Maintenance and Management of Gravel Roads

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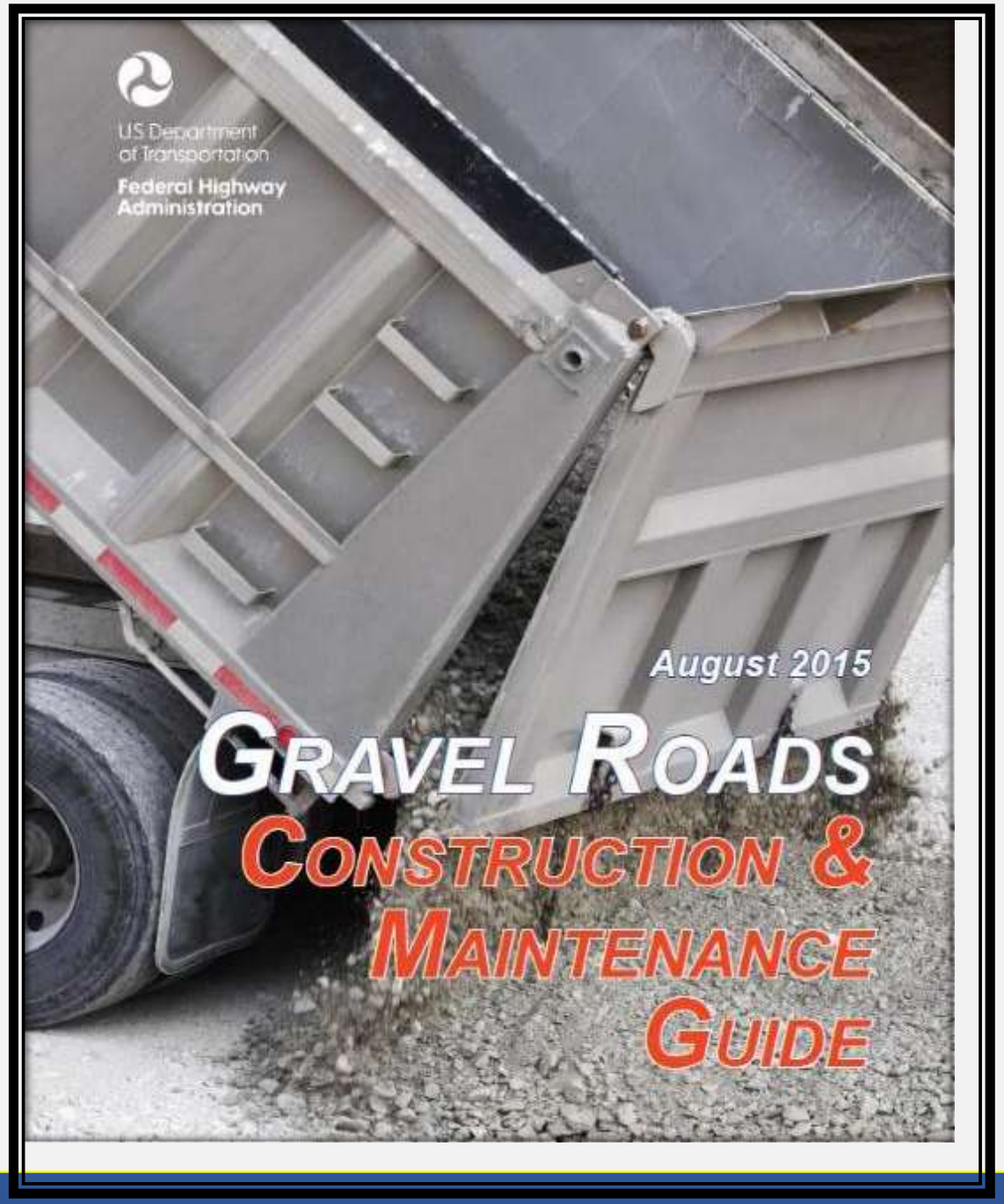
Brookings, South Dakota, USA

Overview of Presentation

- Critical Issues:
  - Roadway Shape or Geometry
  - Maintenance & Rehabilitation Guidance
  - Gravel Quality and Quantity



The Current *Gravel Roads Construction & Maintenance Guide*

Published by the FHWA in September, 2015

Roadway Cross Section Example

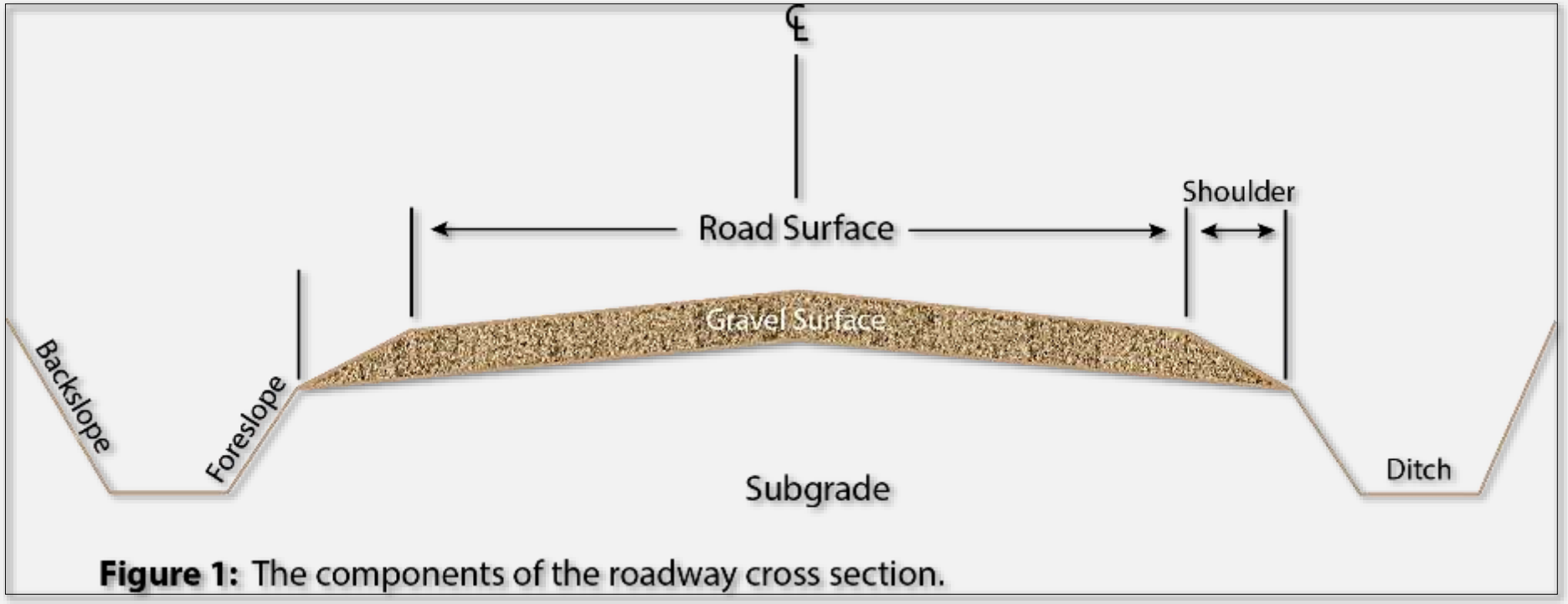
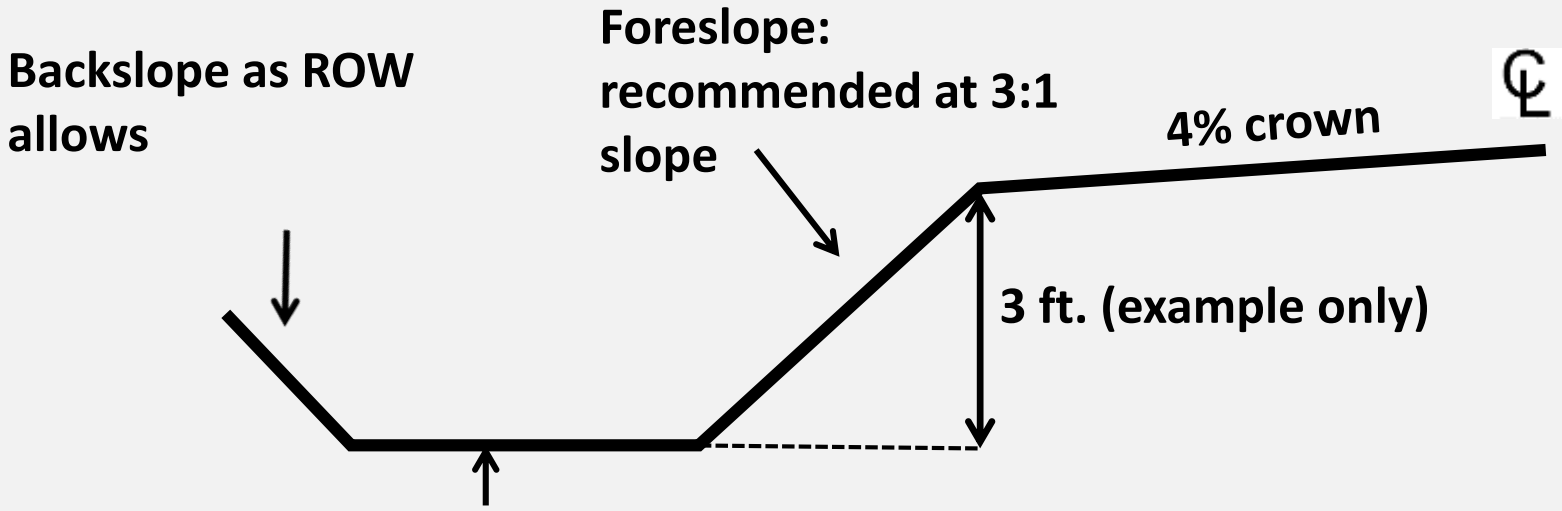


Figure 1: The components of the roadway cross section.

Drawing showing one half of roadway (from center to left)



The challenge is often working in a confined R-O-W.

How those roads look 70 years later

I’ve shifted my focus to local roads

- **Goals for today:**
  - **Share experience**
  - **Try to provide everyone with at least a few points to help you do a good job maintaining gravel roads**
  - **Answer your questions as best I can**

Introduction:

There are two primary things to understand in doing good Gravel Road Maintenance:

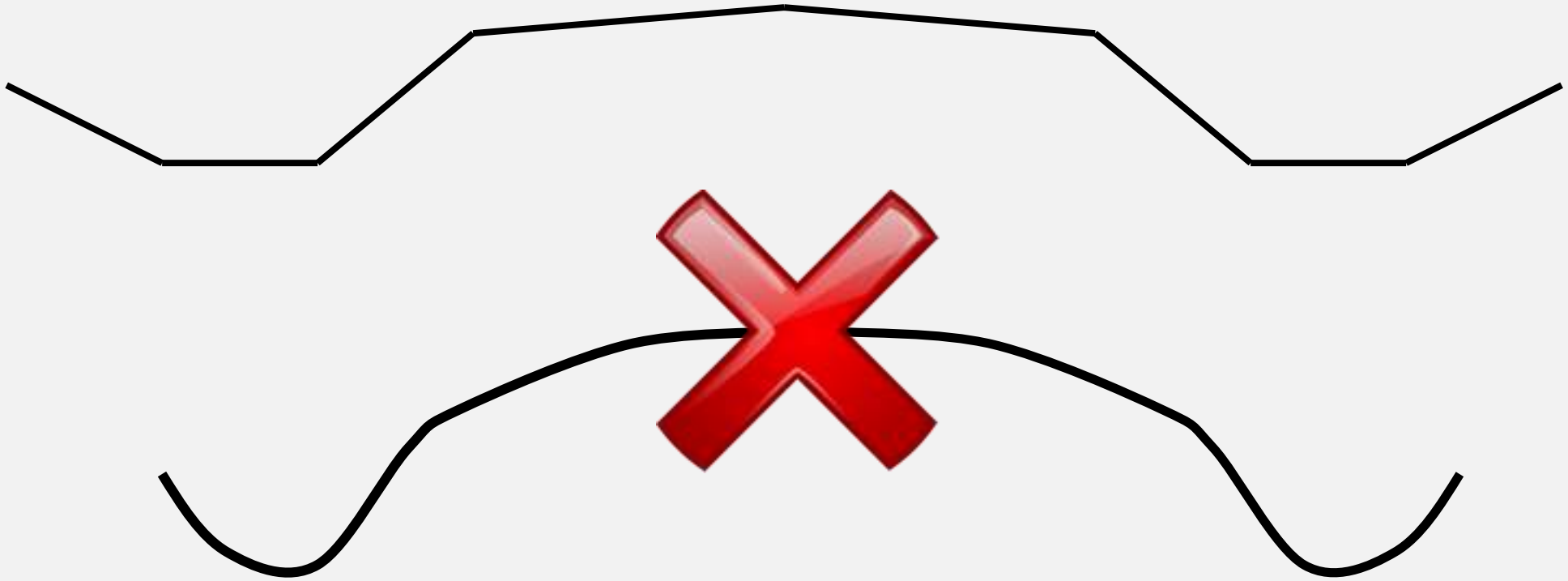
- The use of the Motorgrader and---
- The use of good surface gravel.

(Each is as important as the other!!)

Maintaining Gravel Roads

The use of the grader is critical to get and keep shape on the roadway, but thereafter many gravel road maintenance problems are related to the quality of the surface gravel.

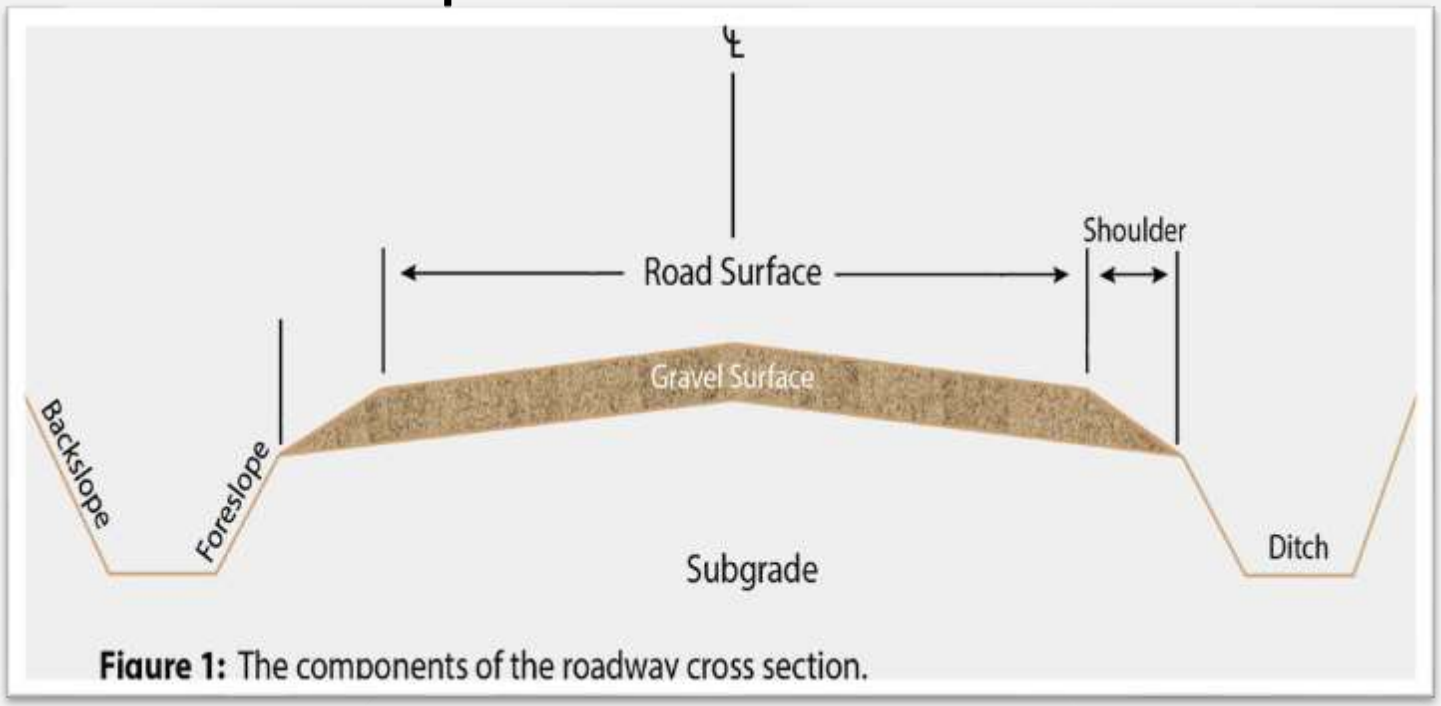
What is Your Mental Picture of Correct Roadway Shape?



Maintaining Gravel Roads

- Understanding correct shape of the roadway cross-section is the most important knowledge an operator can possess.

- Gravel roads constantly change shape!!! Operators and supervisors have to deal with this.



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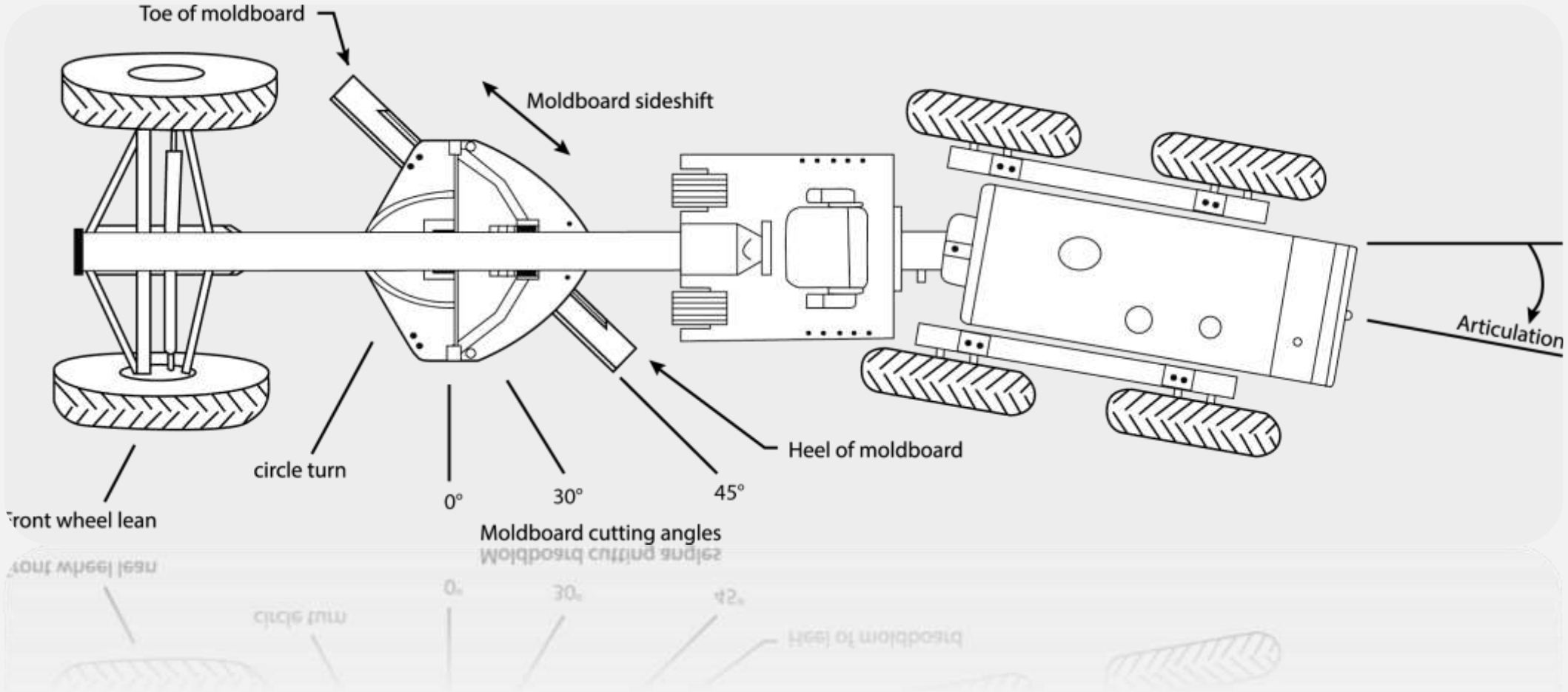
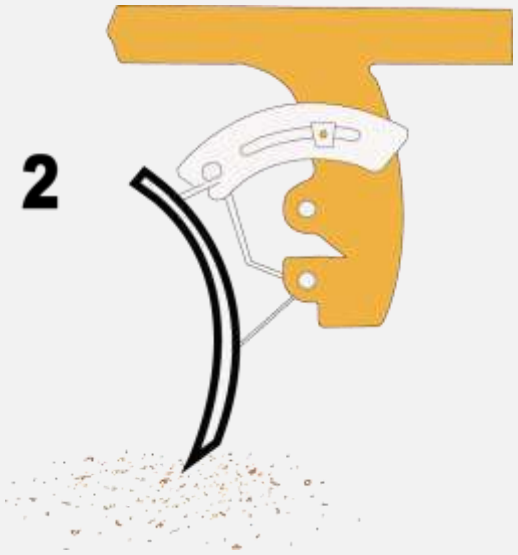

Toe of moldboard
Moldboard sideshift
Articulation
Heel of moldboard
circle turn
Front wheel lean
0°
30°
45°
Moldboard cutting angles

Maintaining Gravel Roads

Important things to understand about the use of the motorgrader:

- Moldboard Angle
- Moldboard Pitch
- Motorgrader Stability
- Operating Speed
- Articulation
- Windrows

Which pitch is correct for maintenance blading?



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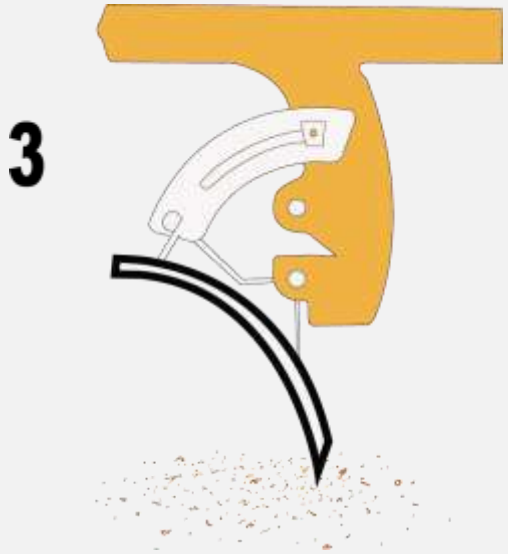


Wide Roads Can Be Extremely Challenging
It was likely graded in the past for base and paving.

Aggressive shoulder pull and still not out to the hinge point

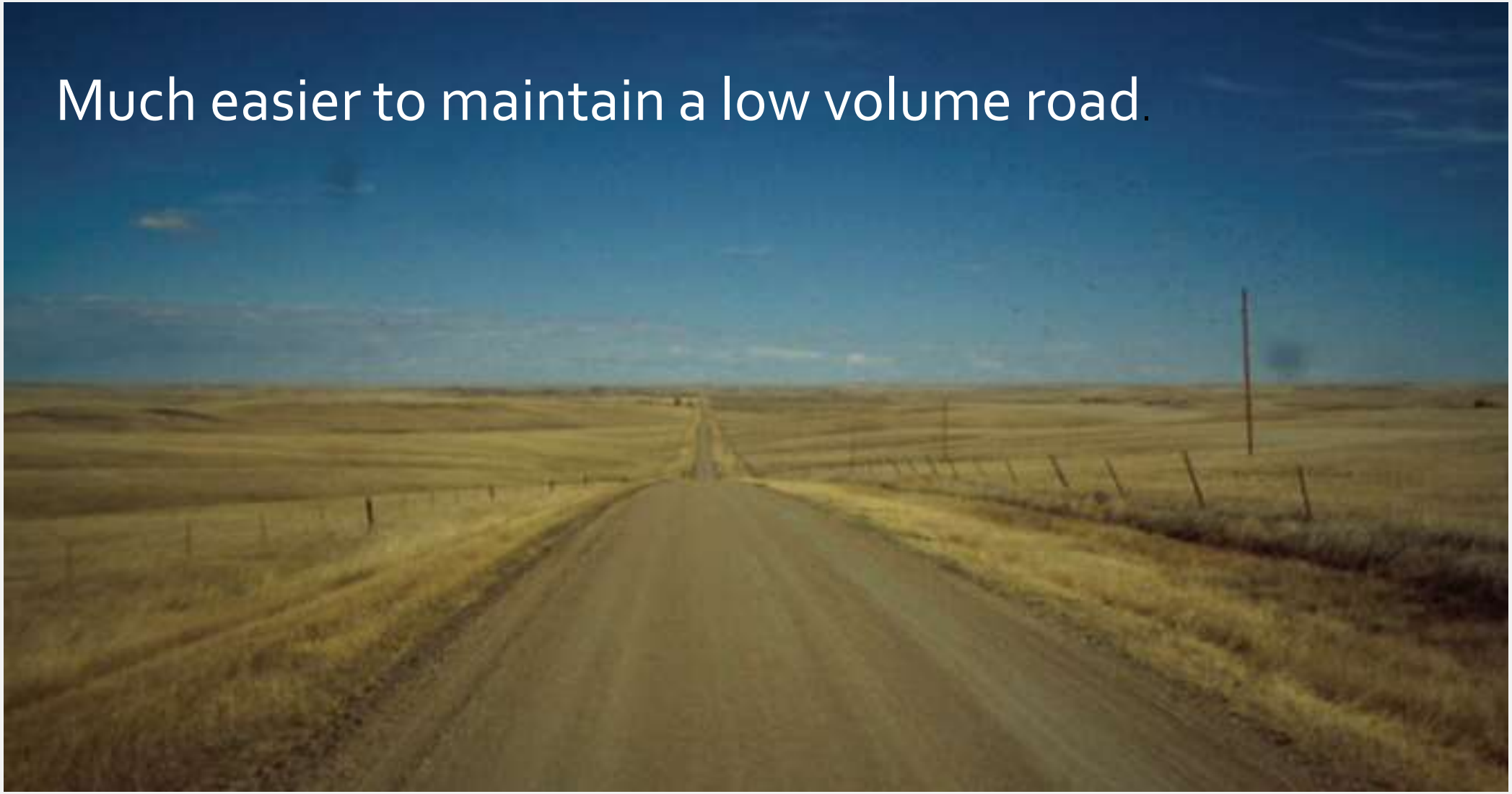
A secondary ditch on the opposite side is not good!

Crown

Every road must have crown.


Actually an inverted crown!!

Much easier to maintain a low volume road.



Some roads have too little crown, this one has too much.

Imagine a cattle trailer on this road.

About 13 inches on a 20′ top

Too much crown tend to force traffic to drive in the middle of the road!

This device can be helpful

But only if it's a <u>crown</u> gauge!

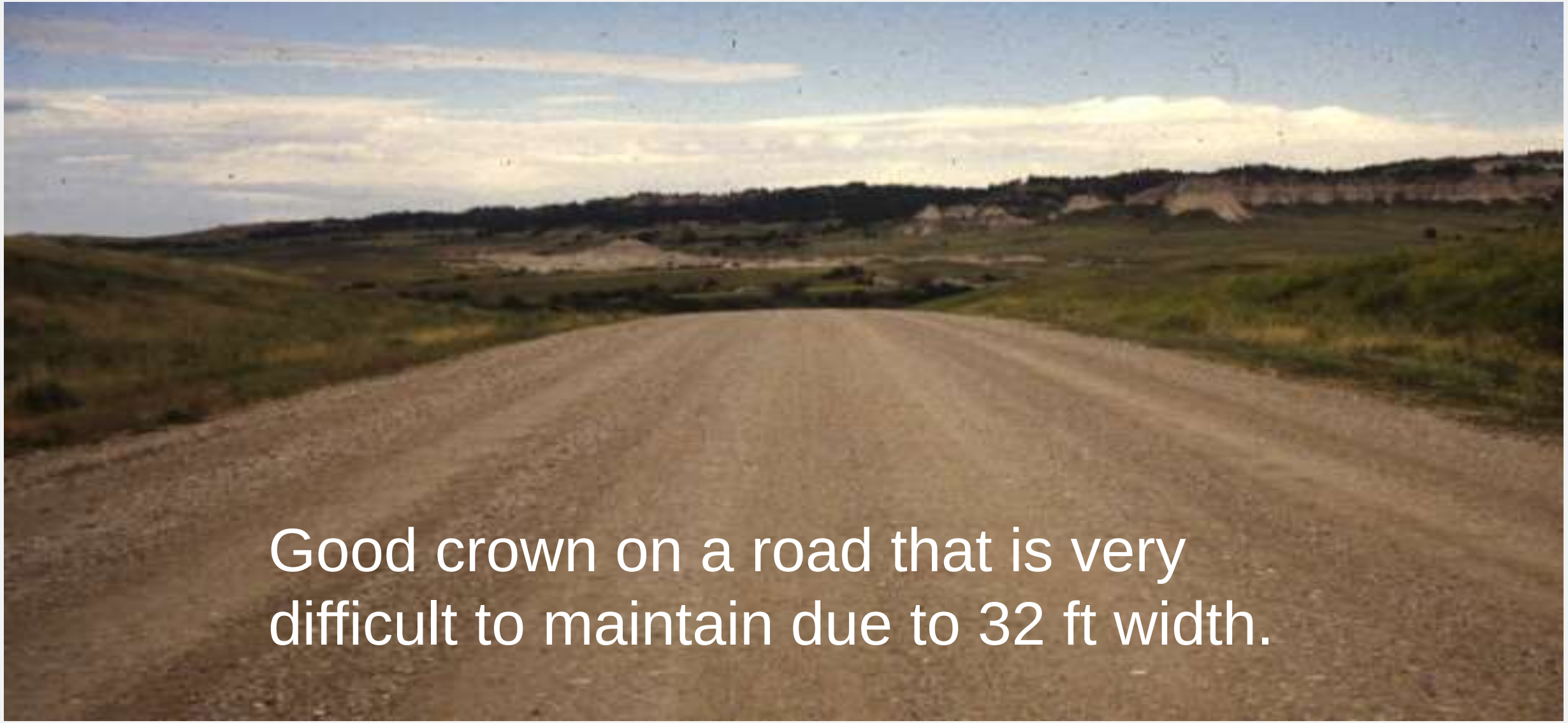
A crown gauge made by SLOPE METER, INC®

A slope meter
made by SLOPE METER, INC®


SLOPE METER NO.2
SLOPE METER, INC.
12 10 8 6 4 2 0 2 4 6 8 10 12
SLOPE METER
SLOPE METER, INC.
2 3 4 5 6 8 0 8 6 5 4 3 2

Slope Control systems on motorgraders are a great aid in construction and rehabilitation

Electronic Slope Reading


Good crown on a road that is very difficult to maintain due to 32 ft width.

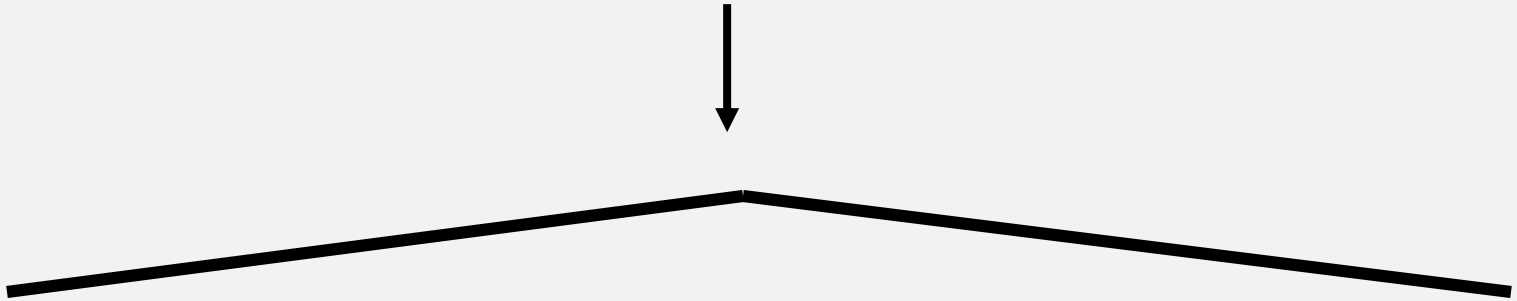

10 25 '01

Lack of crown 2% or less

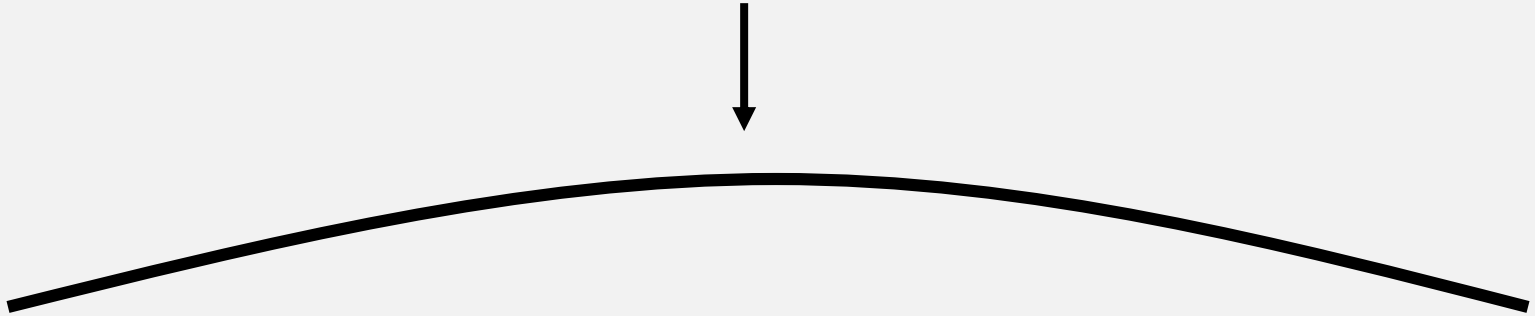
Adequate 4% Crown


45* angle on a 26’ top will not cross centerline

You want crown shaped like this

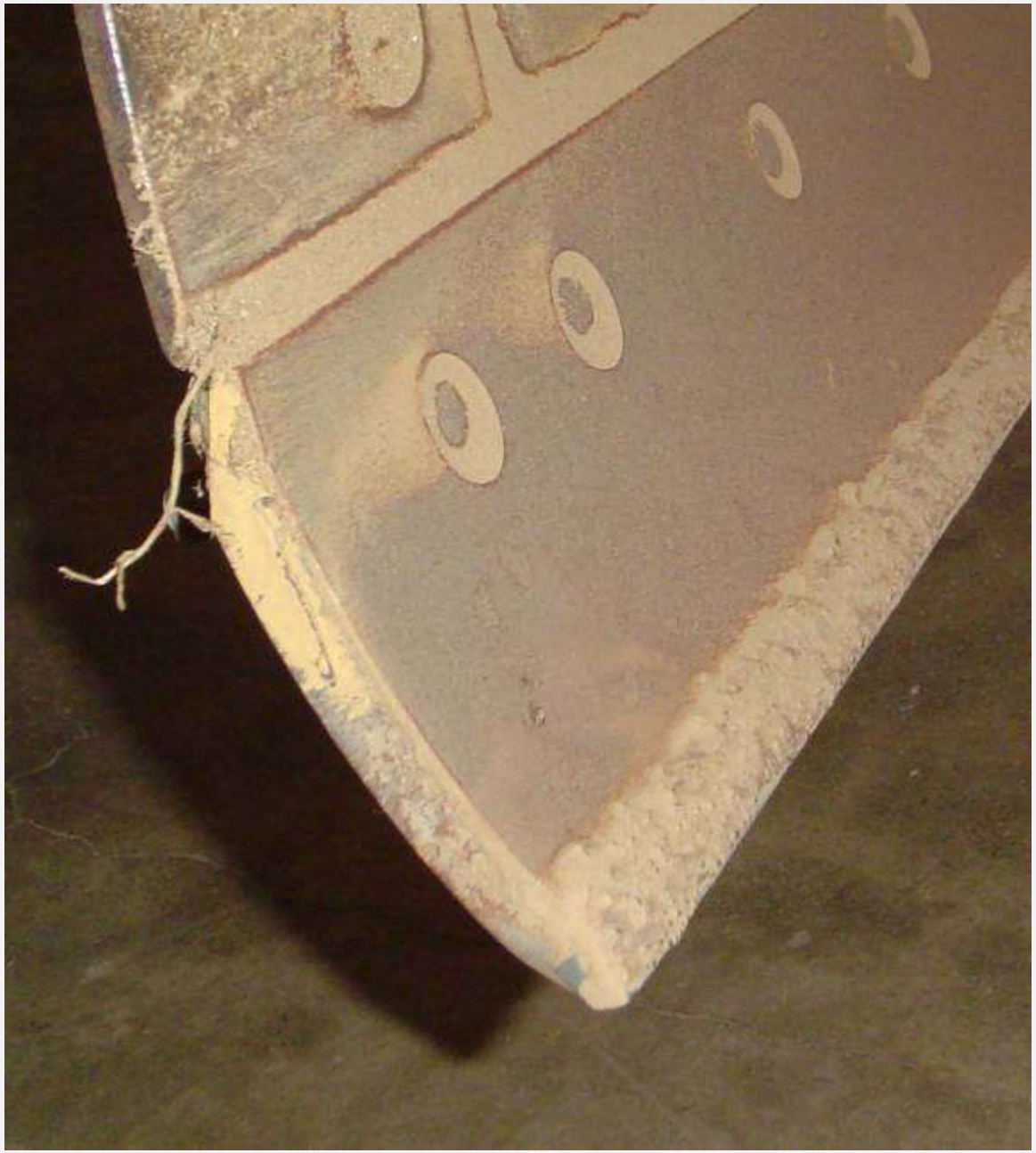


Not like this



Maintaining Gravel Roads

Carbide Cutting edges are one possible answer – expensive, but can give up to two years of use!!!




772B

A simple carpenter's laser level

Crown should be at or near ½ inch per ft (or 4%), Do not exceed 6%!

Example: 24 ft roadway should have approx. 6 inches of crown.

Crown should be straight like the roof of a house.

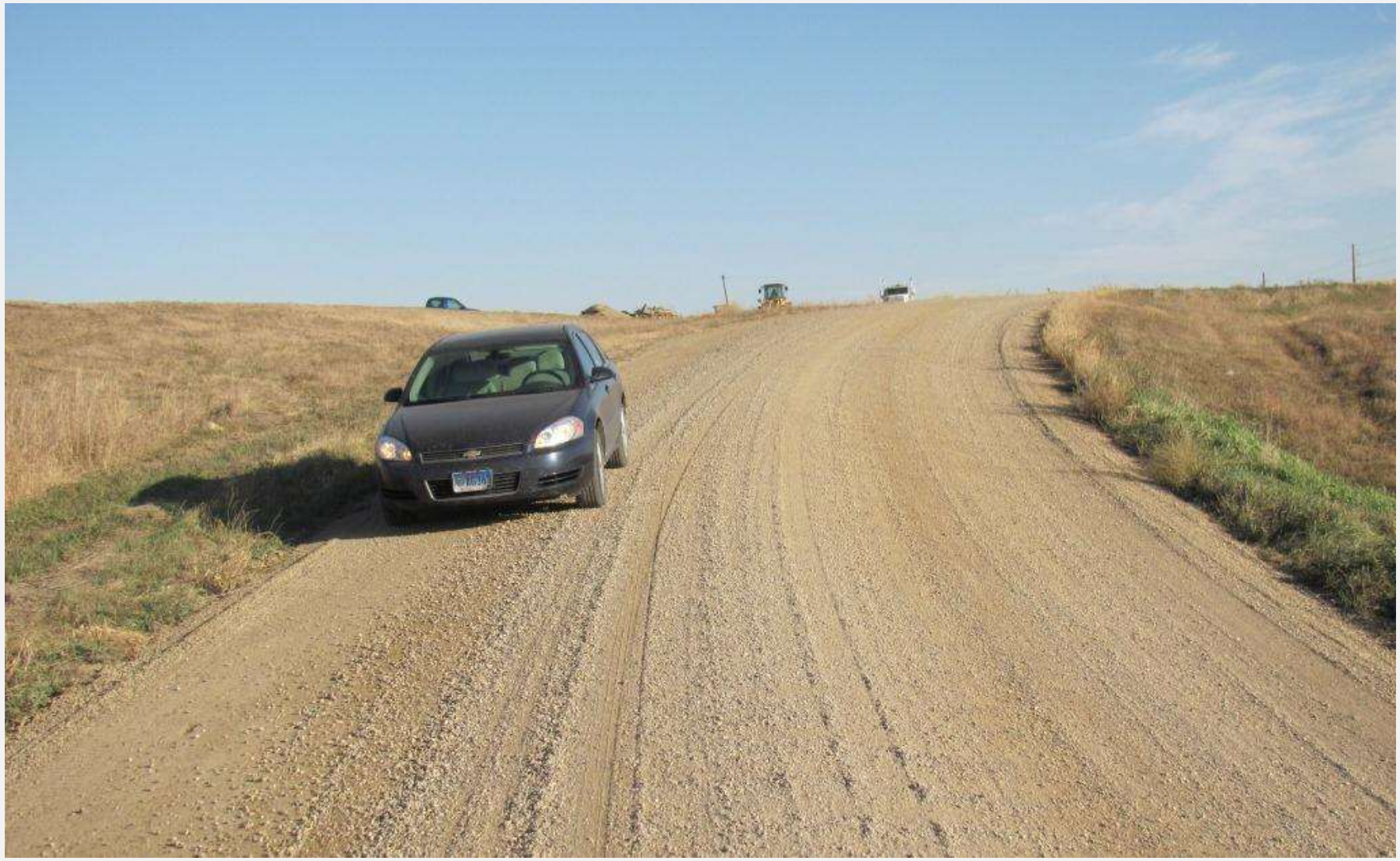
In Summary:

- The motorgrader operator must understand the correct shape needed on the roadway.
- There are special shaping situations such as driveways, intersections, bridge approaches, etc. that need to be understood as well.
- But thereafter, how a gravel road performs depends on quality and quantity of the surface gravel.
- Washboarding, excess loose material, and excessive windrows are primarily due to poor quality of surface gravel.

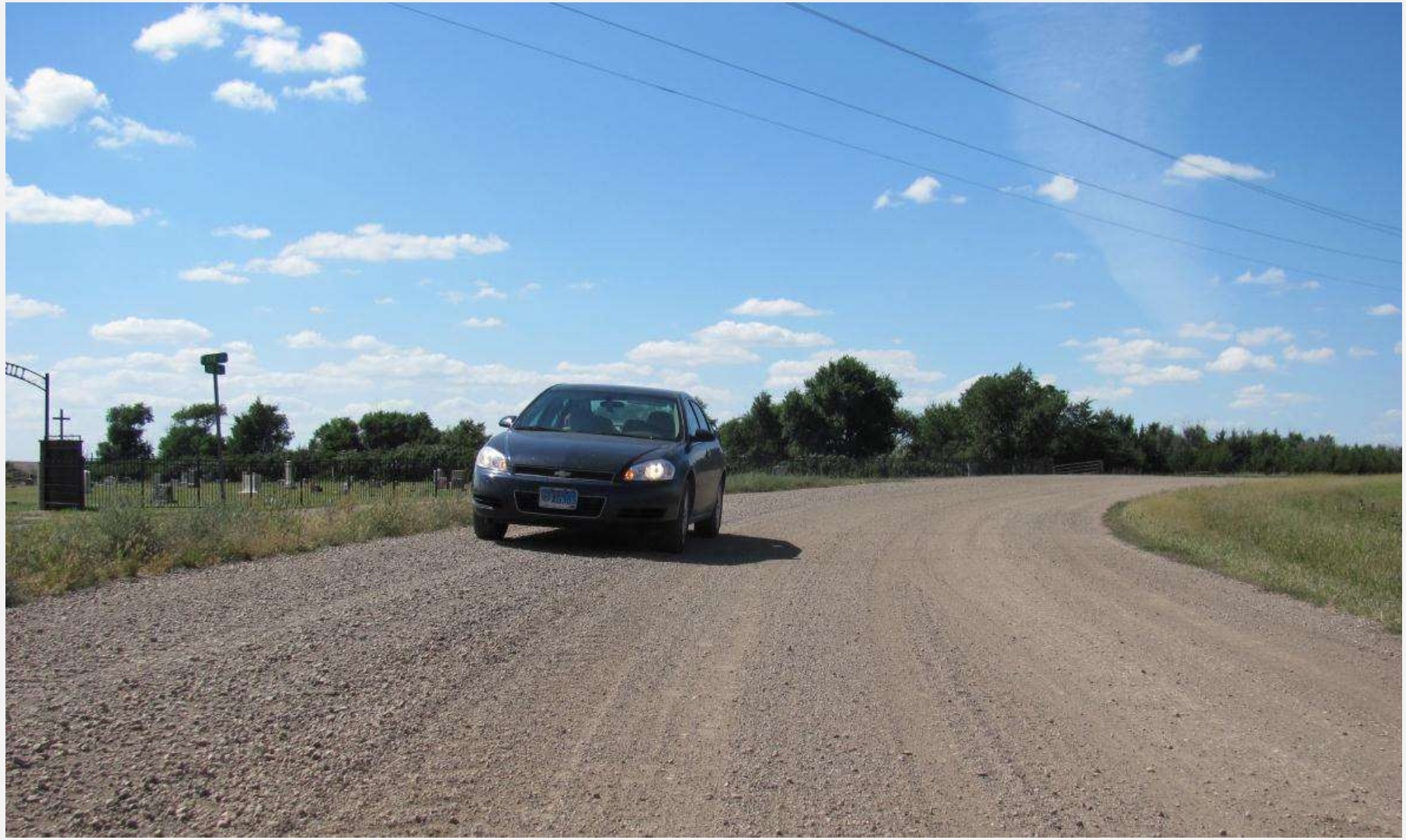
Special Situations

- **Curves**
- **Rail Crossings**
- **Bridges**
- **Intersections**
- **Etc.**

Bad geometry in curves - superelevation



Excellent example:



Proper Sequence of Super Elevation Crown

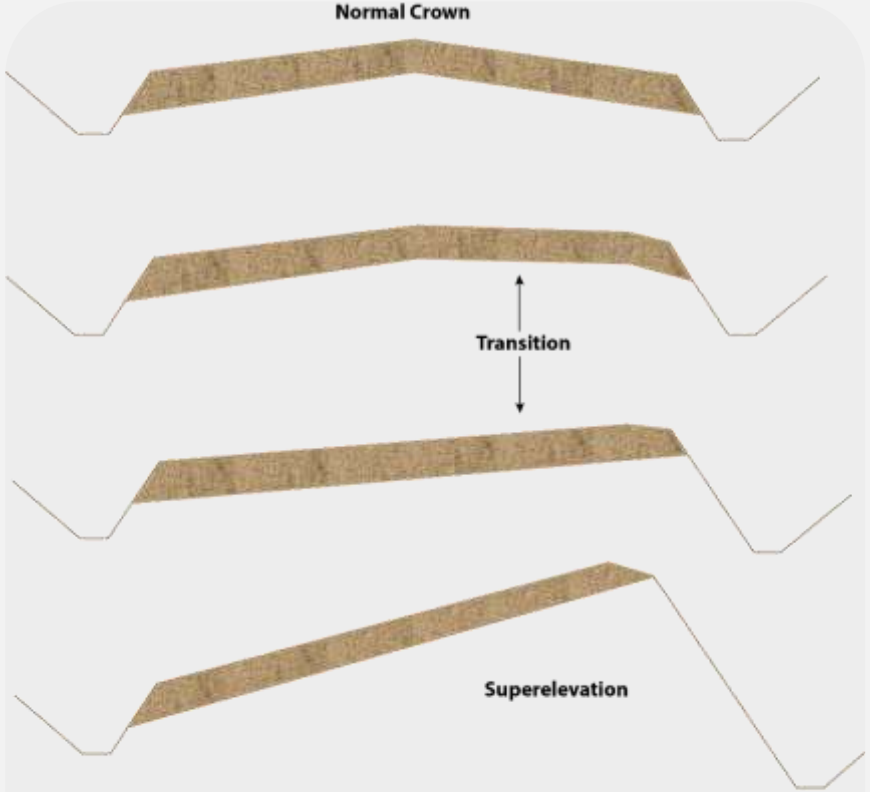


Figure 6: Illustration of the transition from a normal crown to the superelevated shape needed in a curve.

A controlled intersection

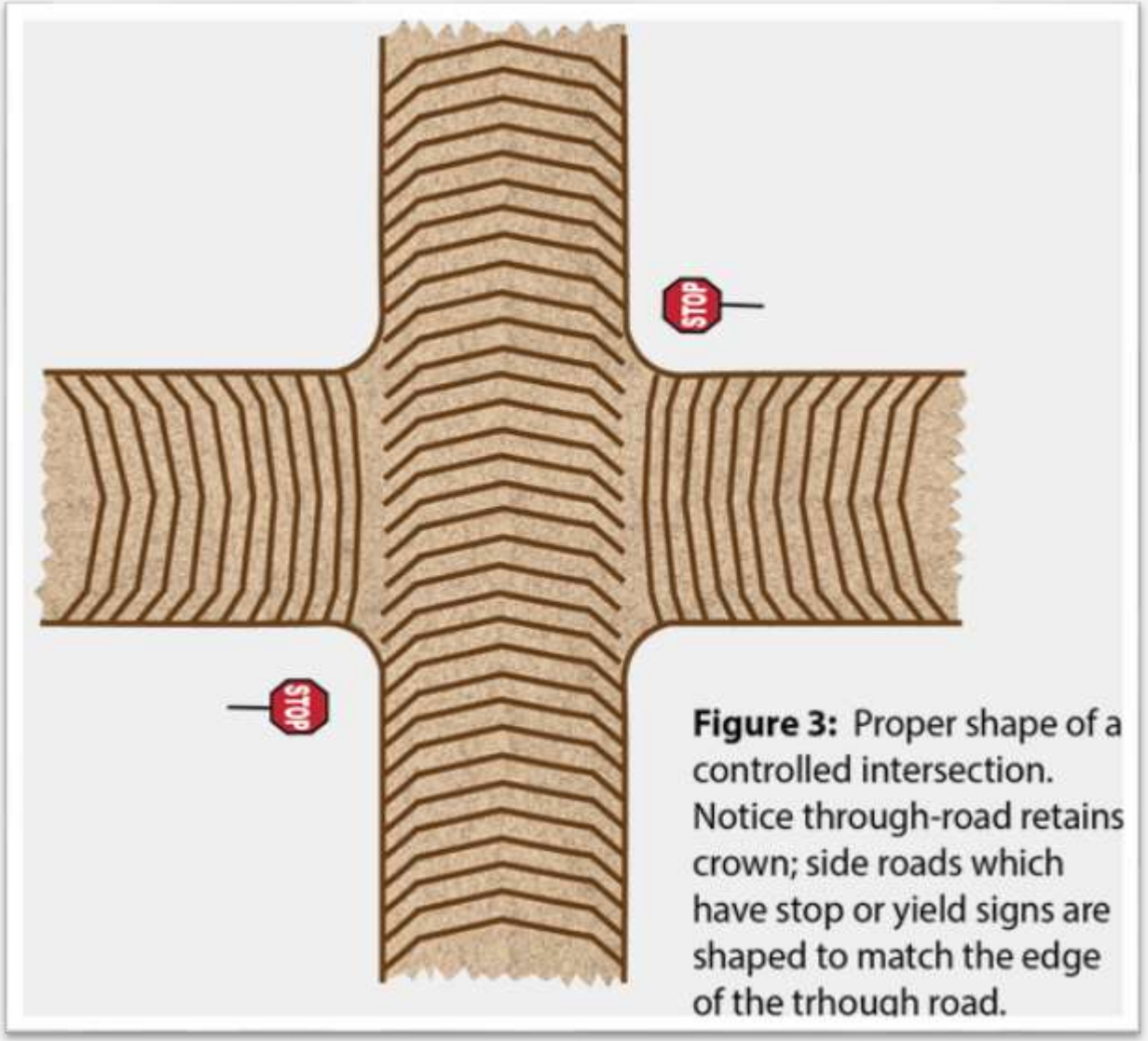


Figure 3: Proper shape of a controlled intersection. Notice through-road retains crown; side roads which have stop or yield signs are shaped to match the edge of the through road.


CAT
140H


CATERPILLAR

An uncontrolled intersection

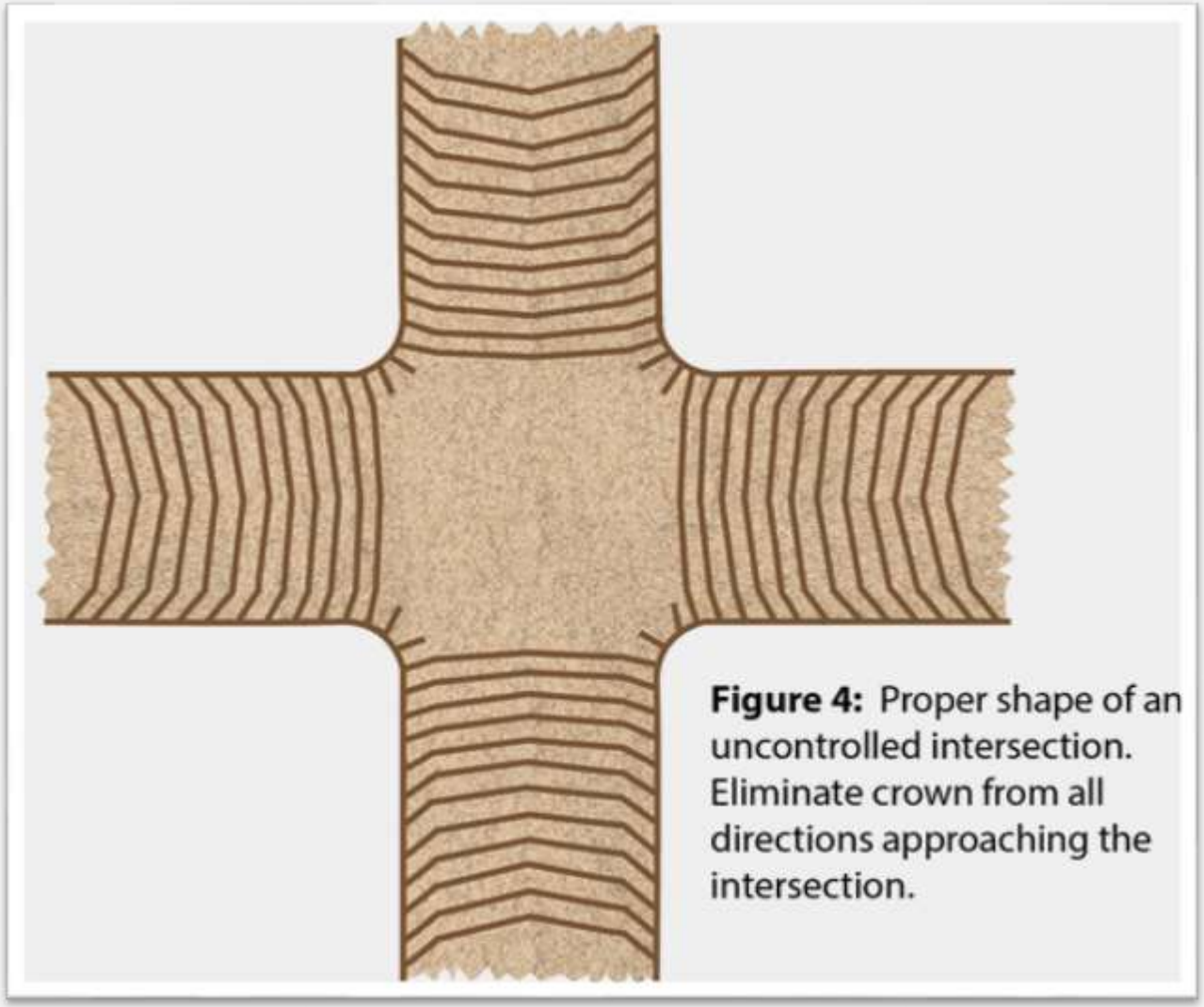
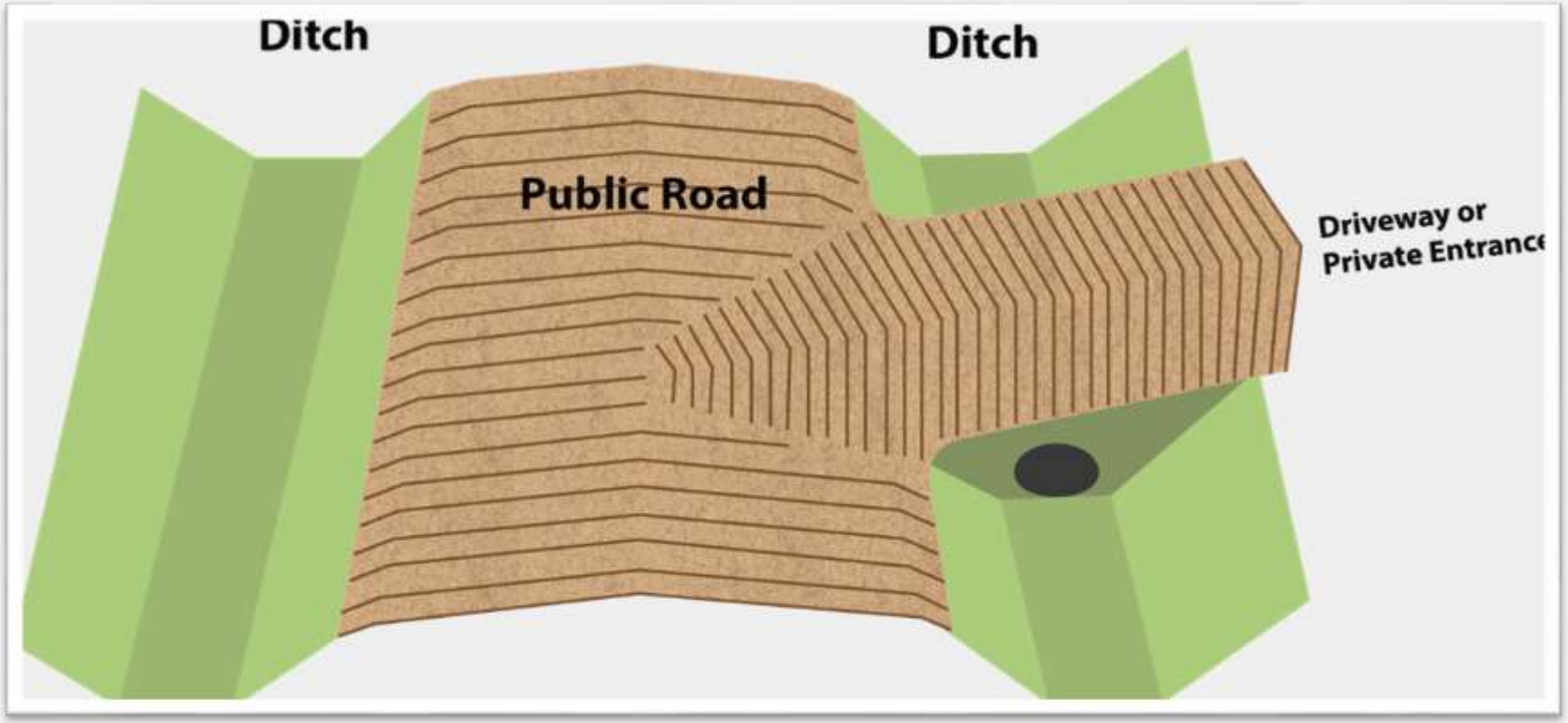
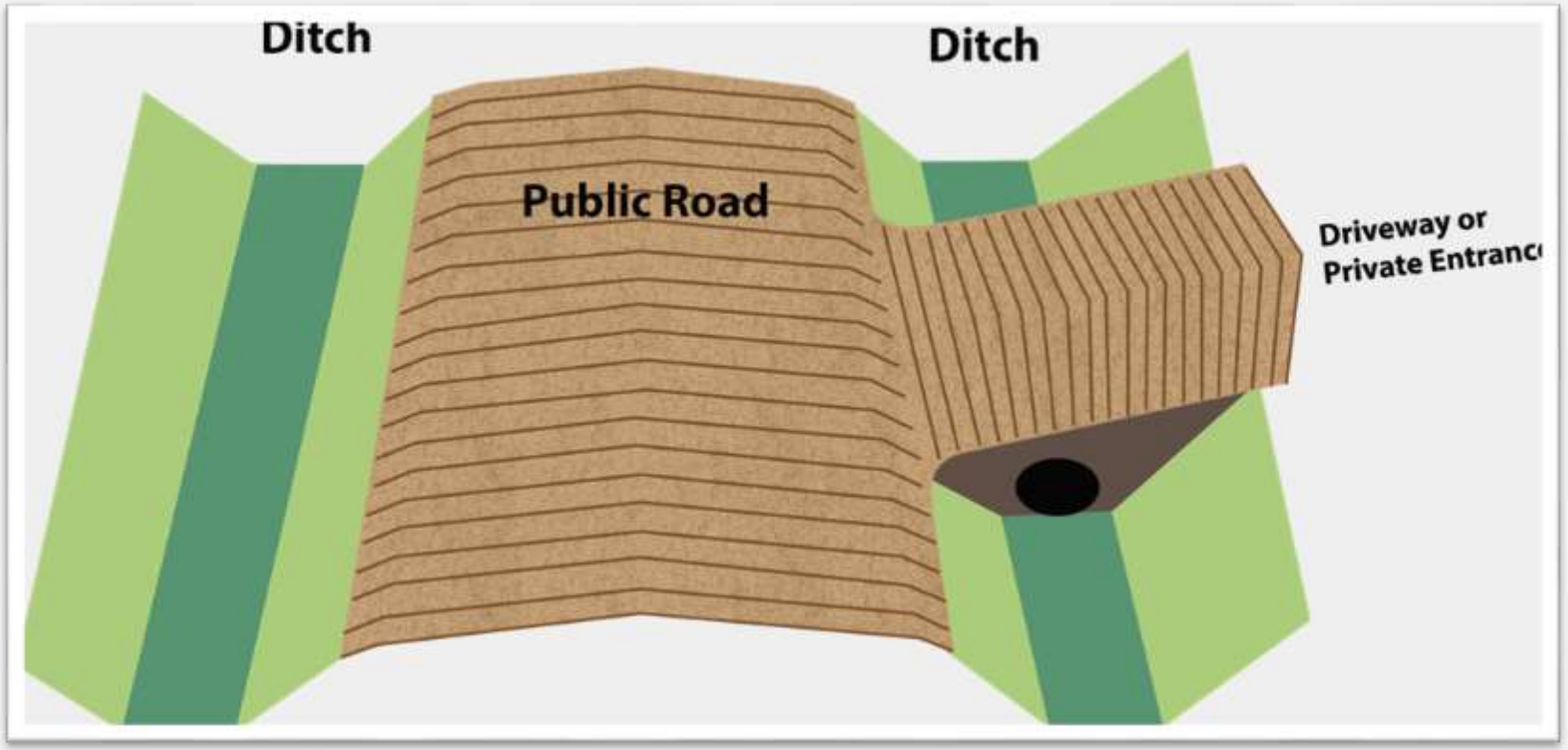


Figure 4: Proper shape of an uncontrolled intersection. Eliminate crown from all directions approaching the intersection.



The <u>wrong way</u> for a driveway or field entrance to match the public road.



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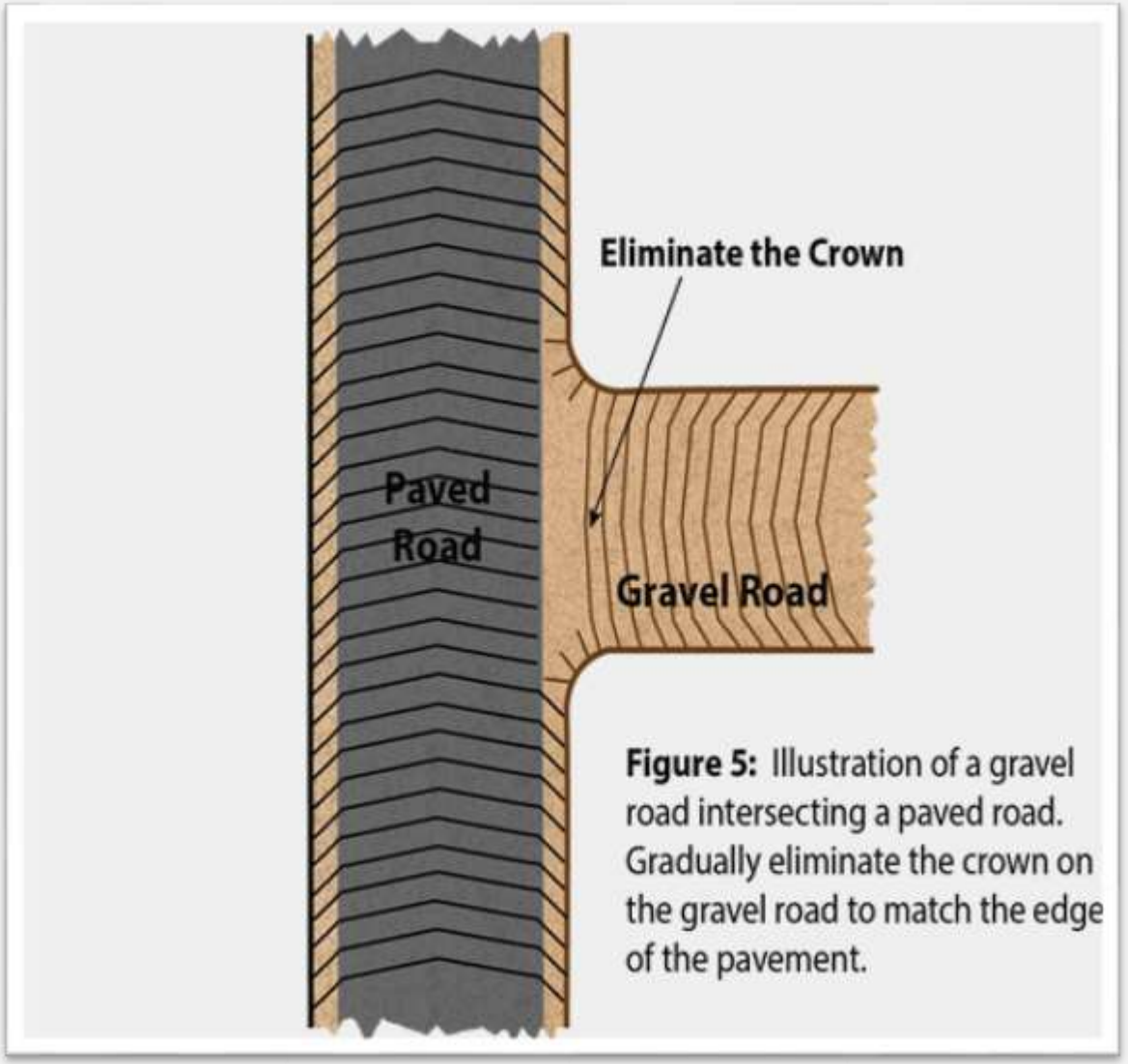


Figure 5: Illustration of a gravel road intersecting a paved road. Gradually eliminate the crown on the gravel road to match the edge of the pavement.

Always a challenge:

Matching the gravel road to edge of pavement at intersections.

Intersection with a paved road.

Danger of loose gravel on pavement

Matching bridge decks.


JUN 25 2005


JCT
94


2003

Railroad – Gravel Road Crossings

Not good!

Not acceptable

Don’t take a chance on derailing one of these!

Be very careful around railroad crossings

A train vs. a road grader is no contest


JUN 16 2004

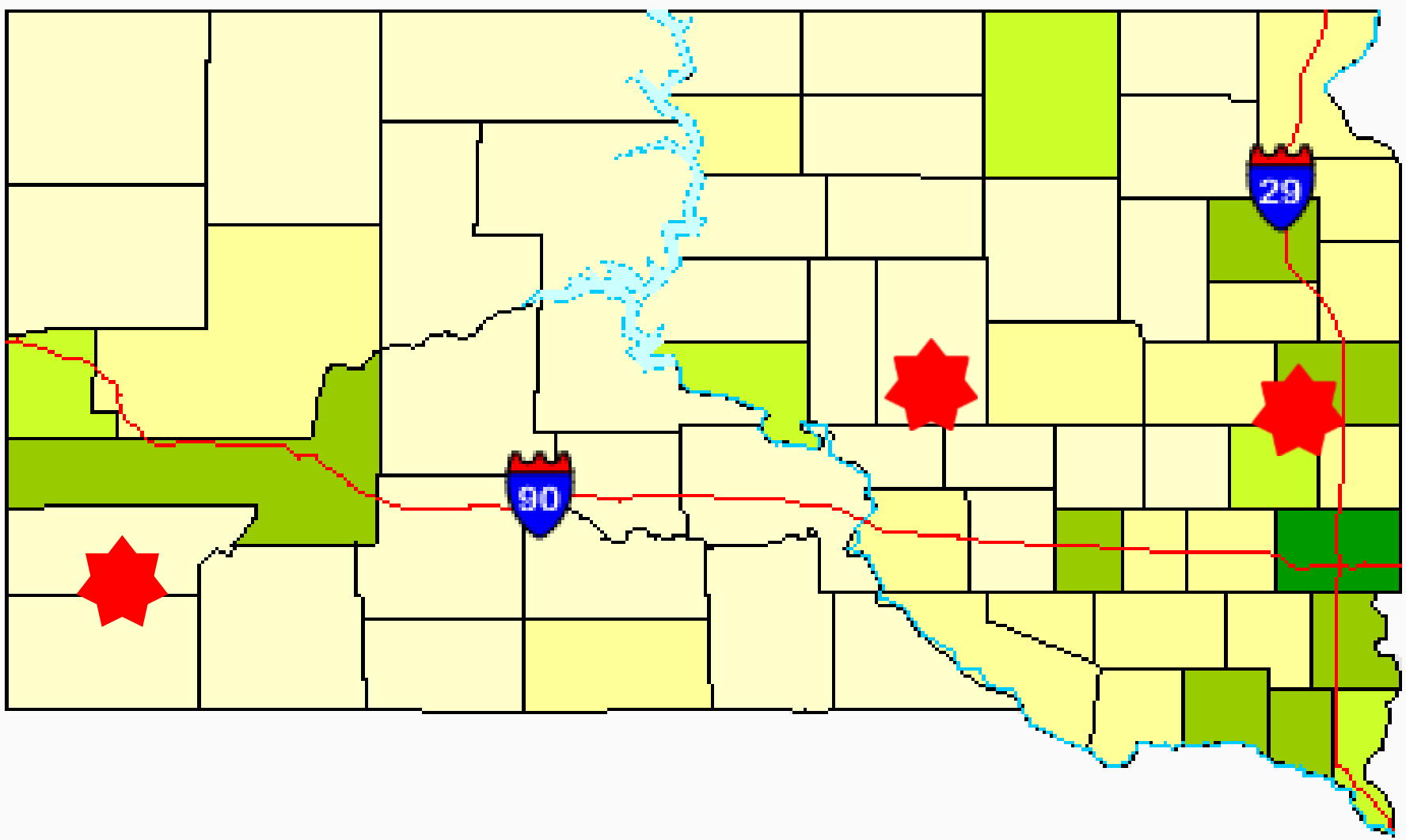
How much does your motorgrader weigh?

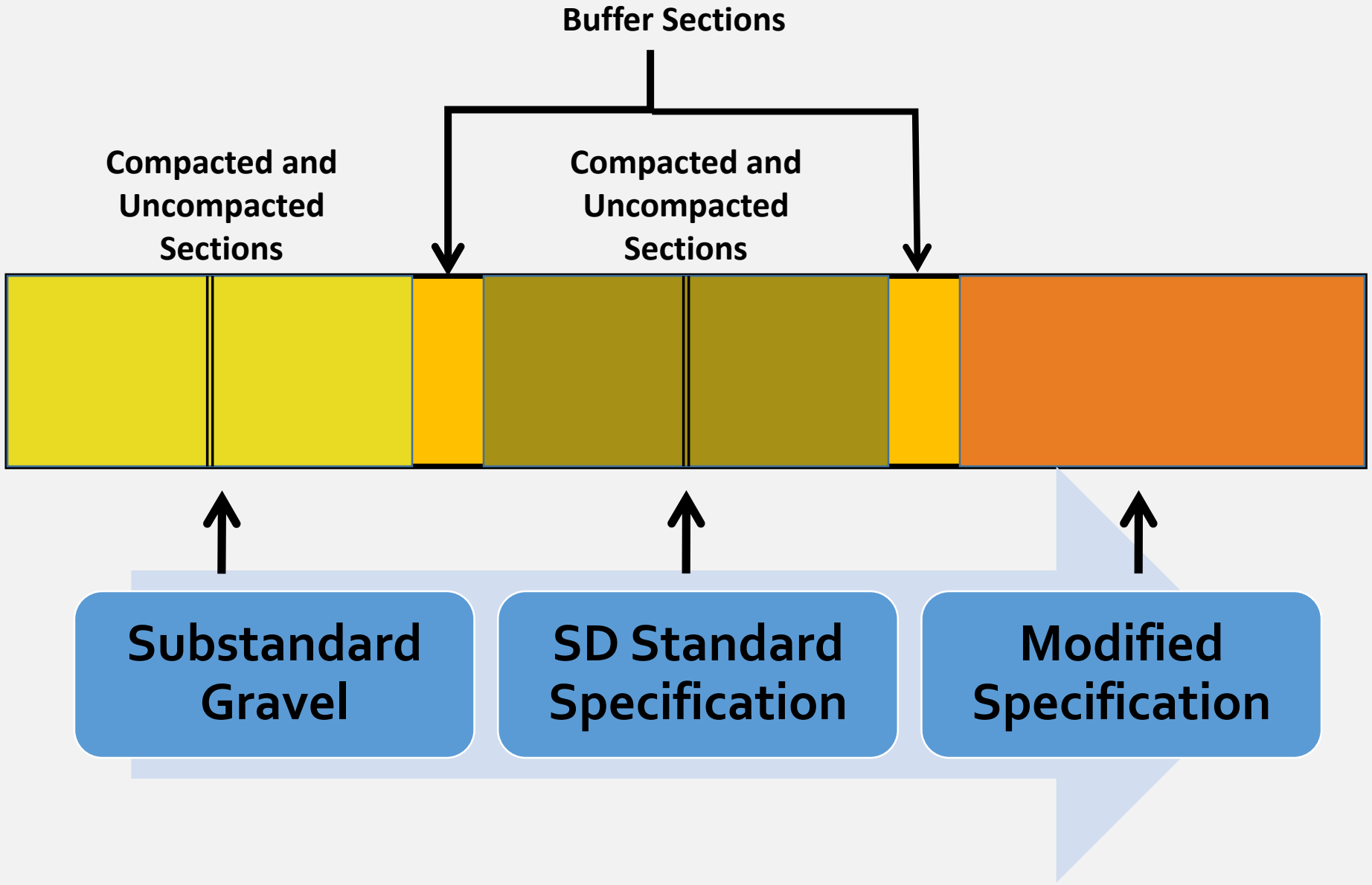
There is a reason for those signs!!

SDDOT/SDLTAP Gravel Road Experimental Project

Lessons Learned Thus Far

Location of Sections:




Buffer Sections
Compacted and Uncompacted Sections
Compacted and Uncompacted Sections
Substandard Gravel
SD Standard Specification
Modified Specification

One way to meet modified spec – blend different material from separate sources

This was done on one section in Brookings Co and one section in Custer Co

More blending or "manufacturing" in the future?

Processing material from a natural clay source

Road mixing to get a high quality surface gravel

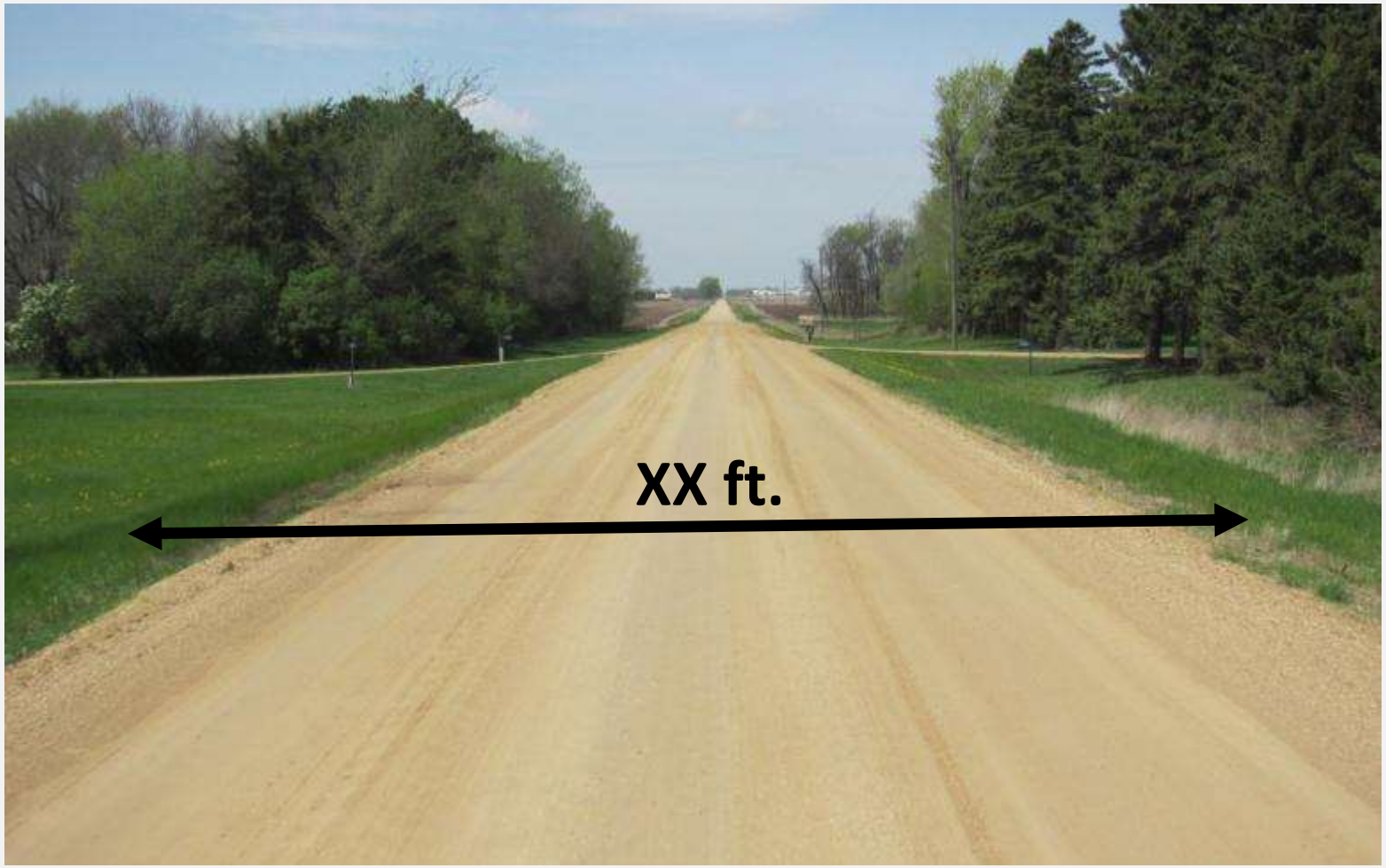

CAT


140H

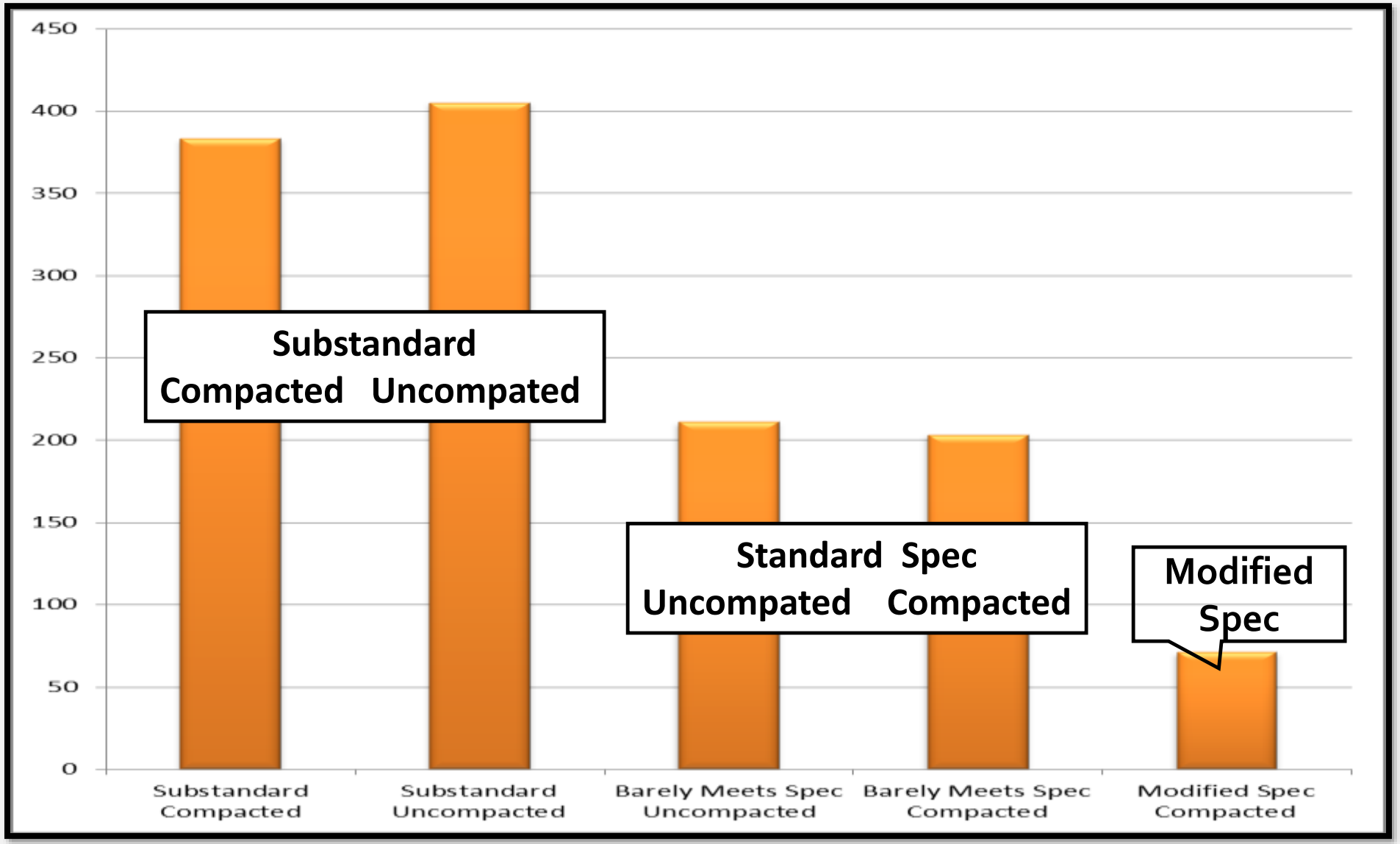
Brookings County Test Sections

Only <u>one month</u> after construction

Change is top-width is measured on traveled way – grass line to grass line



Brookings Section – Loose Aggregate



Deviation in Roadway Width*

- **Brookings Section:**
  - Modified section: **21 ft, 6 in**
  - Substandard section: **24 ft, 7 in**
- **Hand Section:**
  - Modified section: **24 ft, 6 in**
  - Substandard section: **26 ft, 10 in**
- **Custer Section:** No measurement due to uneven cross section

*** Width deviation measured after harvest 2012.**

Corrugation (Washboard)

- No corrugation observed on any sections meeting at least minimum standard specification.
- However, Brookings substandard section had corrugation on 100% of center wheel path at last observation.
- Custer substandard did not have corrugation.

Concluding Points

- Meeting basic SDDOT standard surface gravel specification reduces loose aggregate by 1/3 to 1/2.
- Widest differential was in Brookings County near end of corn harvest with **405 tons** of loose aggregate on substandard section to only **71 tons** on modified section.
- Most interesting fact thus far: **Brookings has done blade maintenance up to four times on substandard section to only once on modified!**

In Summary:

- **The motorgrader operator must understand the correct shape needed on the roadway and how to place new gravel.**
- **<u>But thereafter</u>, how a gravel road performs depends on subgrade condition and quality and quantity of the surface gravel.**
- **Washboarding, excess loose material, and excessive windrows are primarily due to poor quality of surface gravel.**

Stabilization/Dust Control with Chlorides

2018 Tribal Conference

By

SDLTAP

Three primary things that make chloride treatments successful (or fail):

- The quality of the surface gravel.
- Preparation – shaping, drainage correction and coordination with suppliers.
- The application of the product.

Chloride Stabilization is not new!

Quality of Surface Gravel – can't be emphasized enough.

Good Quality Gravel Has:

- Good overall gradation meeting SDDOT Gravel Surfacing specification.
- Top size of stone not exceeding three quarters of an inch
- 8 to 15% passing a #200 sieve (by weight).
- Minimum PI (plasticity index) of 4 and maximum of 12 is very important.

Road Surface Preparation

- Generally loosen the top one to two inches of gravel.
- A "bit type" cutting edge on the grader will do a nice job of loosening the surface and blending the stone, sand and fines.
- The surface must crowned properly and shaped uniformly.
- Crown should be at or near 4%. Never exceed 6%.
- If the material is dry, it is important to pre-wet the road to near optimum moisture prior to treatment.

Good surface gravel and road preparation – always the keys

Good control of moisture in gravel

Excellent example of working material and using water:

Final Key is good application of the product:

- Should be applied through a pressurized spray bar that gives a uniform application across the road surface.
- Truck travel speed and output of the spray bar must be carefully calibrated for uniform application rate on the entire length and width of the road.
- Unless the rate of application is less than .3 gal per square yard, the product should be applied in two shots with ample time for absorption in between.

Good treatment after pre-wetting

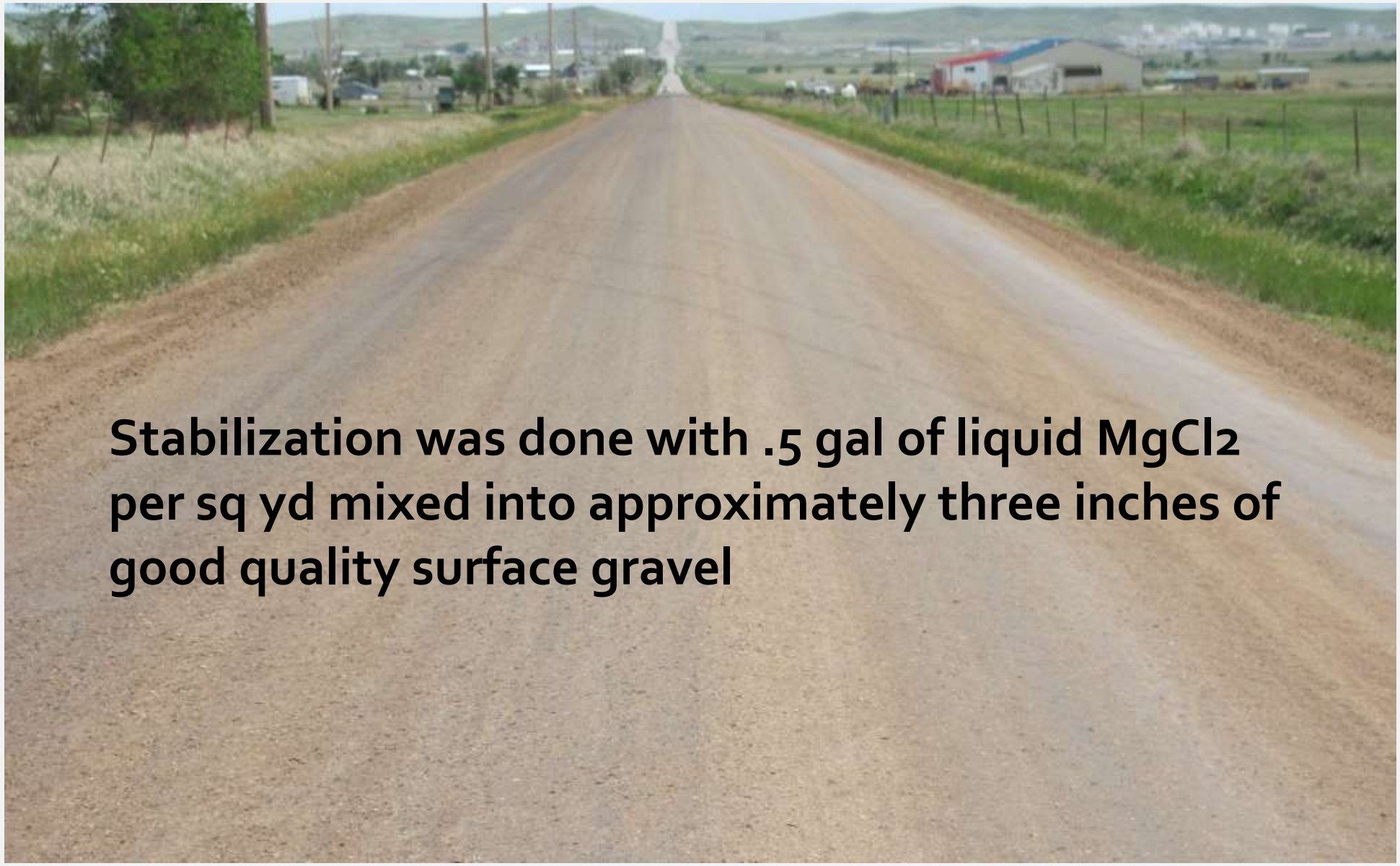
An Example of Chloride Stabilization:

- Elk Vale Road in Meade County, SD
  - Located directly east and north of Rapid City
  - Serves a growing area near an interstate highway exit
  - Classification: Rural Major Collector
  - Last Meade Co traffic count is 645
  - Became impossible to maintain as gravel surface

Elk Vale Rd transitions from pavement in Pennington County to unpaved in Meade County

Originally constructed in May, 2011
Excellent performance after first year

Close-up view of stabilized surface after one year


Stabilization was done with .5 gal of liquid MgCl2 per sq yd mixed into approximately three inches of good quality surface gravel


No blade maintenance was done between construction in summer of 2011 and surface retreatment in summer of 2012!

Some basic cost comparison data

- Total reconstruction of the road and paving would cost approximately $800,000 per mile.
- Meade County had to find an alternative.
- Total cost of new gravel and initial treatment was $25,000 per mile.
- In the immediate future, annual surface reshape and retreatment is planned.
- Annual retreatment cost is estimated at $7,000 to $8,000 per mile.

Late 2012 Traffic Count Breakdown

- Northbound
  - 12/04/2012 299 total vehicles 22 trucks

12-2013 count by SDDOT showed average 635 vehicles per day and average 103 trucks per day (16% of total volume)

  - 12/05/2012339 total vehicles 92 trucks
  - 12/06/2012 319 total vehicles 76 trucks
- **Total***
  - **12/04/2012 610 total vehicles 91 trucks**
  - **12/05/2012 658 total vehicles 120 trucks**
  - **12/06/2012 636 total vehicles 98 trucks**

***Meade County count tallied over 700 vehicles in earlier count with 25% trucks**

Follow-up observation last year – 10-24-13

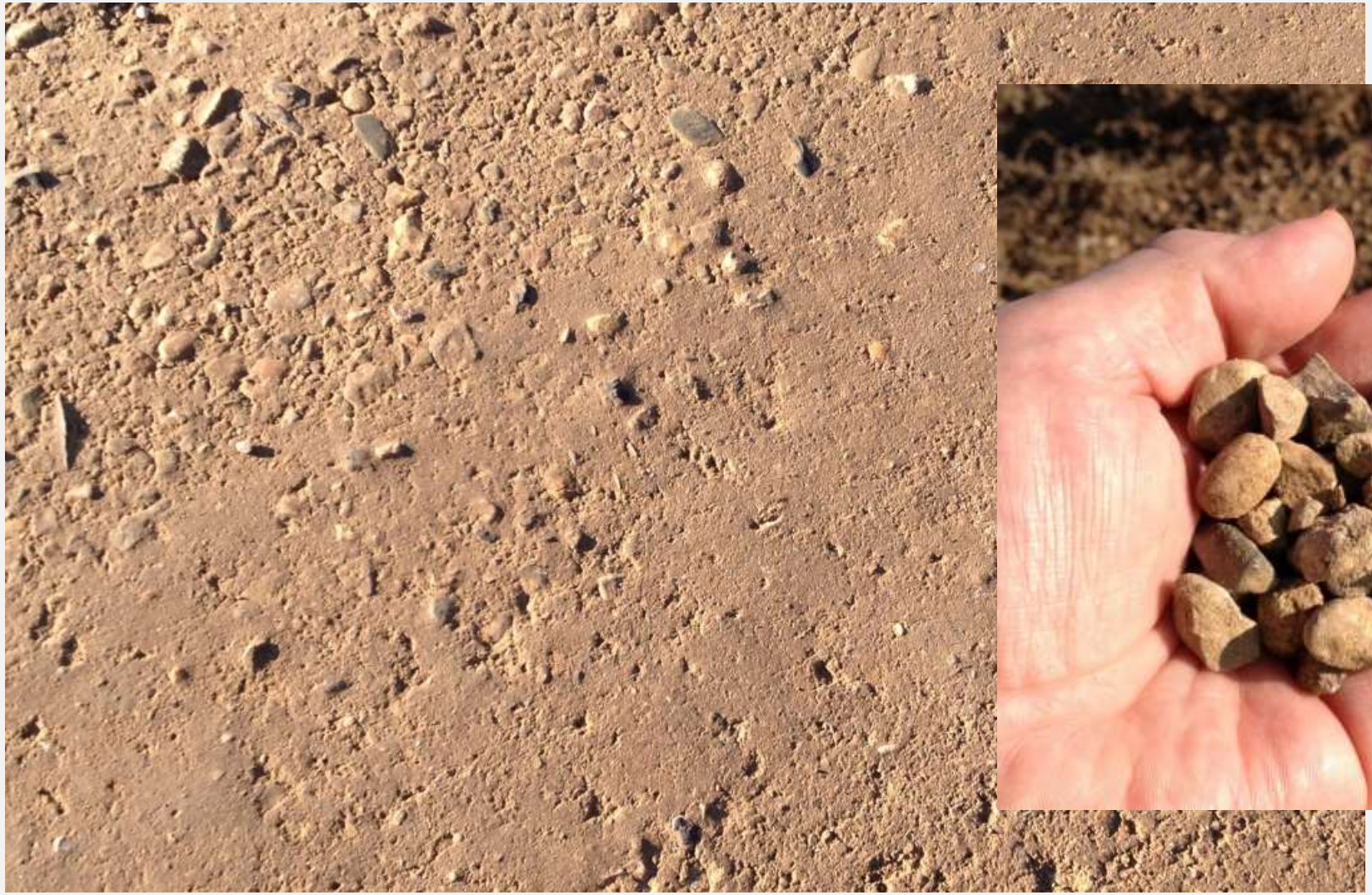
2013 Maintenance Record

- Reshape surface with bit-type cutting edges in late spring, obtain optimum moisture in gravel
- One treatment of $MgCl_2$ at .5 gal* per sq yd
- No rolling after treatment – simply let traffic do the compaction
- One blade maintenance cycle during the season

*Application rate on $MgCl_2$ will likely be reduced next year due to residual build-up in the gravel.

Most of the section still tightly bound and performing well

Again, the first key is good surface gravel



The road still very heavily traveled

The most significant distress on the section

Intersecting road – approximately half of the traffic volume and not stabilized

This is after receiving approx 30 inches of snow on 10-4 & 10-5-13

Observation one week ago – 2-29-14

Same location – left shoulder

Same location – right shoulder

SOUTH BOUND VIEW OF HILL – ROAD CENTER – APPROX 7% GRADE

COMPARISON TO UNTREATED SECTION
1 MILE NORTH OF TREATED SECTION

It works when you do it right!

Thank you

Dealing with Winter Snow Maintenance

2017 SDATAT Road Conference

By:

Chuck Fromelt

SDLTAP Tech Assistance Provider

Presentation Overview

- Eliminate “Snow Traps” whenever possible
- Define Snow Routes
- Who Calls for the Plow?
- Good Plowing/Winging Techniques

Snow Trap - Just a few little trees???

Here is the problem caused by those trees by end of winter:

This road was clear for miles except for this large drift!

It doesn’t take much to start a drift

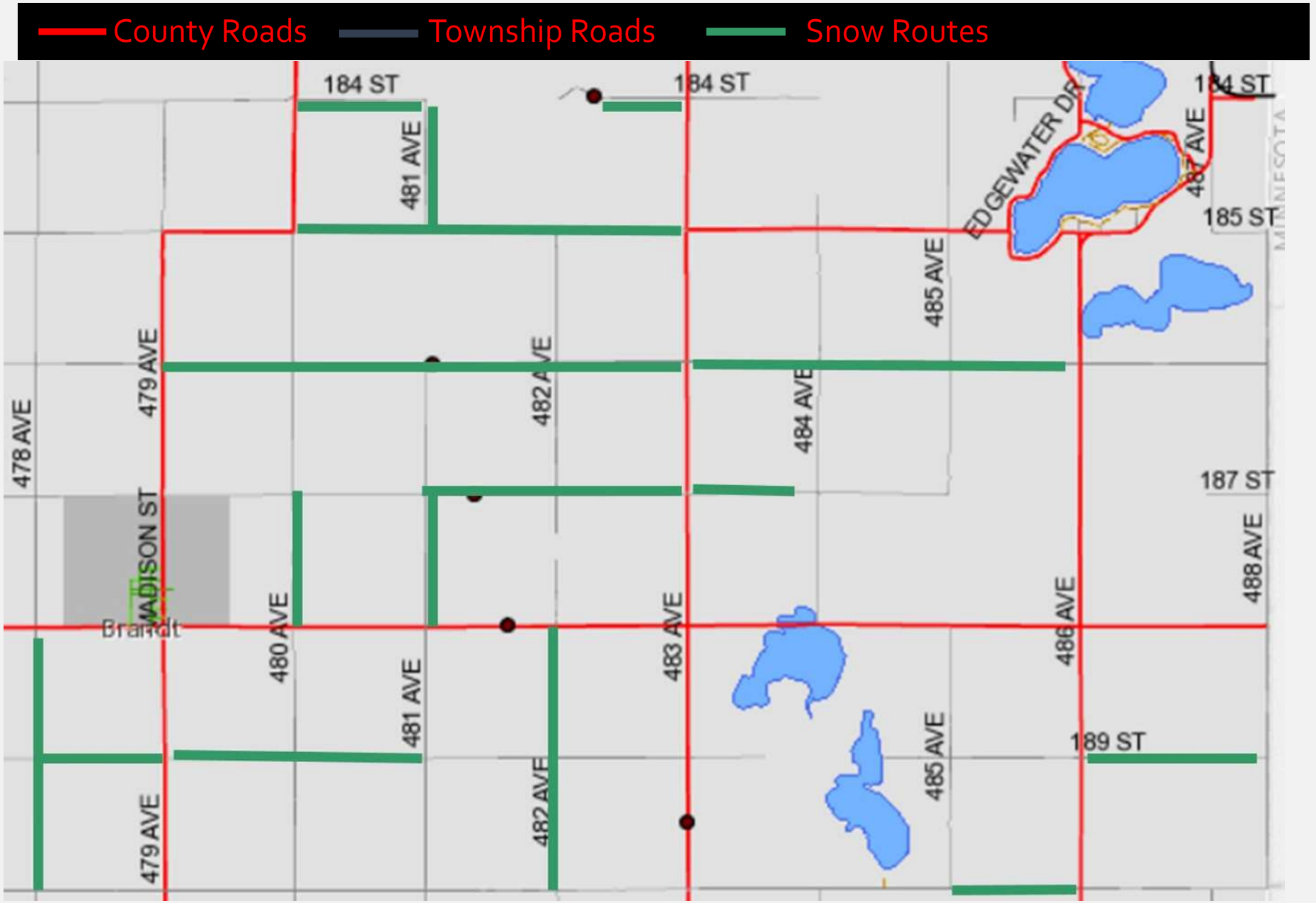
Potential problem

Bales too close to R-O-W!

A bad winter and trees, buildings and machinery too close to the road

Other Potential Snow Traps

- Hay stacks beside the road?
- Machinery parked near the road?
- Buildings built near the road?
- Residents pushing snow from their driveways and piled at edge of road?
- Other?
- Remember to designate snow routes!!


County Roads
Township Roads
Snow Routes
184 ST
184 ST
184 ST
481 AVE
EDGEWATER DR
487 AVE
185 ST
485 AVE
479 AVE
482 AVE
484 AVE
478 AVE
187 ST
MADISON ST
488 AVE
Brandt
480 AVE
483 AVE
486 AVE
481 AVE
485 AVE
189 ST
479 AVE
482 AVE

Who Makes the Call for Snow Plowing?

- Board Chairman or ?
  - Avoid confusion – plan ahead.
- Contractor determines when to plow?
  - Can work if trusted to make good decisions.
- If township owns a grader, does operator determine when to plow?
  - Again, communicate, have a plan.
- Other?

Plowing and Winging Principles

- A critical issue to understand.
- Careful about what you ask for.
- Proper use of the snow wing will help in later storms or make the problem much worse.

A little history:

Ridging – A Bad Example!

Start Right With the First Storm!

Another Good Example

Use of under blade, V-plow & wing simultaneously – requires skill!

First break-through

A job well done

The mailbox – you have to deal with it

Running past a driveway

No more ridge than this if possible

The truck is fast, but winging needed soon

Winging or a blower needed before next storm

Taper or benching is better

Ridge for next storm

Holds too much snow in next storm

Policy on helping the public?

No traction w/empty truck

When it really gets tough!

Keep the snow off the road in late winter

Allow snowmelt to run off road

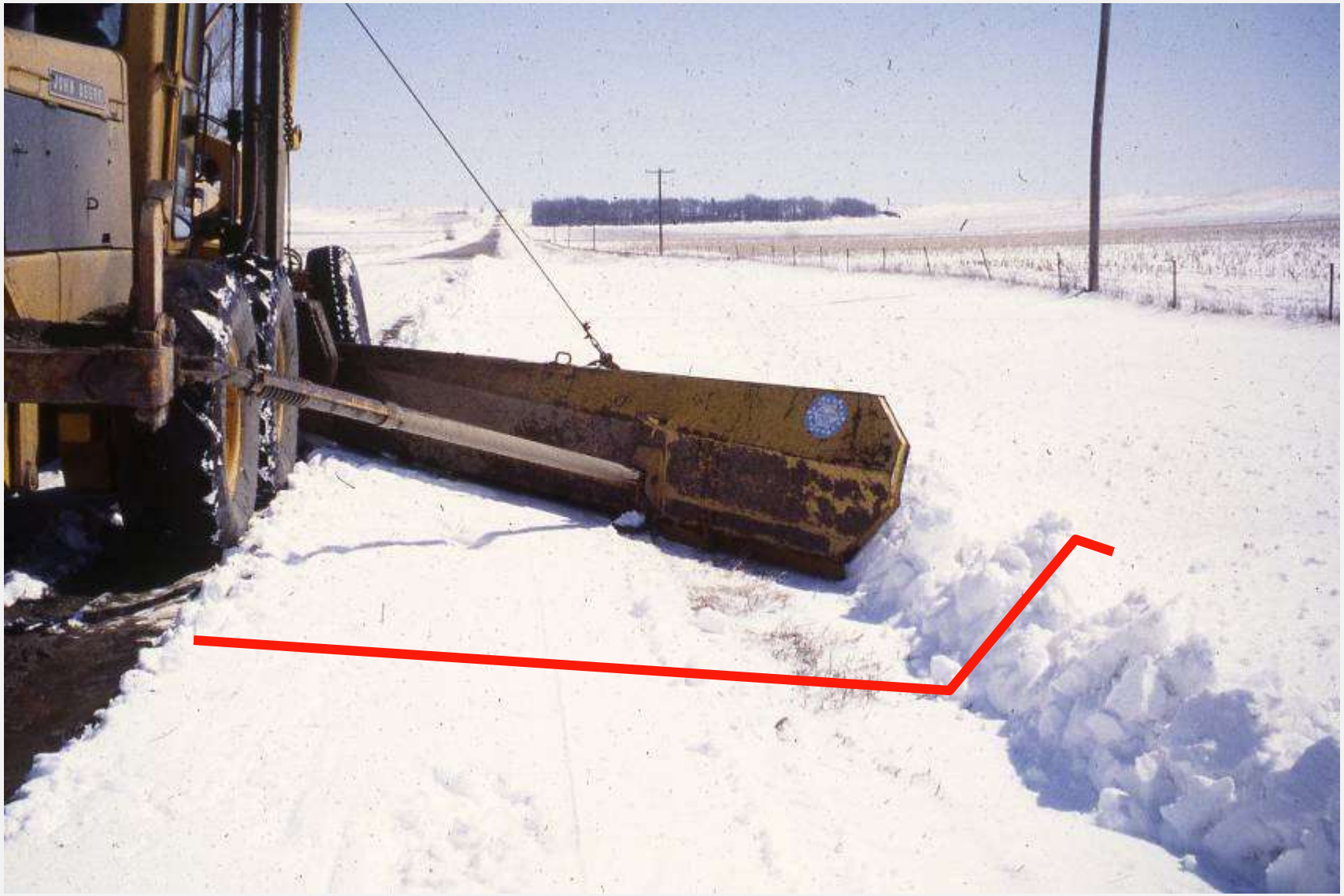
What happens if you don’t

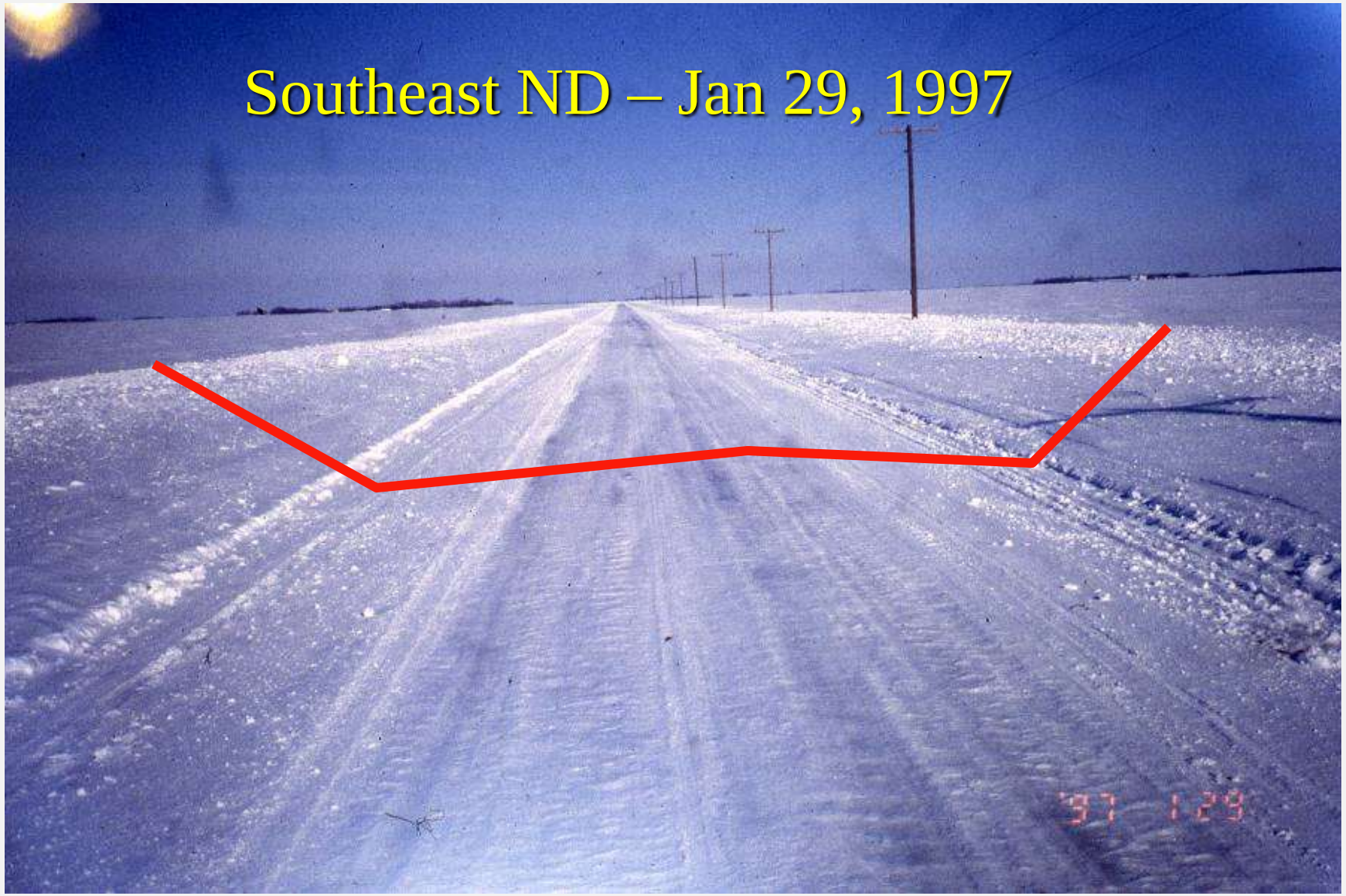
Be careful!

Sometimes it takes two units

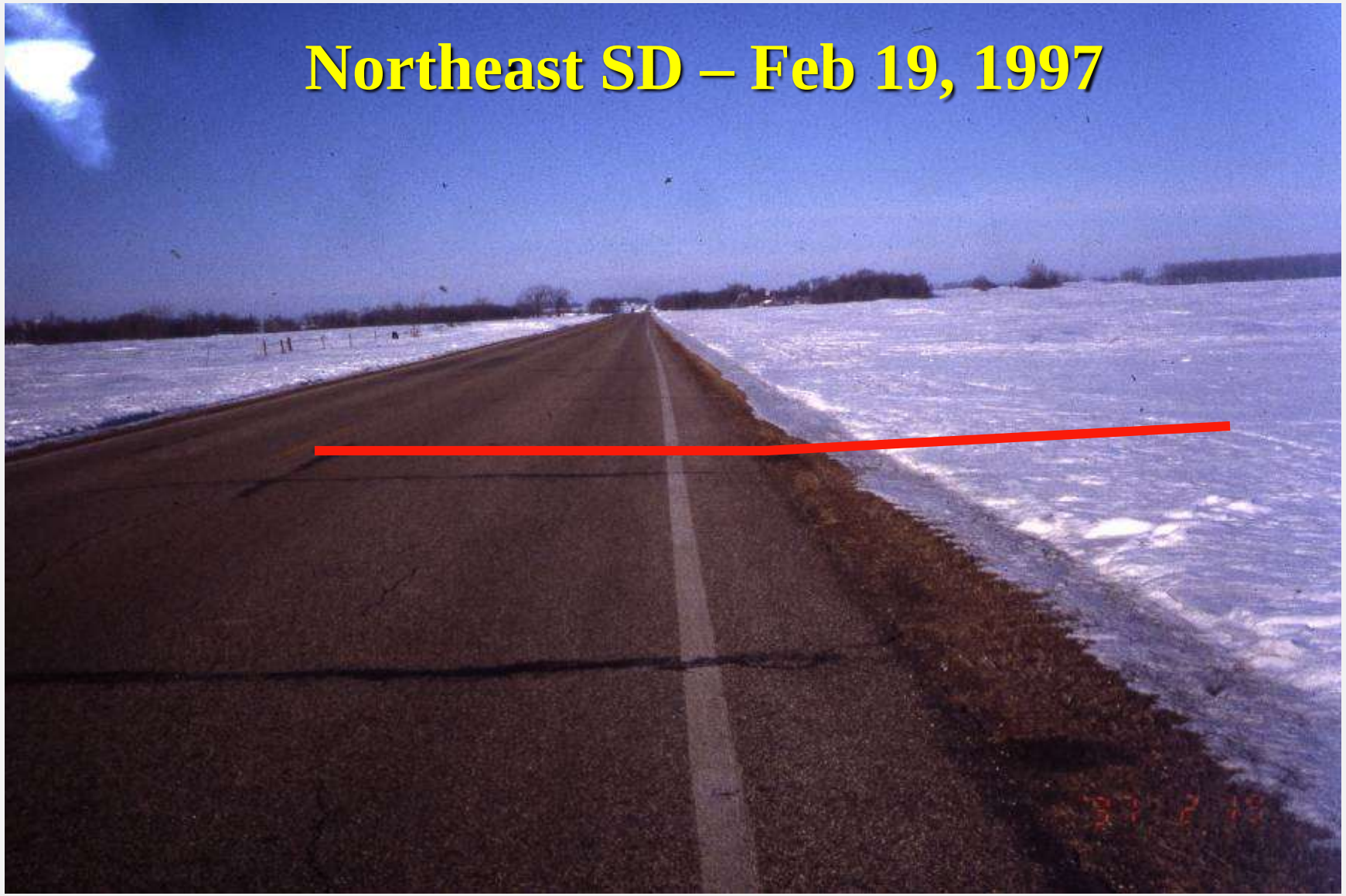
Communicate With Landowner !


STOP




Southeast ND – Jan 29, 1997

Northeast SD – Feb 19, 1997



Don’t Cast the Gravel Off!

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www.sdstate.edu/jerome-j-lohr-engineering/sd-local-transportation-assistance-program

Get ready to face the challenges of maintaining gravel roads in the future!

Good Luck and Thank You!

BASIC SIGNING

MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), 2009 EDITION

CLIFF REUER

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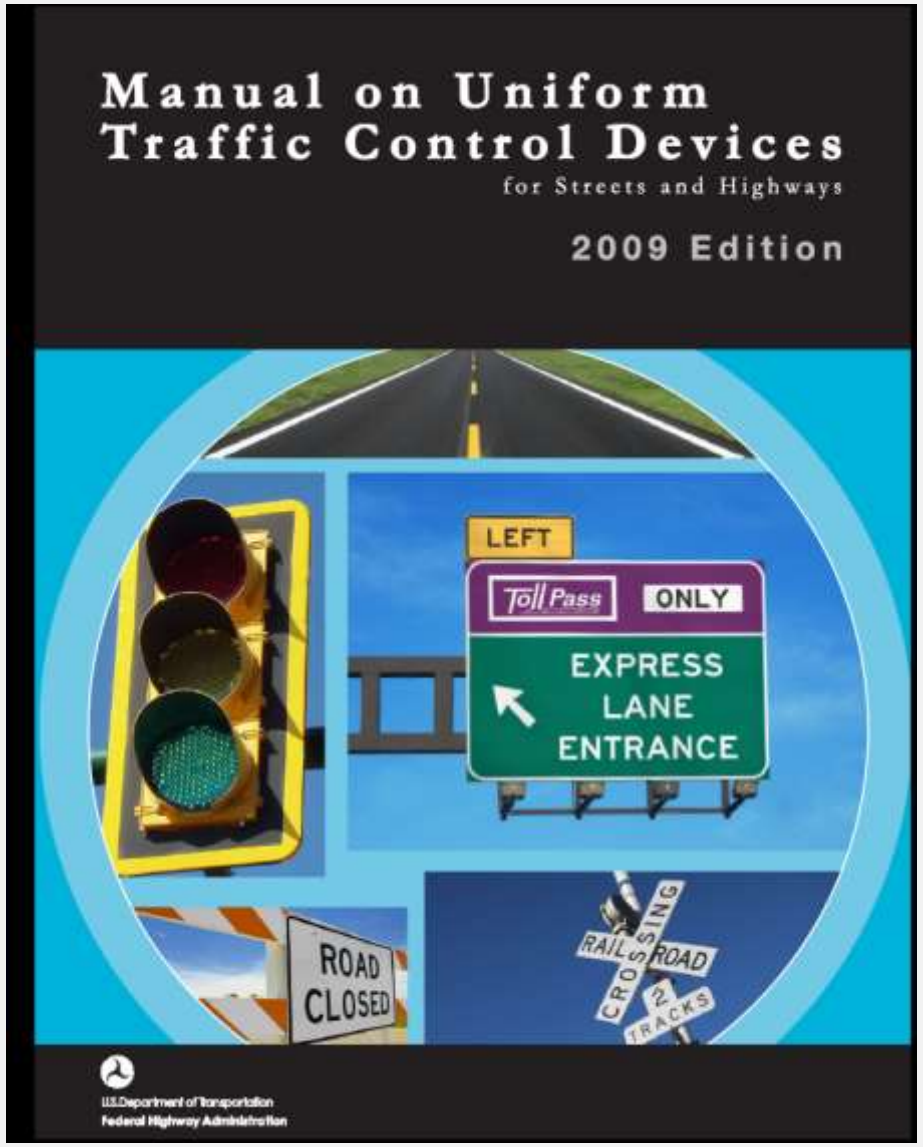
605-209-8932 (c)

cliff.reuer @state.sd.us

MUTCD – 2009 EDITION



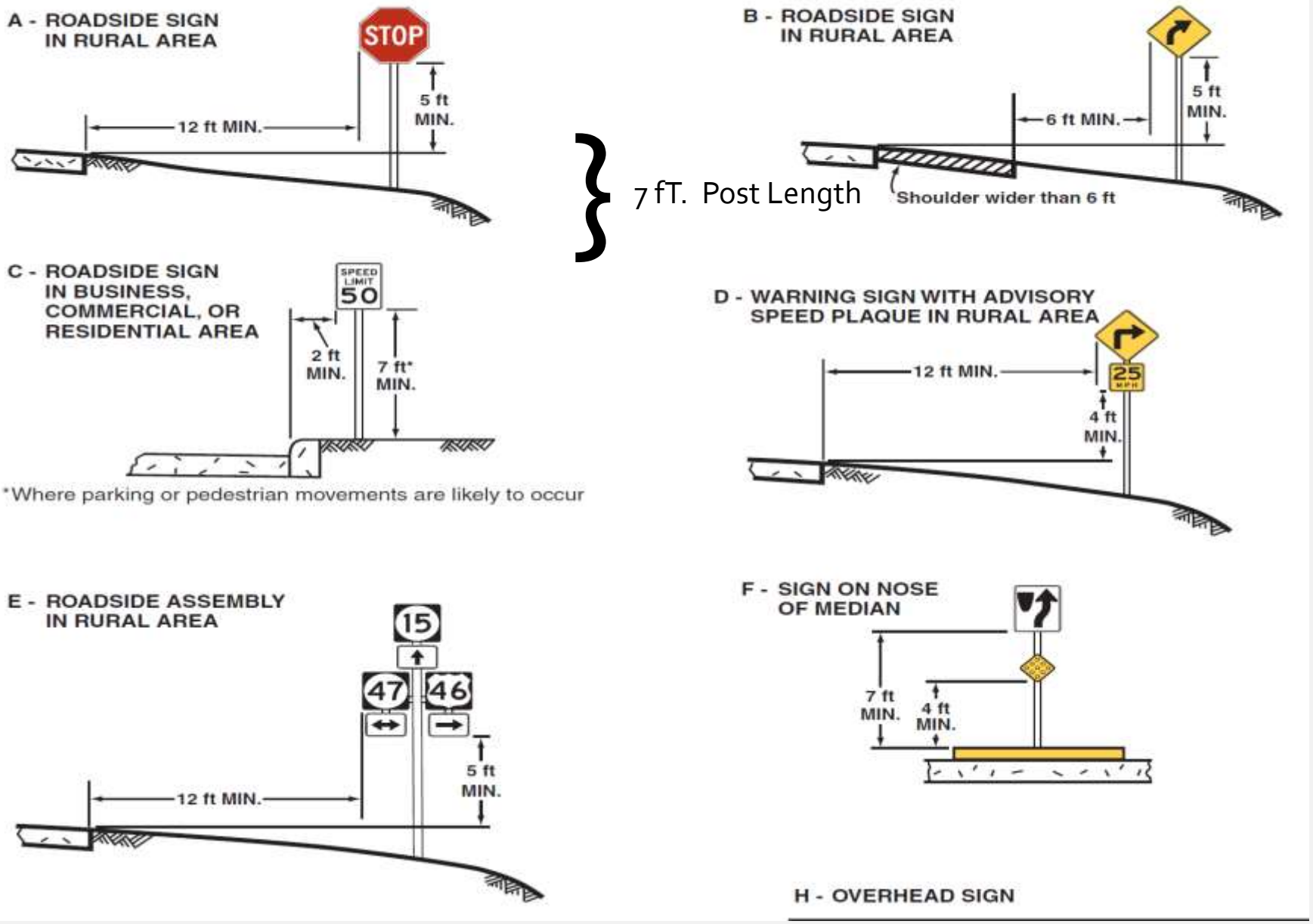
RESPONSIBILITY

Section 1A.07 Responsibility for Traffic Control Devices

Standard:

01 **The responsibility for the design, placement, operation, maintenance, and uniformity of traffic control devices shall rest with the public agency or the official having jurisdiction, or, in the case of private roads open to public travel, with the private owner or private official having jurisdiction. 23 CFR 655.603 adopts the MUTCD as the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel (see definition in Section 1A.13). When a State or other Federal agency manual or supplement is required, that manual or supplement shall be in substantial conformance with the National MUTCD.**

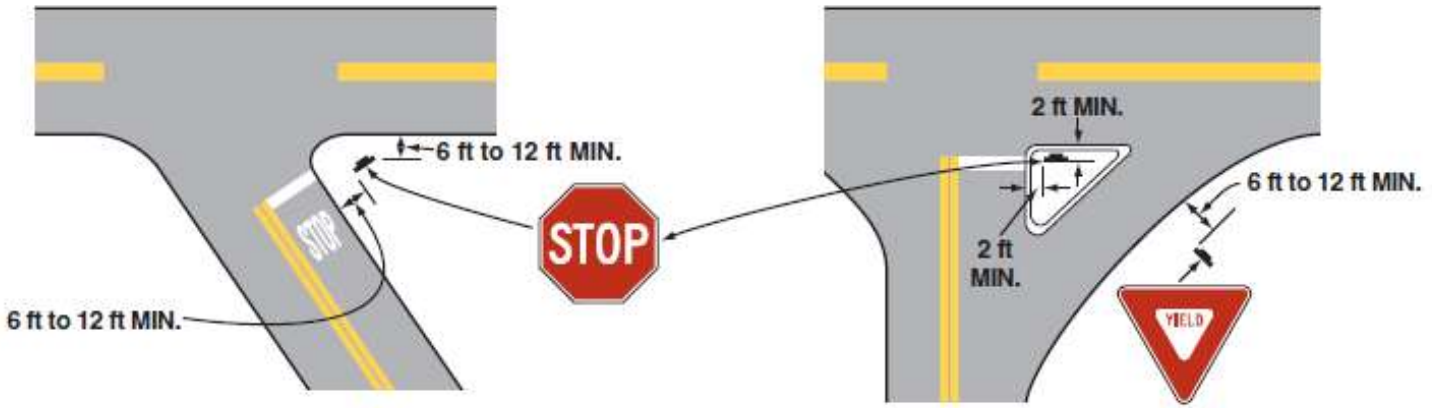
Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations



HEIGHT REQUIREMENT

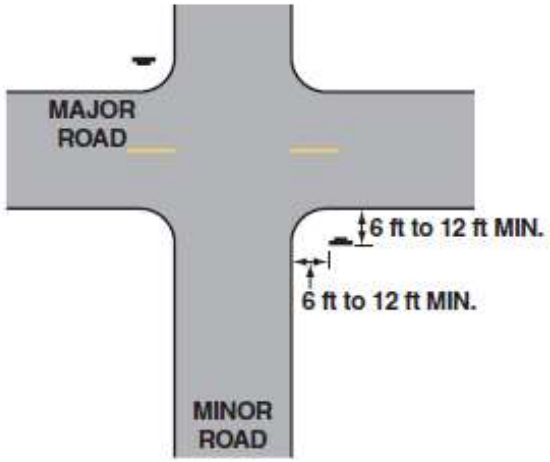
- Seven foot from ground to bottom of sign.
  - Usually obtained by going down in in slope.
  - Crash test indicates sign will go over top of SMALL vehicle.
  - Computer simulation for MID-SIZE & LIGHT TRUCKS indicate the same danger as for small vehicles with 7 foot post length – More study!!

Figure 2A-3. Examples of Locations for Some Typical Signs at Intersections

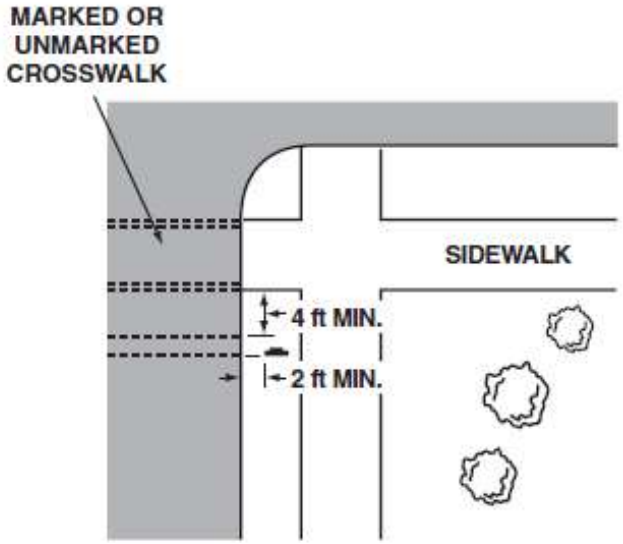


A - ACUTE ANGLE INTERSECTION

B - CHANNELIZED INTERSECTION



C - MINOR CROSSROAD



D - URBAN INTERSECTION

WARNING SIGN PLACEMENT

Table 2C-4. Guidelines for Advance Placement of Warning Signs

Posted or 85th-Percentile Speed	Advance Placement Distance[1]								
	Condition A: Speed reduction and lane changing in heavy traffic[2]	Condition B: Deceleration to the listed advisory speed (mph) for the condition							
		0[3]	10[4]	20[4]	30[4]	40[4]	50[4]	60[4]	70[4]
20 mph	225 ft	100 ft[6]	N/A[5]	—	—	—	—	—	—
25 mph	325 ft	100 ft[6]	N/A[5]	N/A[5]	—	—	—	—	—
30 mph	460 ft	100 ft[6]	N/A[5]	N/A[5]	—	—	—	—	—
35 mph	565 ft	100 ft[6]	N/A[5]	N/A[5]	N/A[5]	—	—	—	—
40 mph	670 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—	—
45 mph	775 ft	175 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—
50 mph	885 ft	250 ft	200 ft	175 ft	125 ft	100 ft[6]	—	—	—
55 mph	990 ft	325 ft	275 ft	225 ft	200 ft	125 ft	N/A[5]	—	—
60 mph	1,100 ft	400 ft	350 ft	325 ft	275 ft	200 ft	100 ft[6]	—	—
65 mph	1,200 ft	475 ft	450 ft	400 ft	350 ft	275 ft	200 ft	100 ft[6]	—
70 mph	1,250 ft	550 ft	525 ft	500 ft	450 ft	375 ft	275 ft	150 ft	—
75 mph	1,350 ft	650 ft	625 ft	600 ft	550 ft	475 ft	375 ft	250 ft	100 ft[6]

[1] The distances are adjusted for a sign legibility distance of 180 feet for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 feet, which is appropriate for an alignment warning symbol sign. For Conditions A and B, warning signs with less than 6-inch legend or more than four words, a minimum of 100 feet should be added to the advance placement distance to provide adequate legibility of the warning sign.

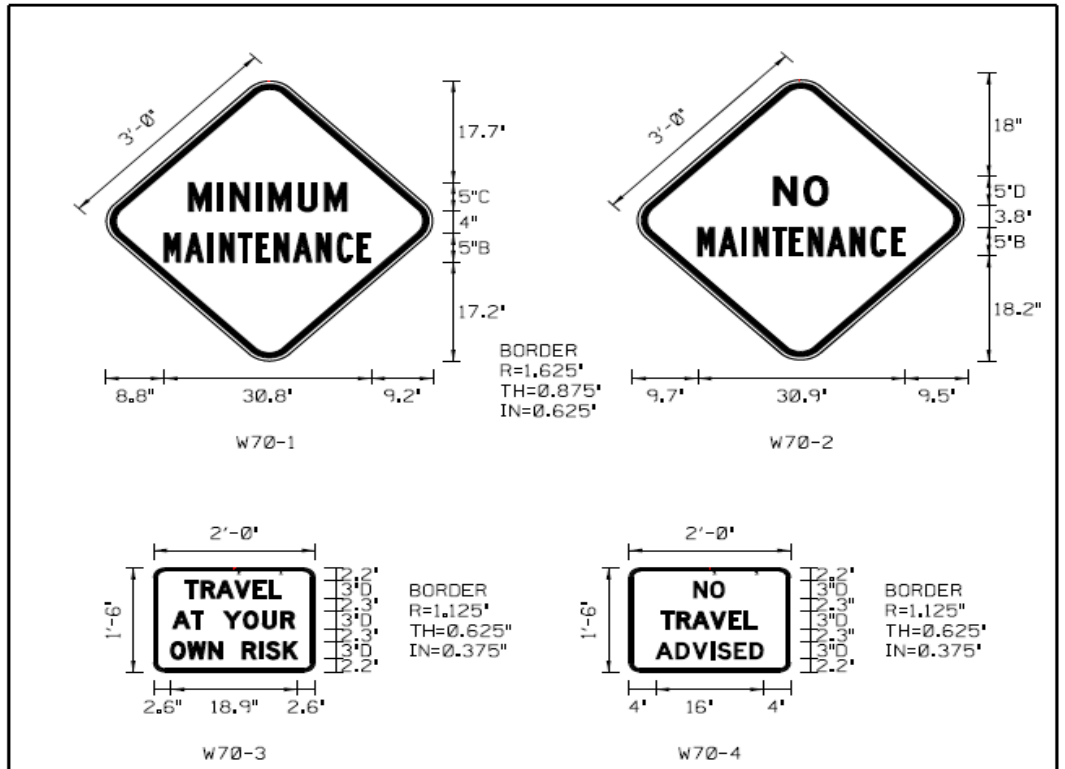
[2] Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are determined by providing the driver a PRT of 14.0 to 14.5 seconds for vehicle maneuvers (2005 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 180 feet for the appropriate sign.

[3] Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. The distances are based on the 2005 AASHTO Policy, Exhibit 3-1, Stopping Sight Distance, providing a PRT of 2.5 seconds, a deceleration rate of 11.2 feet/second^2, minus the sign legibility distance of 180 feet.

[4] Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PRT, a vehicle deceleration rate of 10 feet/second^2, minus the sign legibility distance of 250 feet.

[5] No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing. An alignment warning sign may be placed anywhere from the point of curvature up to 100 feet in advance of the curve. However, the alignment warning sign should be installed in advance of the curve and at least 100 feet from any other signs.

[6] The minimum advance placement distance is listed as 100 feet to provide adequate spacing between signs.



Legend and border shall be black vinyl non-reflective material on yellow super/very high intensity prismatic retroreflective background.

The W70-3 shall be installed at each location where a W70-1 is installed and a W70-4 shall be installed at each location where a W70-2 is installed.

Use of the W70-2 & W70-4 sign shall be limited to Township Roads only.

October 2,2014

	SDDOT	SIGN DETAIL FOR MINIMUM & NO MAINTENANCE ROADS	SPECIAL DETAIL L50
			Sheet 1 of 1

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