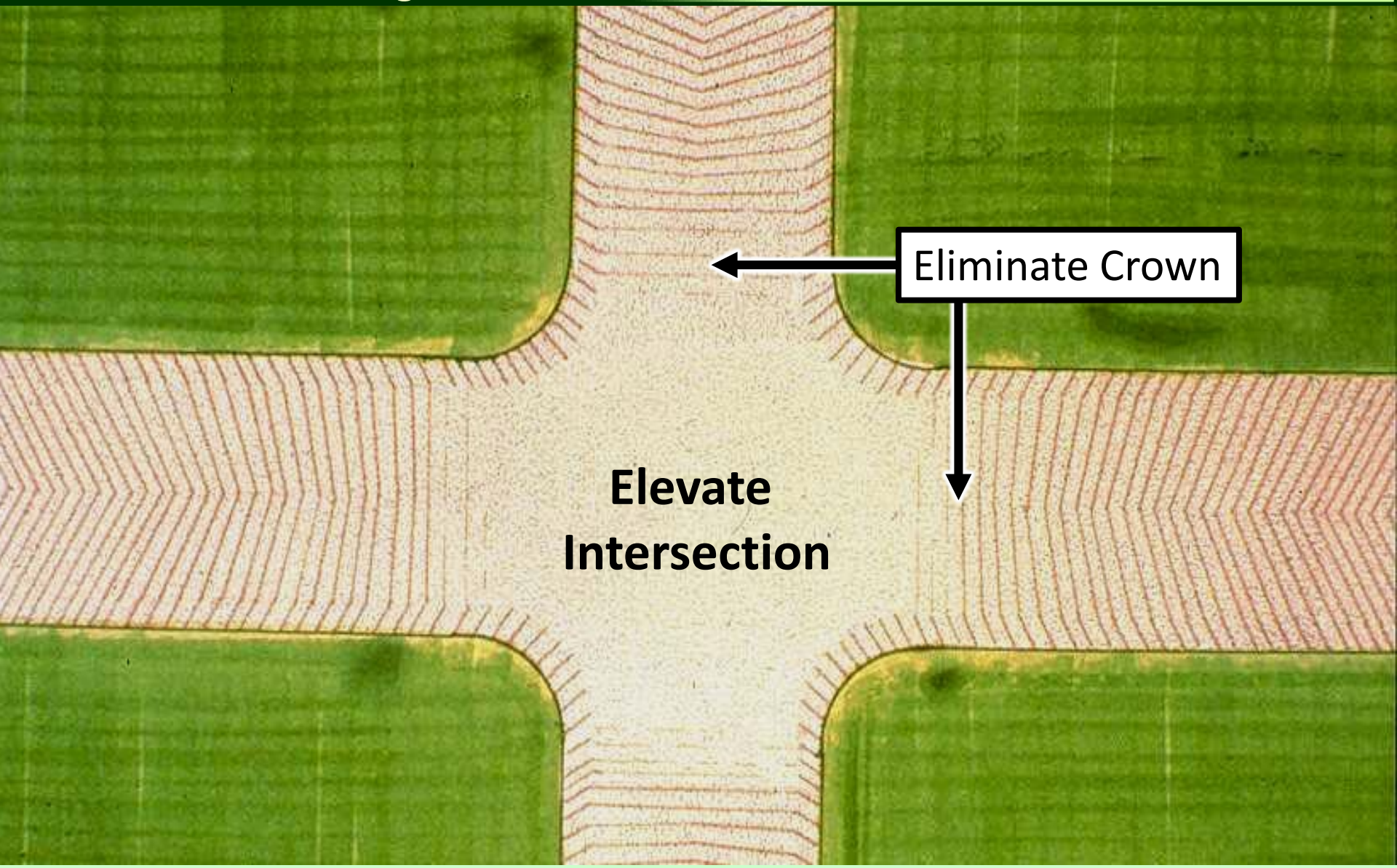
concrete

gravel

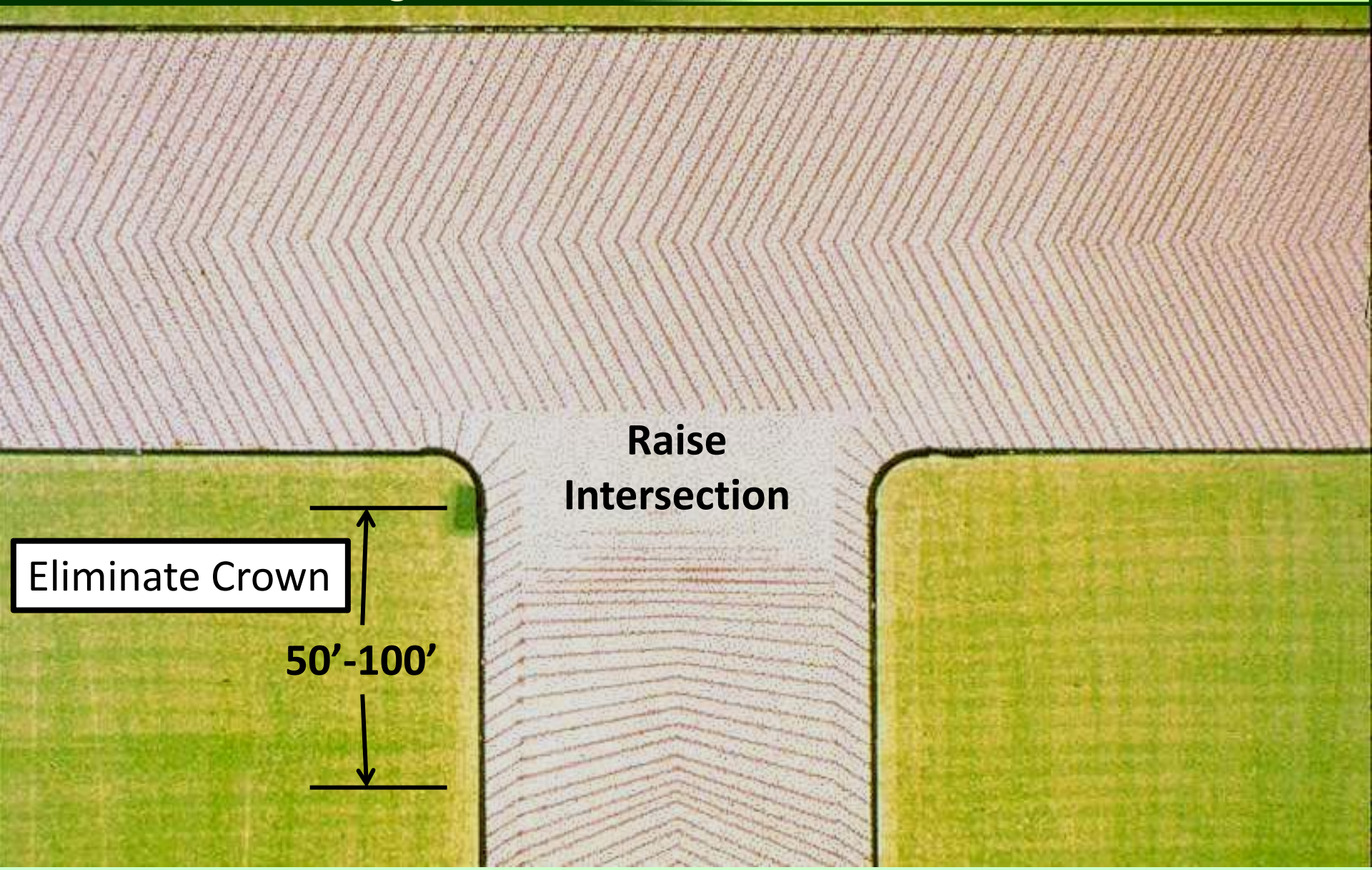
Adjust Transitions

Gradually eliminate crown 50 to 100 feet from intersection.

Adjust Transitions



Raise Intersection higher than incoming roads



Terminal “T” intersection Transition

Paved aprons

- Paved aprons can be used when transitioning from a DSA road to a paved road
- Paved aprons protect your gravel road from excessive wear due to turning, braking and acceleration
- Aprons can extend up to 100’ in length

Contact you Conservation District for additional guidance!

Road Surface Drainage: ESMPs

Paved Aprons

Take extra time where gravel meets pavement

How:

- Consider options to limit run-on to gravel surface
- Ensure transition area is compacted
- Elevate gravel surface where possible
- Consider geogrid reinforcement

Adjust Transitions

Adjust Transitions

Surface Maintenance: ESMPs

Adjust Transitions

Install, shape and compact driving surface

Road Surface and Drainage ESM Practices:

1. Establish and Maintain Effective Crown
2. Maintain Surface As Needed
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4. **Add Surface Drainage Controls**
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7. Maintaining Quality Aggregate

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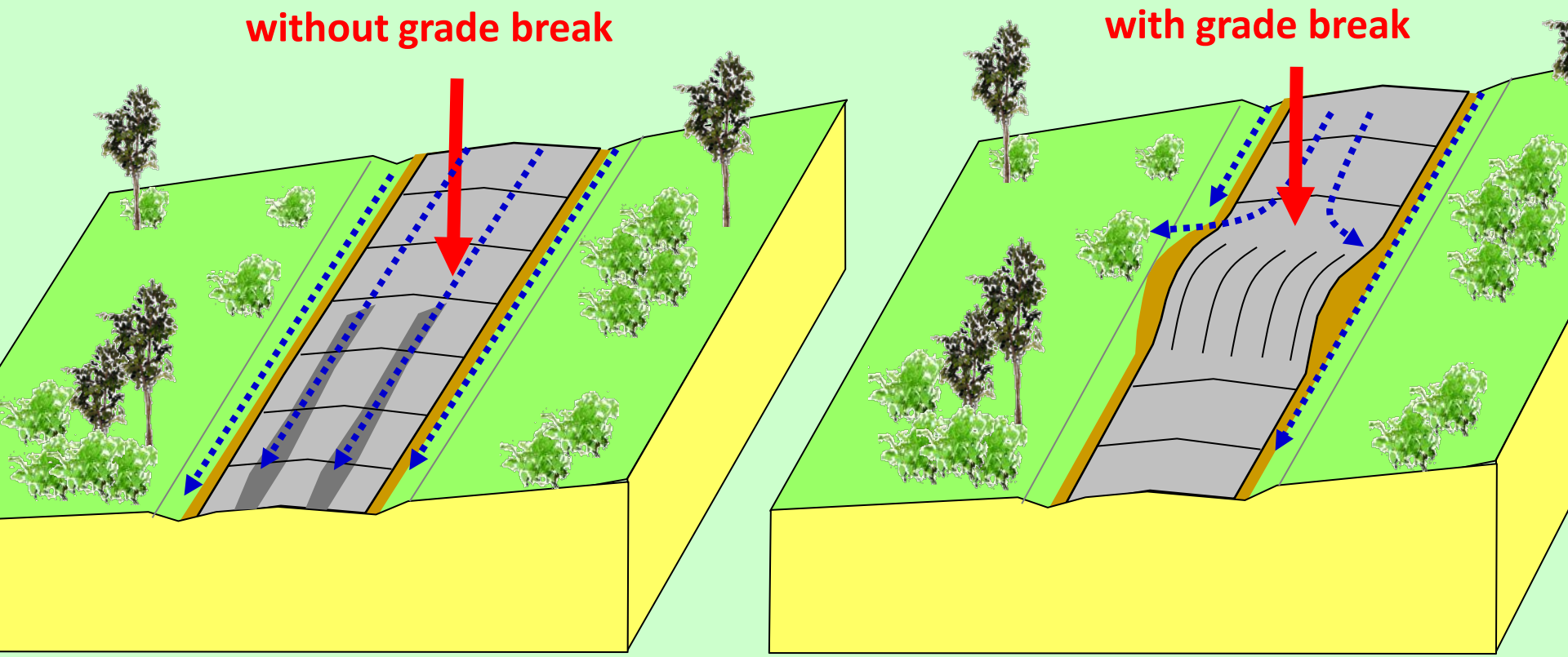
Grade Break: A small increase in road elevation on a downhill slope, which forces water off the road.

Grade Breaks keep water from running down the road.

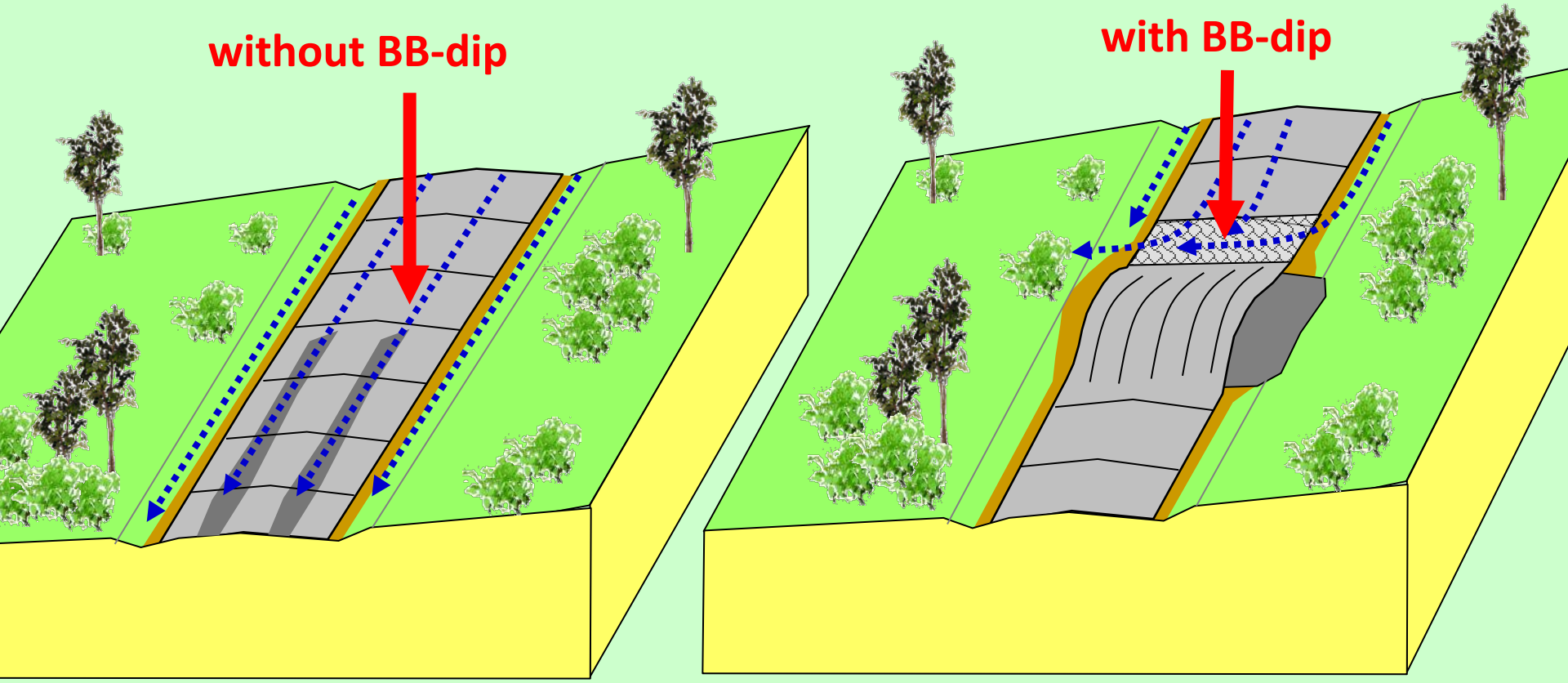


Must make a reverse grade or Grade Break will quickly fail

Can incorporate a shallow cross pipe into a grade break

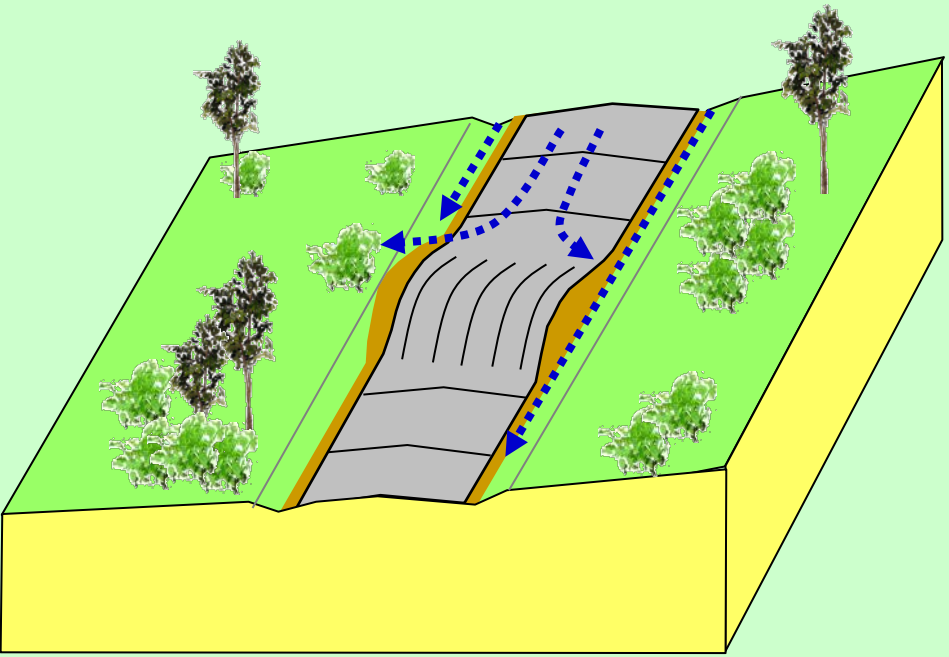
Broad-Based Dip: A small increase in road elevation that conveys water from the uphill ditch across the road surface to a discharge area.

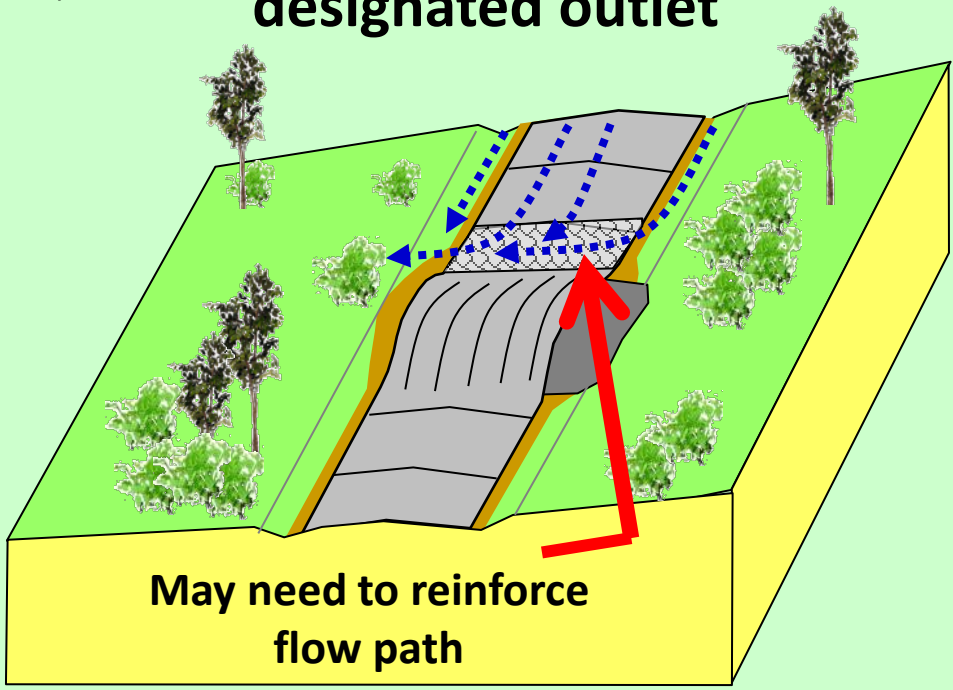
BB-dips prevent water from running down the road.



Surface Drainage Controls

GRADE BREAK	-VS-	BROAD-BASED DIP
Straight across road		Angled across road
Like “elongated speed bumps”		Similar to a “water bar”
Designed to shed water to both sides of road		Designed to direct flow to designated outlet





Grade Breaks and Broad-Based Dips

Considerations:

- For lower volume roads
- Where grading intervals are insufficient on hills
- Before streams and changes in grade
- Where pipes are not practical

Challenges:

- Easy to remove by plowing or grading
- May not be suitable on steep slopes

*Grade Breaks may be used for cover on shallow crosspipes

Mark Grade Breaks and Broad-Based Dips

Road Surface and Drainage ESM Practices:

1. Establish and Maintain Effective Crown
2. Maintain Surface As Needed
3. Adjust Transitions
4. Add Surface Drainage Controls
5. **Winter Maintenance**
6. Surface Stabilization
7. Maintaining Quality Aggregate

Winter Maintenance of Unpaved Roads

Don't plow out crown!

- Use caution when surface is soft
- Consider plow shoes
- Use anti-skid and avoid salt!
- Leave an insulating snow layer if possible

Plow doesn't know where snow ends and the gravel begins...

Too easy to throw your road surface on the bank

Surface is most vulnerable during the thaw

Caution now will save $ and headaches later

Use Anti-skid and **Avoid Salt** (chlorides)

Don't make the thaw any worse!

Always use equipment suited to the job!

Road Surface and Drainage ESM Practices:

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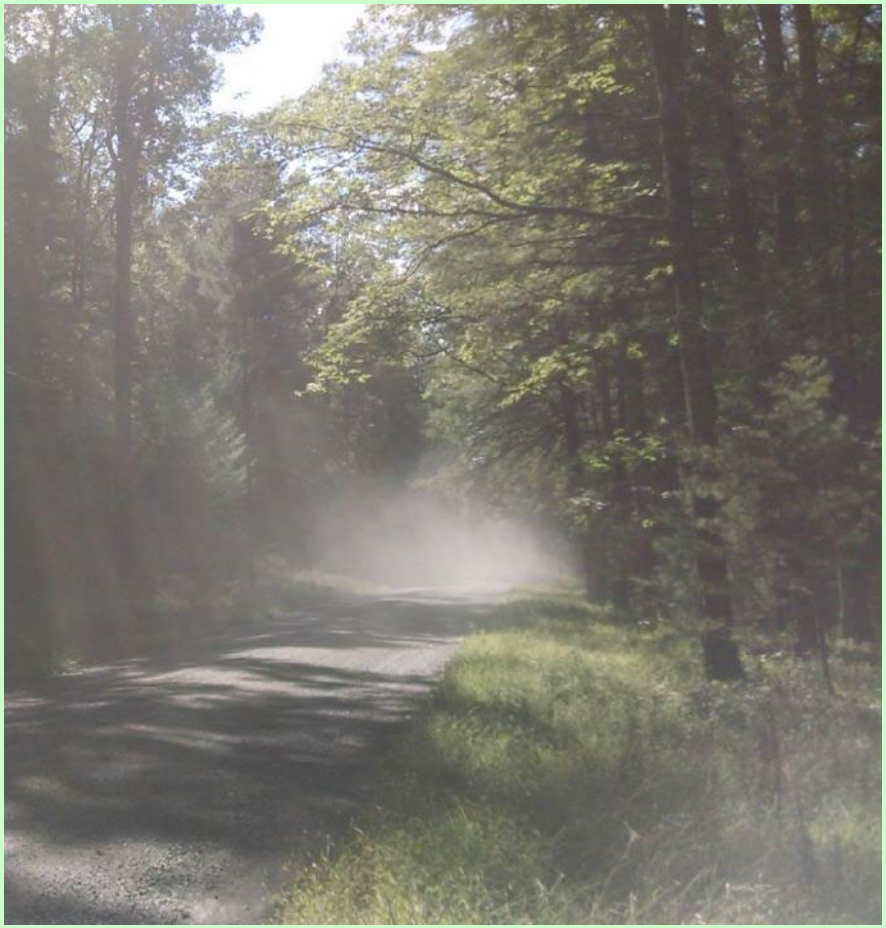
7. Maintaining Quality Aggregate

Dust is the loss of road fines.

Fines are necessary to bind road aggregates.

Dust means the road is deteriorating.

Dust increases pollution & maintenance costs.



If a dust product or stabilizer is used, follow manufacturer guidelines

DGLVR Program Product Eligibility

Are Dust Suppressants and Stabilizers an eligible expense???

yes, but…

Consult your local Conservation District

- Must be part of a comprehensive project
- There is declining use in DGLVR Program
- Many prior products have chosen not to renew
- Some new products are currently under review

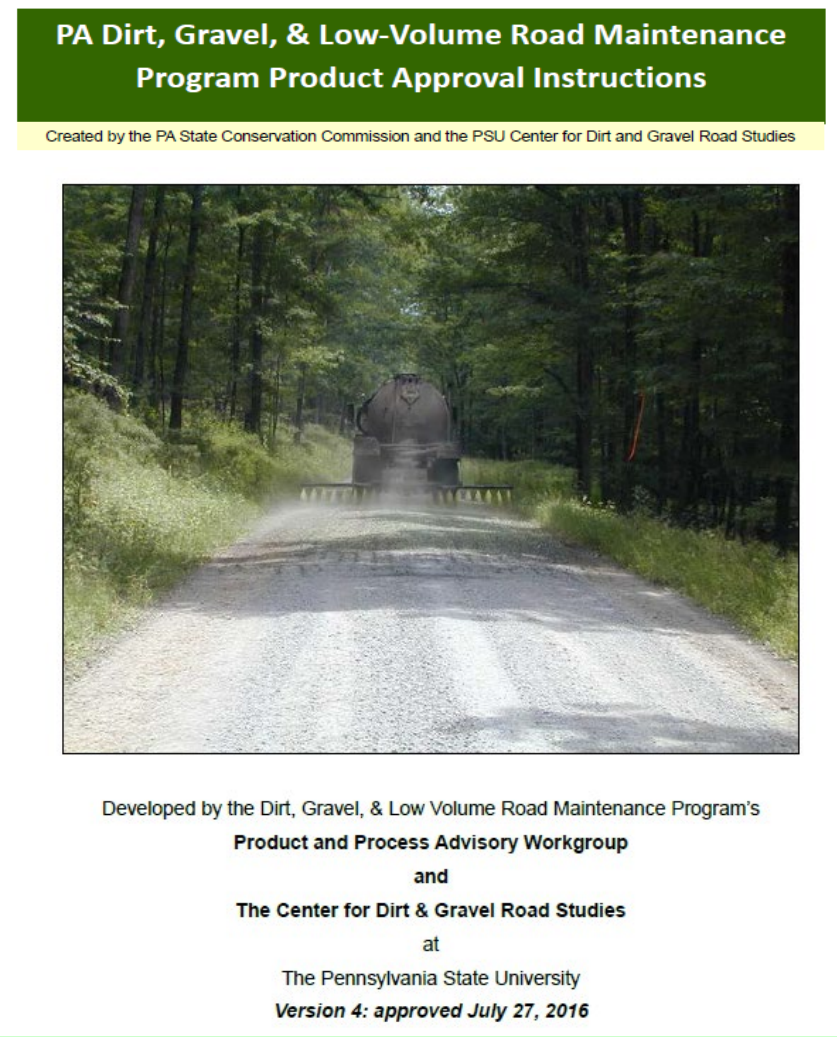
Commonly used Dust Suppressants that cannot be used in the DGLVR Program:

- Chlorides & Brines
- Cutbacks oils MC30 & MC70

Approved Products for the DGLVR Program

- Approved by the SCC and environmentally sound.
- Passed all DGLVR testing requirements

*An Approved Products list is included in the ESM Manual for this training



Road Surface and Drainage ESM Practices:

1. Establish and Maintain Effective Crown
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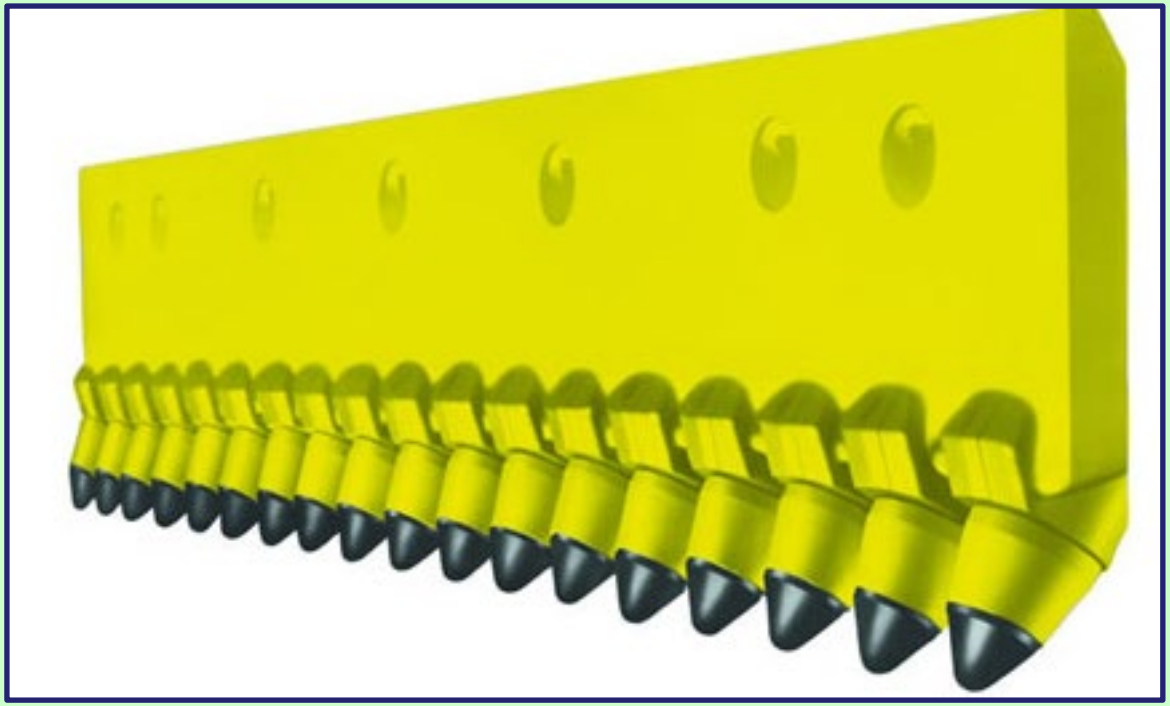
7. **Maintaining Quality Aggregate**

Maintaining Quality Aggregate

Rotating Carbide Toothed Grader Blade is recommended!!

Carbide Toothed Grader Blade: Has replaceable rotating carbide tipped teeth. Often called a "stinger blade."*



* John Deere's carbide grader blade

Maintaining Quality Aggregate

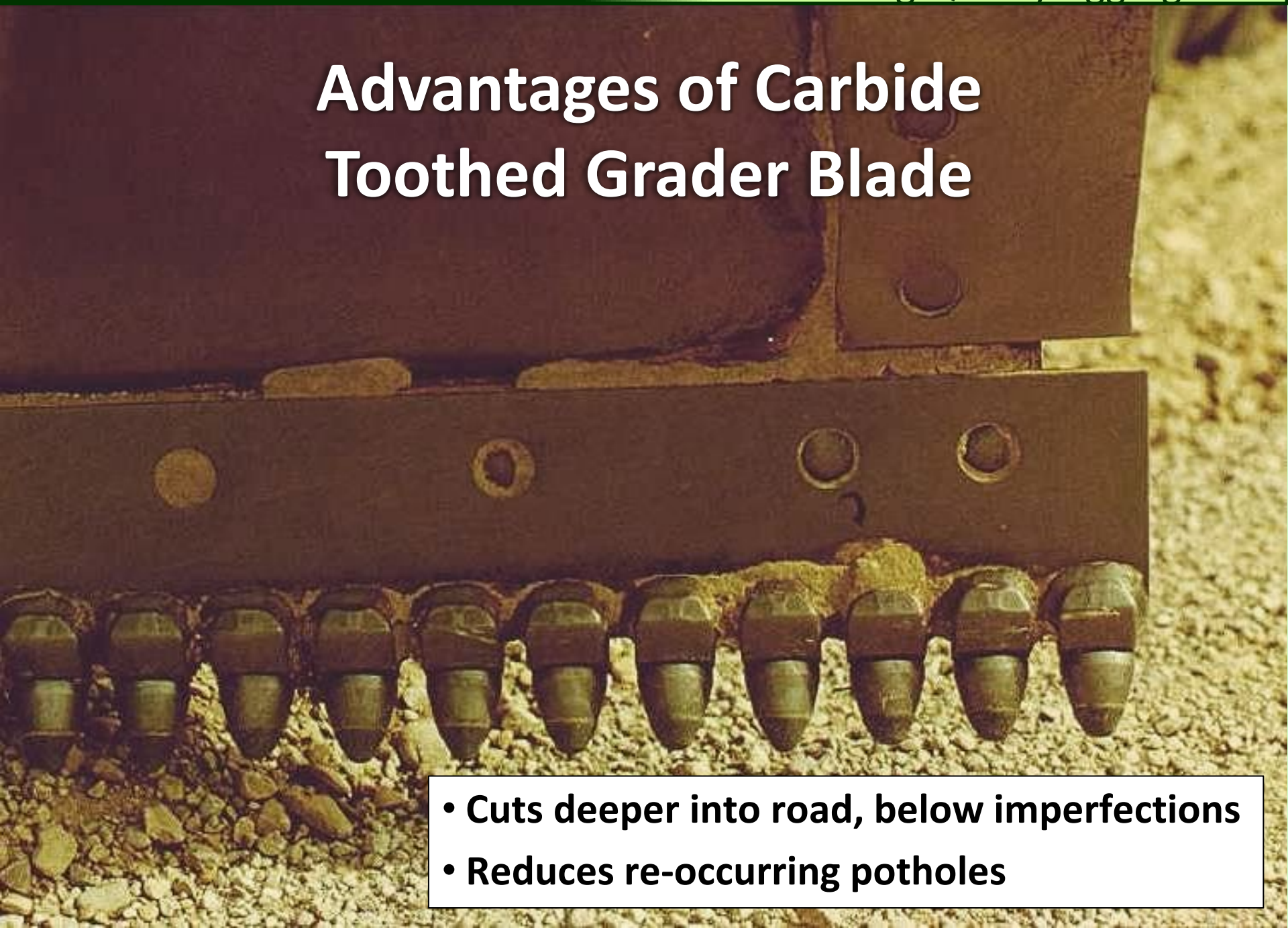
Advantages of carbide toothed vs standard straight blade:

- More aggressive and productive
- More durable & better investment (outlasts 20:1)
- Scarifies surface to improve bonding
- Blends material during grading
- Shatters exposed rock
- Works in wet conditions
- Eliminates need for raking

Common Issues With Traditional Blade

- **Middle often not addressed during grading.**
- **Pothole structure usually remains intact.**
- **Segregated stone not remixed with road fines.**

Advantages of Carbide Toothed Grader Blade



- Cuts deeper into road, below imperfections
- Reduces re-occurring potholes

Advantages of Carbide Toothed Grader Blade

Improves adhesion

Advantages of Carbide Toothed Grader Blade

- Reincorporates fines locked into the road
- Reduces stone segregation / blends aggregate

Advantages of Carbide Toothed Grader Blade

Shatters imbedded rock

Maintaining Quality Aggregate

Carbide toothed vs. standard straight blade considerations:

- Higher initial investment
- Requires “learning curve”

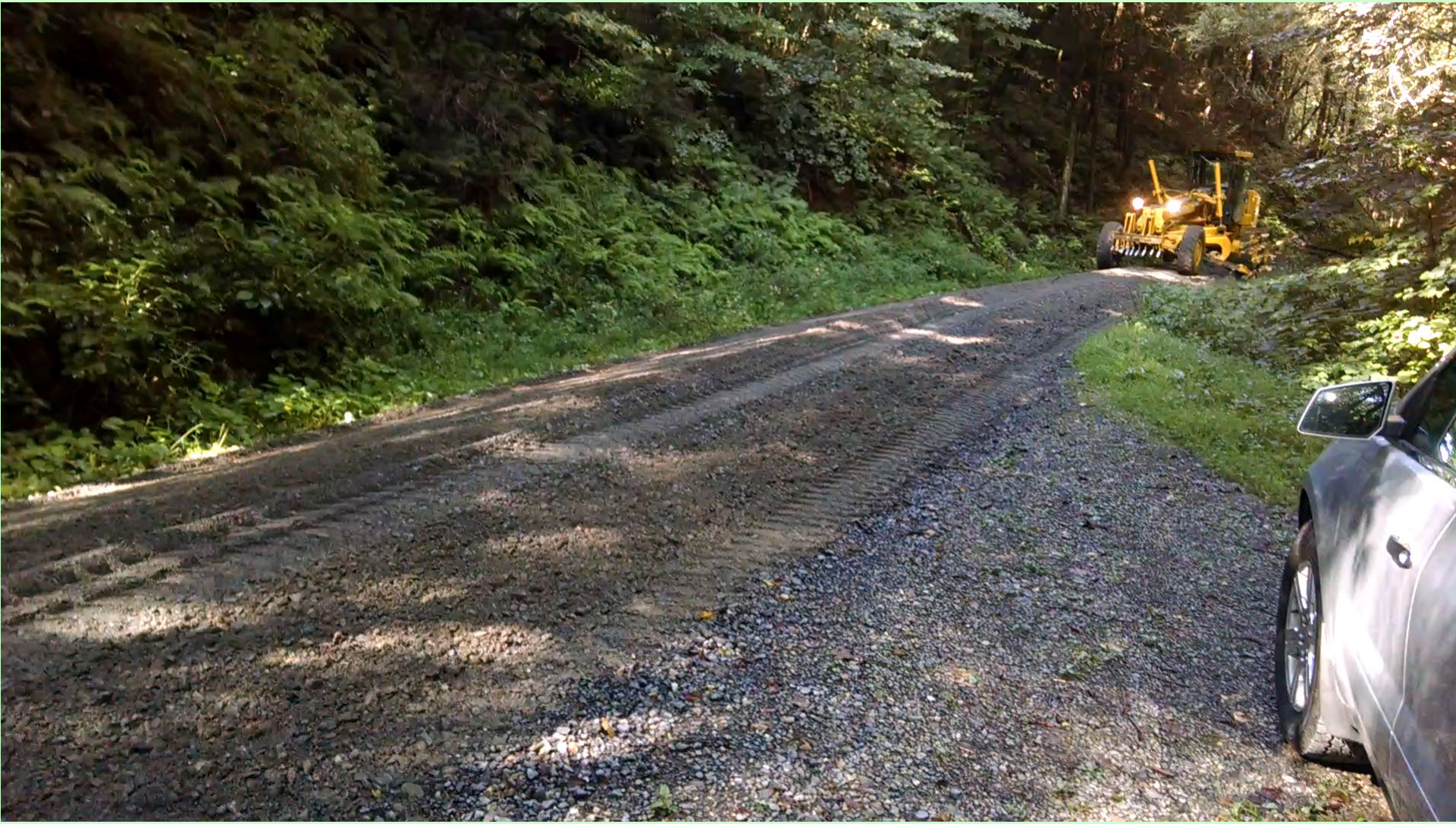
Maintaining quality aggregate

Use a 1 ¼” thick blade (or larger)

Carbide Toothed Grader Blade Grading sequence:

1. Scratch the road surface
2. Generate workable material and establish desired road shape
3. Spread the material
4. Groom & shape the road
5. Compact at optimum moisture

Maintaining quality aggregate



The grading process for a carbide toothed grader blade is in the DSA handbook and Technical Bulletins:

Driving Surface Aggregate Handbook

Driving Surface Aggregate (DSA) Handbook

July 2022

This DSA Handbook is intended for use in Pennsylvania's Dirt, Gravel, and Low-Volume Road Maintenance Program.

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Technical Bulletin

Grading Sequence with a Rotating Carbide-Tipped Grader Blades

PennState Center for Dirt and Gravel Road Studies 2/2019

Carbide–tipped blade systems offer numerous benefits over traditional straight grader blades for maintenance grading operations. This is the preferred tool for maintaining a road surfaced with a quality aggregate, such as Driving Surface Aggregate (DSA). This document is prepared for operators not familiar with the rotating carbide-tipped blade. Minor adjustments to techniques used with traditional straight blades will allow the blade to perform at maximum potential. Presented here is the road surface grading sequence using a rotating carbide-tipped grader blade:

1. Scratch the Road Surface
2. Restore Proper Cross-Slope
3. Spread the Material
4. Groom the Road
5. Compact

The sequence outlined here depicts the process for grading a center-crown shaped road.

1. SCRATCH THE ROAD SURFACE

The first step in grading is to loosen and roughen the entire surface of the road. The shallow grooves created by a carbide-tipped blade eliminate shear planes and act as anchor points, greatly improving binding of the newly graded material.

ically one pass in each direction is sufficient to loosen the rial and prepare the center of the road to receive material. scratching the surface, stay on one side of the crown he centerline (see Figure 1). Scratch/loosen the road o the depth of the deepest point in the road cross-is particularly important to cut the road (cross-file) to the bottom of any washboards or shallow ay require additional passes.

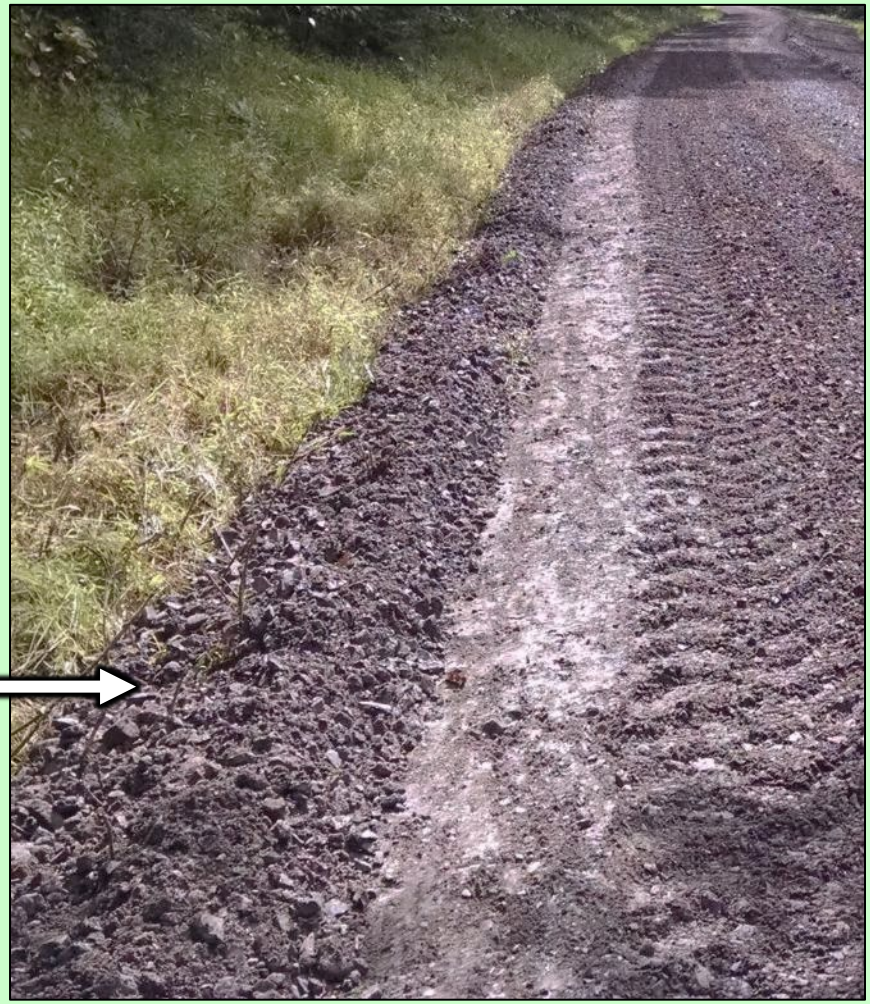
ould be cut below the bottom with a grader- or other toothed digging equipment tor). This is to destroy the shape of the e, and to educe the potential for the hole atch the center of the road when pair crown is a recipe for future boards (see Photo 1).

Figure 1.

Focus on effective side-slope
…and verify your work

Side slope must be continuous to the ditch!

- Remove windrows along shoulder during grading
- Don't leave a trailing lip when grading
- Windrows and grader lips are **Artificial Berms** that work against you!



Moisture is a must for maximum compaction!

Grade when there is moisture in the road or make your own

Compaction is critical to maintaining aggregate and extending maintenance cycles

After grading, compact with a Vibratory Roller – the biggest you can get!

Maintaining Quality Aggregate

The benefit of compaction can't be stressed enough

Remember!!

CROWN

is your road's first line of defense!

Without it, you are fighting a losing battle!!

Surface Maintenance

ADDITIONAL RESOURCES:

- Your Conservation District
- Your Municipal Engineer
- www.dirtandgravelroads.org
  - Grading Technical Bulletins

next chapter:
Road Ditches