

**REAAA**<sup>®</sup>

Driving Progress

ROAD ENGINEERING ASSOCIATION OF ASIA & AUSTRALASIA (NZ)

# Driving Surface Aggregate (DSA) Lessons from Pennsylvania

---

STEVE BLOSER | PENN STATE UNIVERSITY



## **Disclaimer:**

I am NOT trying to sell you DSA or convince you that you need to “make” DSA  
(I don't get a cut)

My goal is to start a conversation about improving aggregate quality and encourage you to think a little more about what you are purchasing.

**What is typically the most expensive part of unpaved road maintenance?**

**What is typically the most expensive part of unpaved road maintenance?**



**What is typically the most expensive part of unpaved road maintenance?**



**What specification do you use when you buy surface?**

**What is typically the most expensive part of unpaved road maintenance?**



**What specification do you use when you buy surface?**

**“Well...it depends...”**

## Driving Surface Aggregate (DSA)

- **DSA need and development**
- DSA Specification
- DSA Placement
- Research
- Maintenance



# DSA Need and Development

- There was no specification for unbound surface aggregate in PA
- Rock being used was designed for asphalt base, fill, or even “unspecified”
- A wide variety of different sources used regionally with limited success.
  - Unraveling
  - Rutting
  - Constant Maintenance
  - Runoff







# DSA History and Development

- DSA was developed to achieve maximum compaction density
- Reduce sediment runoff
- Reduce deformations and loss
- Lengthen Maintech cycles



# DSA History and Development

- Developed in 2000
- Several refinements, as recent as May 2022
- Over 1.2 Million Tons placed by Program (lifetime) - ~55,000 triaxle truck loads



# DSA History and Development

## Pennsylvania

- Limestone
- Sandstone

## New Zealand

- Greywacke
- Basalt



**DSA does not specify a parent material, as long as spec can be met.  
Most of the principles discussed here still apply**

## Driving Surface Aggregate (DSA)

- DSA need and development
- **DSA Specification**
- DSA Placement
- Research
- Maintenance



## Disclaimer #2:

Aggregate choice depends on a wide variety of factors including availability, geology, and climate.

These concepts may work for some of you, others will think what you are about to see is crazy.

PA is blessed with a lot of quarries, still food for thought in remote “make your own aggregate” areas.

# DSA Spec:

- Size or Gradation
- Plasticity Index
- Resistance to Abrasion
- Soundness
- Moisture

# DSA Spec: GRADATION

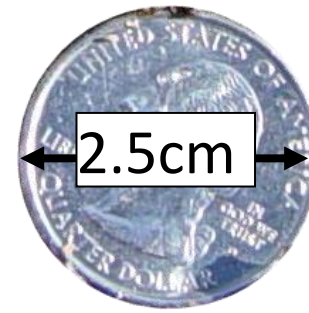
**Open -vs- Well graded aggregates:**  
drainage and compaction are mutually exclusive



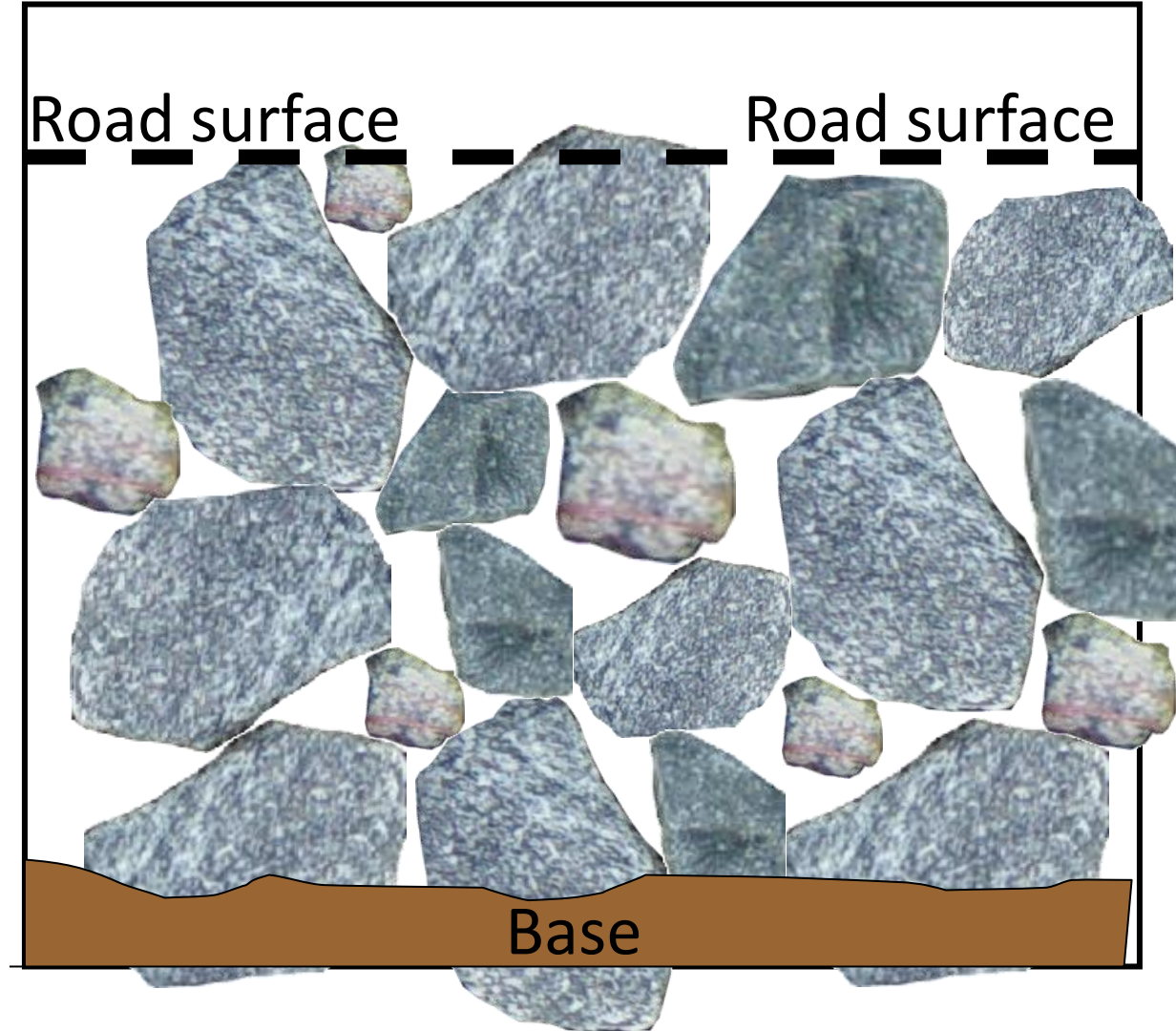


# DSA Spec: GRADATION

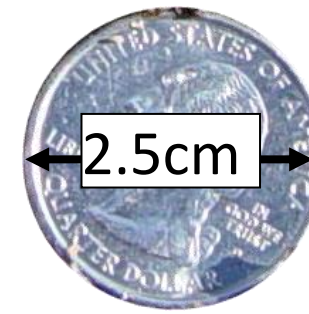
A mixture of  
only large  
stones will  
fail!!



LOW  
VOLUME  
ROADS  
WORKSHOP  
2022

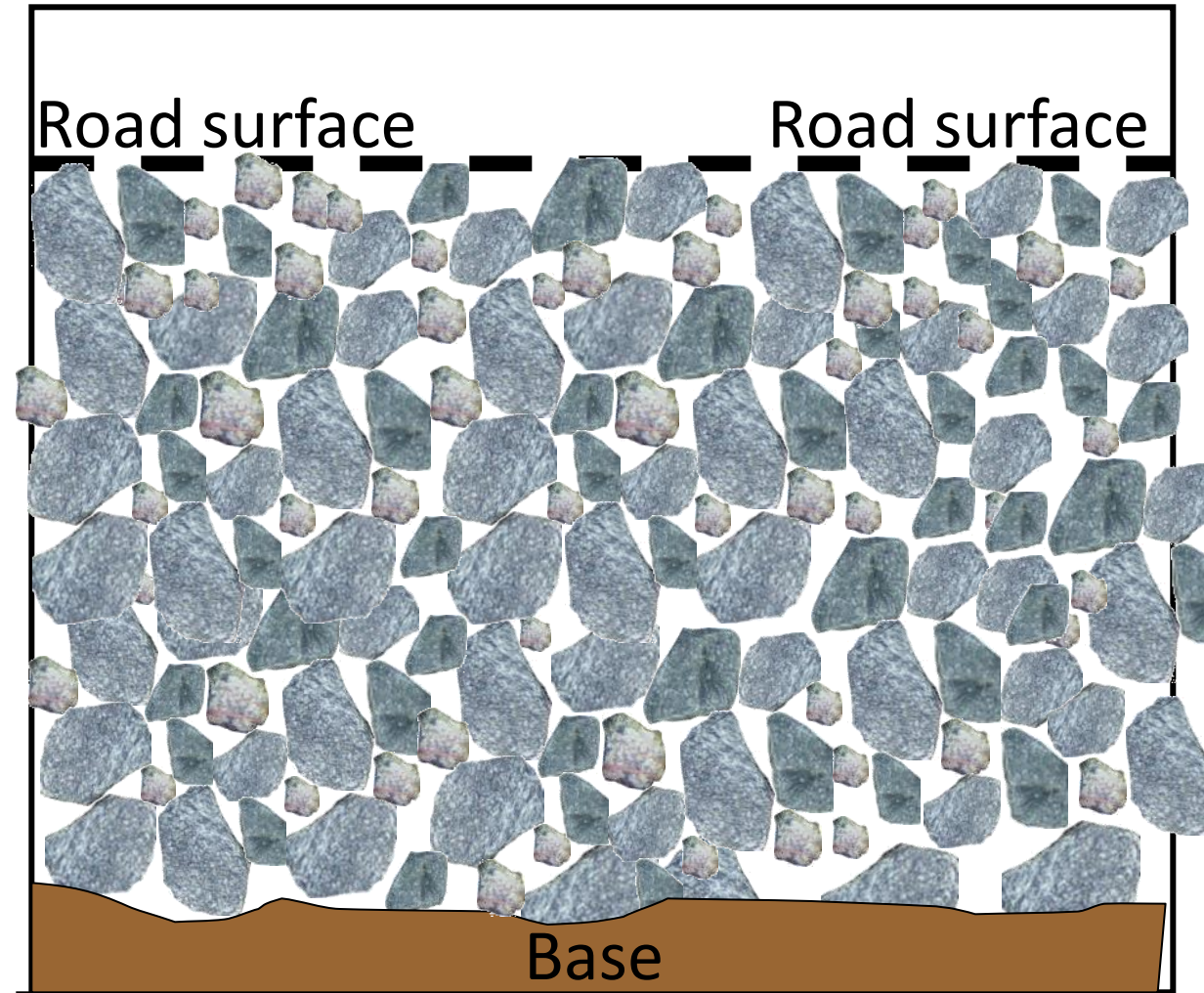


# DSA Spec: GRADATION

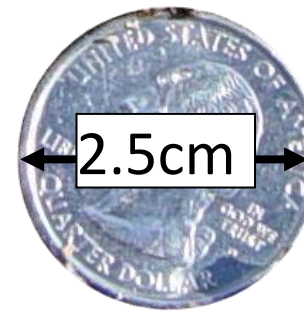


LOW  
VOLUME  
ROADS  
WORKSHOP  
2022

A mixture of  
only small  
stones will  
fail!!

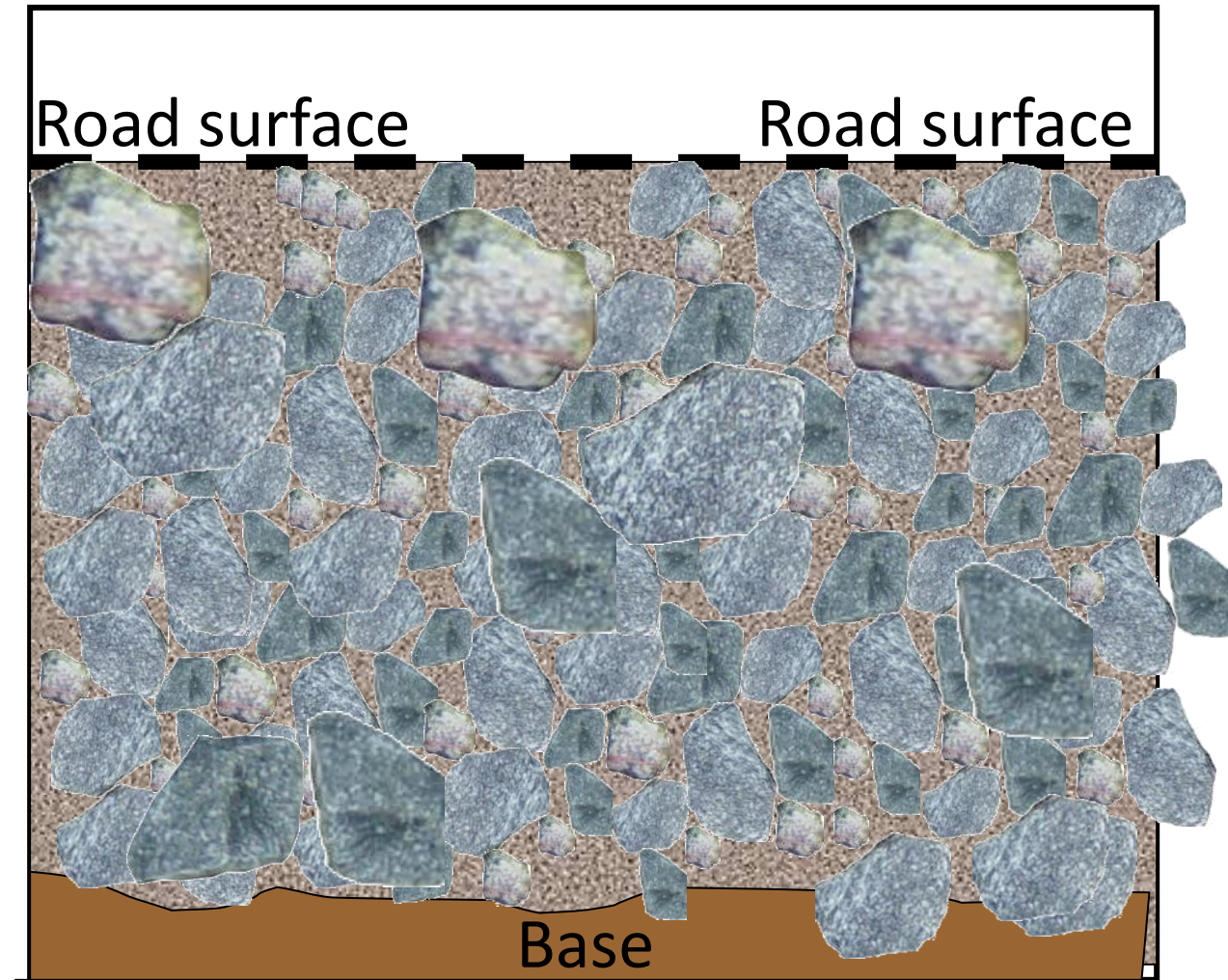


# DSA Spec: GRADATION



**LOW  
VOLUME  
ROADS  
WORKSHOP**  
2022

Must include variety of rock sizes  
Including sufficient non-clay fines



# DSA Spec: GRADATION

## The DSA spec:

% passing by weight

Passing Sieve	Lower %	Higher %
1½ inch	100	-
¾ inch	65	97
#4 (¼ ")	30	65
#16 (1/16 ")	15	30
#200(1/200 ")	10	15*

\* Up to 17

% passing by weight

Passing Sieve	Lower %	Higher %
38 mm	100	-
19 mm	65	97
#4 (6.3mm)	30	65
#16 (1.6mm)	15	30
#200(“.13mm)	10	15*

# DSA Spec: GRADATION



20%

3/4"



32.5%

#4

"Midline"  
Percent by  
weight



25%

#16



10%

+ #200



12.5%

- #200

# DSA Spec: GRADATION



**DSA**



**Base course**

# DSA Spec: GRADATION

LOW  
VOLUME  
ROADS  
WORKSHOP  
2022

**10-15% by weight “Rock Fines” are the glue that holds aggregate together!**



# DSA Spec: PLASTICITY

Let's talk about.....CLAY

What is a good plasticity for a surface aggregate”

Plasticity Index is an approximation of clay content, 0 = non-plastic



# DSA Spec: PLASTICITY

Let's talk about.....CLAY

What is a good plasticity for a surface aggregate”

Plasticity Index is an approximation of clay content, 0 = non-plastic

**In PA, DSA has a plasticity limit of 0-4**

- Wet humid climate
- Hard winter freezes
- Lots of shallow groundwater

# DSA Spec: PLASTICITY

LOW  
VOLUME  
ROADS  
WORKSHOP  
2022

Let's talk about.....CLAY

What is a good plasticity for a surface aggregate?



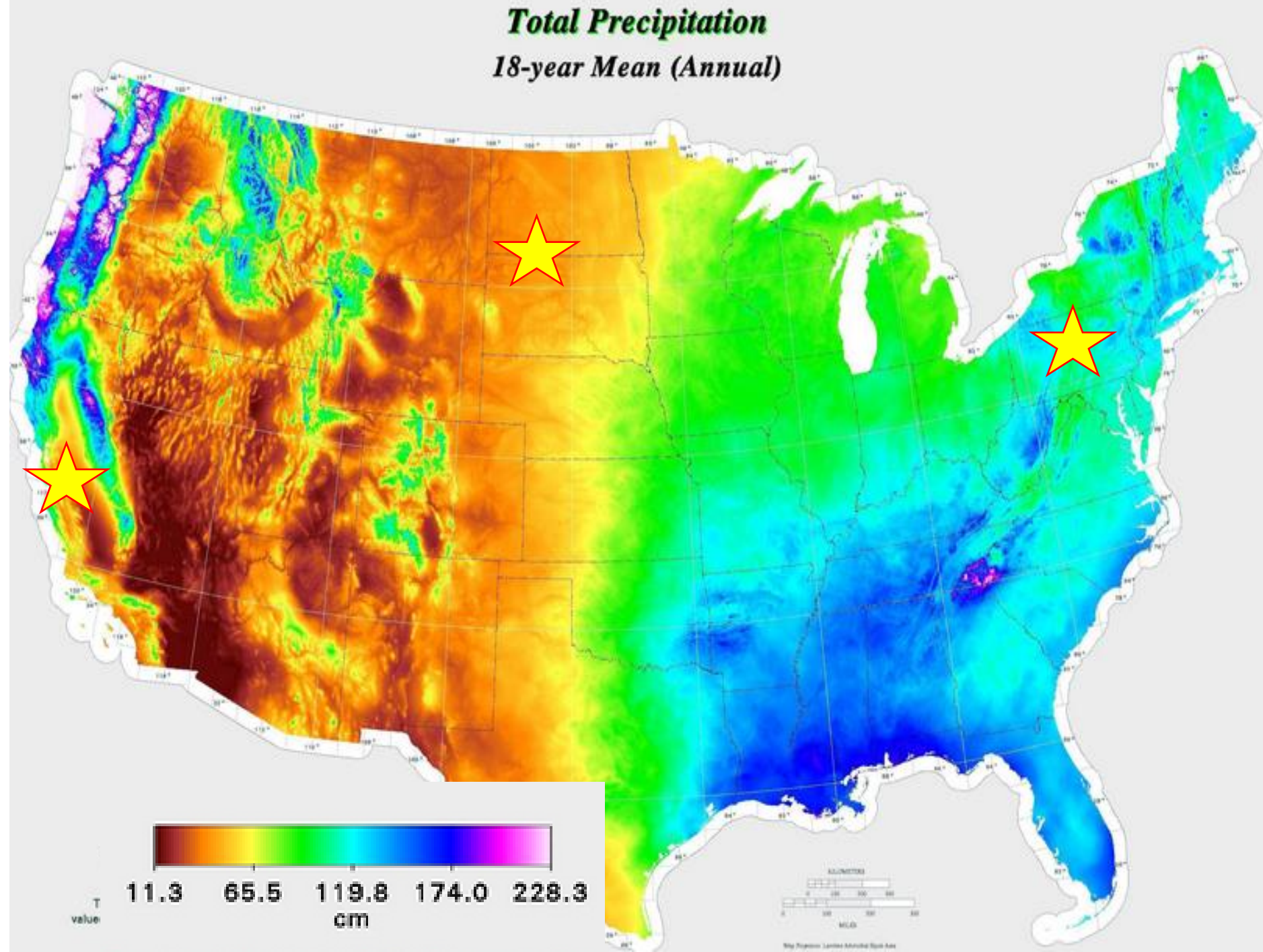
# DSA Spec: Plasticity

- Plasticity limit of 0-4 on DSA
- DSA must have 10-15% “fines”, but fines must be crushed rock, almost non-plastic.
- Clay will increase dust and make “mud season” worse in PA.
- You may hear contrary advice from some of my counterparts in more arid conditions. PA is humid, with ~120cm of rainfall and a 50cm frost depth.

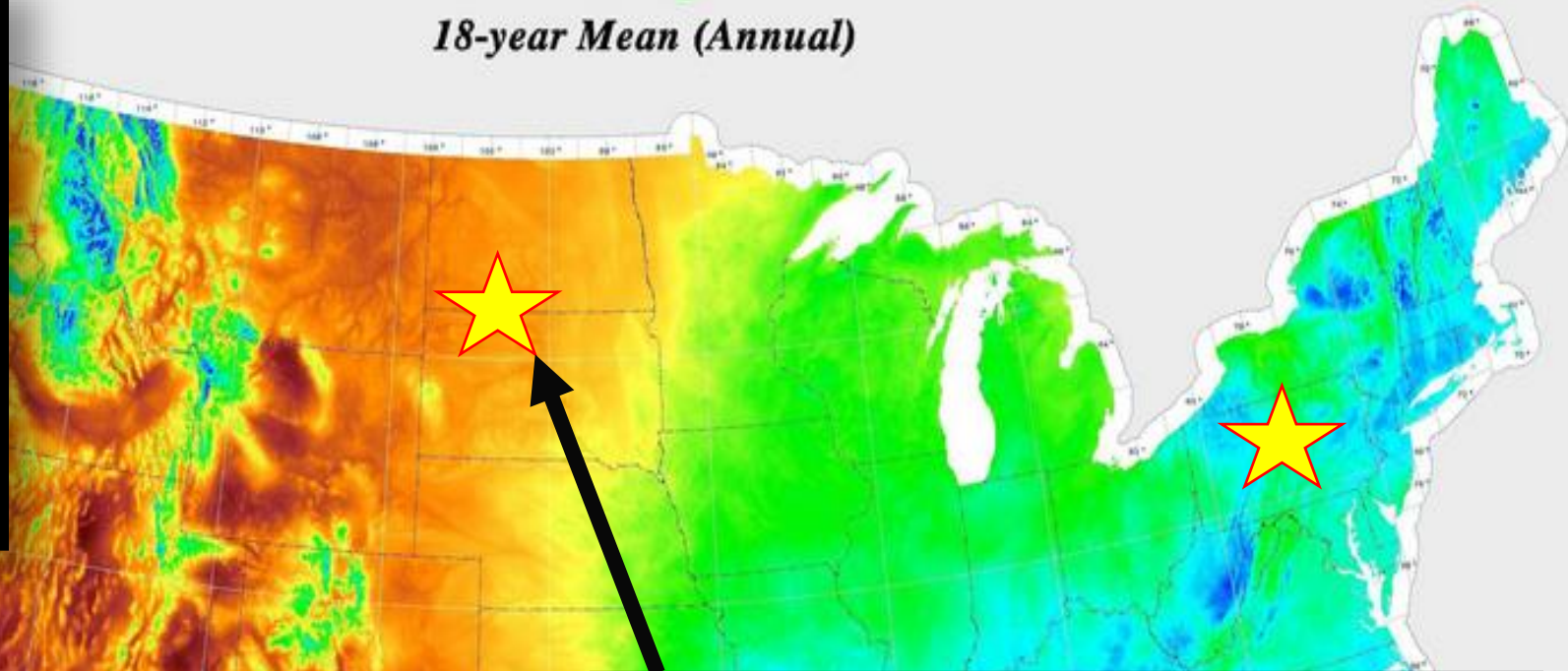


# DSA Spec: Plasticity

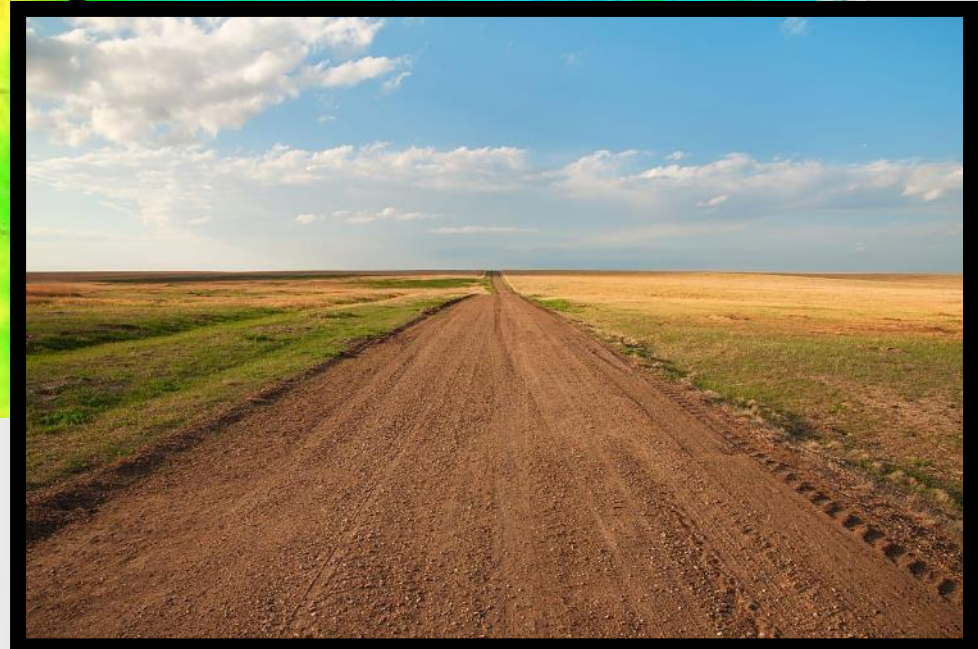
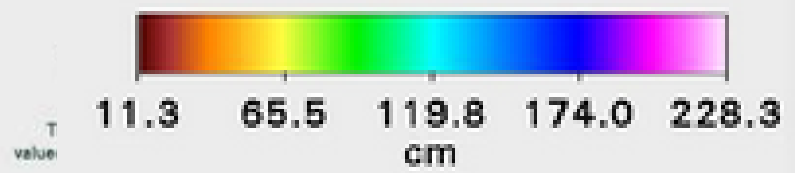
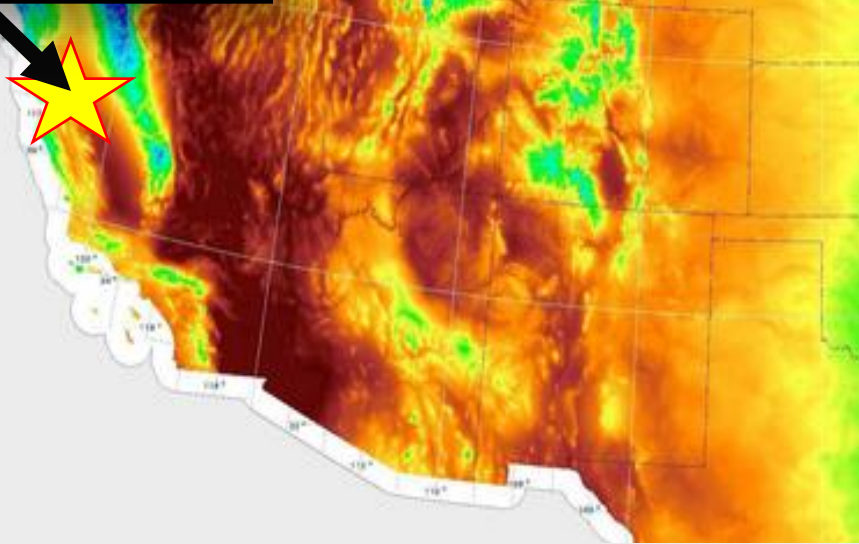
- You may hear contrary advice from some of my counterparts in more



**Total Precipitation**  
**18-year Mean (Annual)**

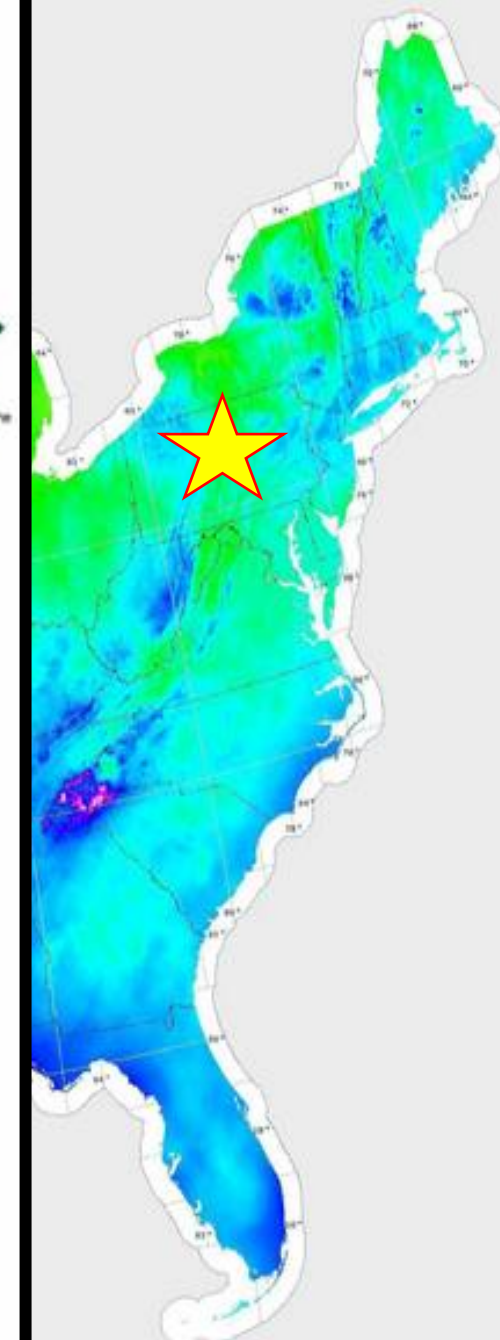
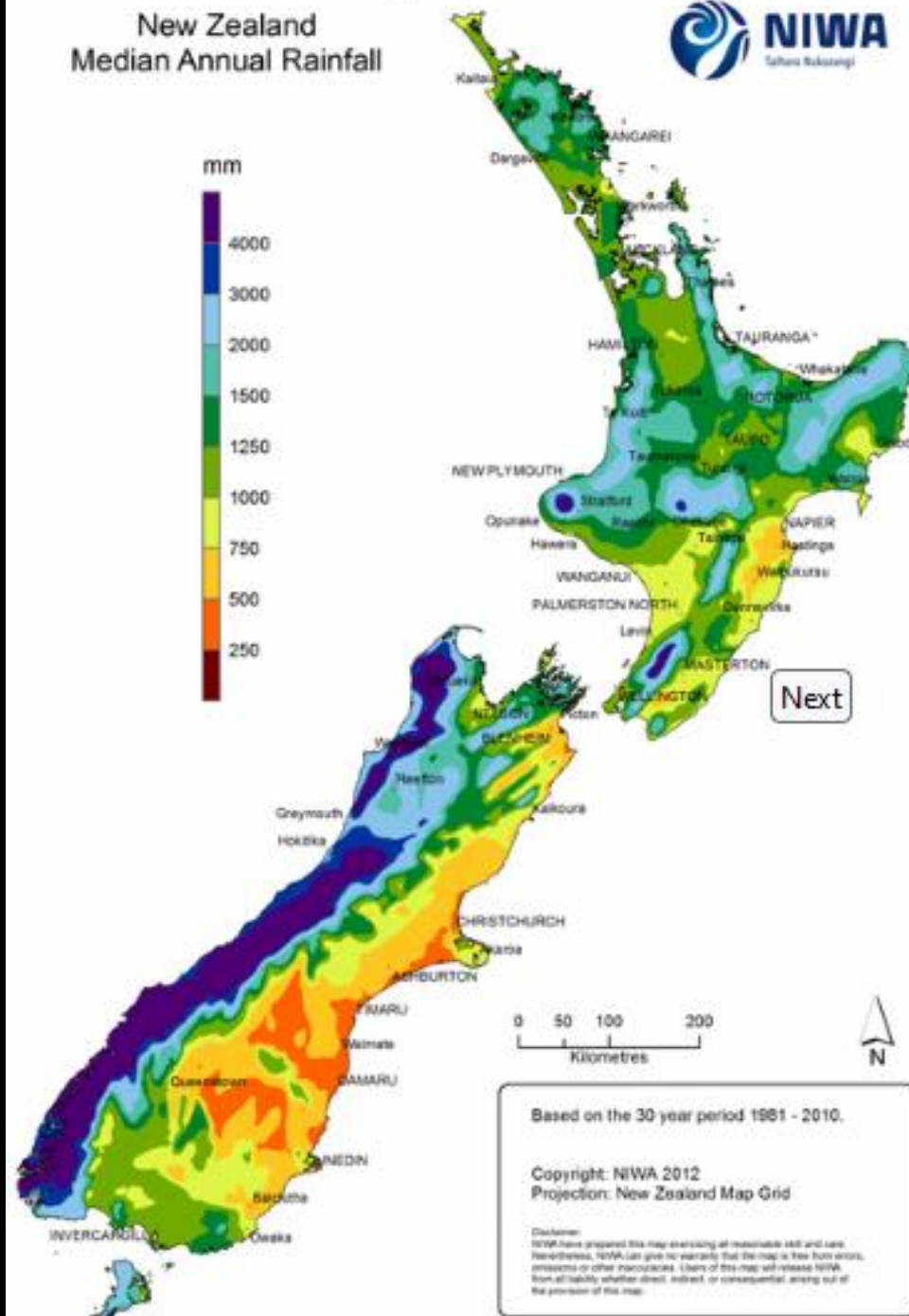
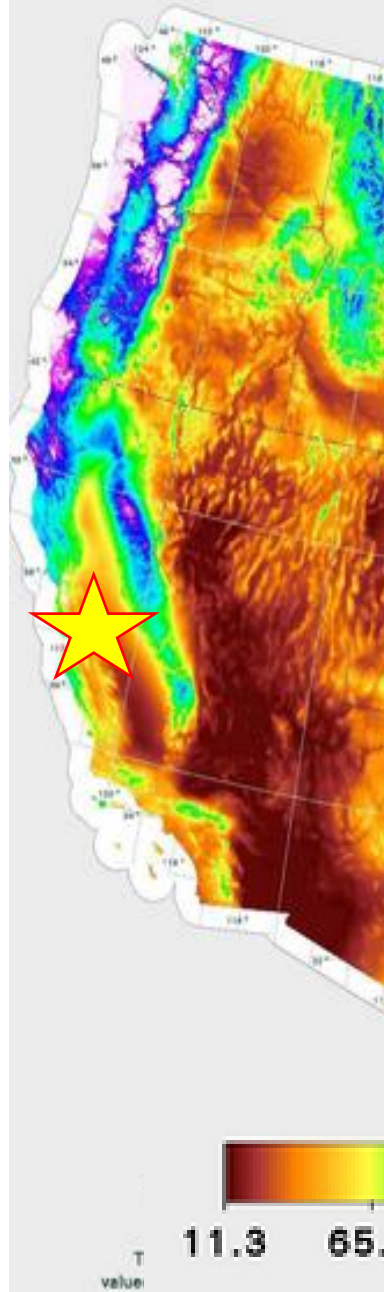


some of my  
counterparts  
in more



# DSA Spec: Plasticity

- You may hear contrary advice from some of my counterparts in more



# DSA Spec: Toughness

- The tougher an aggregate is, the more likely it is to resist degradation under traffic and erosion
- DSA SPEC: **LA abrasion of less than 45%**

LA abrasion test (Los Angeles)

-Aggregate is placed in steel drum with **steel spheres** and rotated.

- Results are expressed as % loss

**Lower % = less crushing = harder aggregate**



# DSA Spec: Soundness

- The more sound an aggregate is, the less likely it is to break down under freeze thaw
- DSA SPEC: **Soundness 20% or less**

Sodium Sulfate test simulates freezing

BEFORE



AFTER

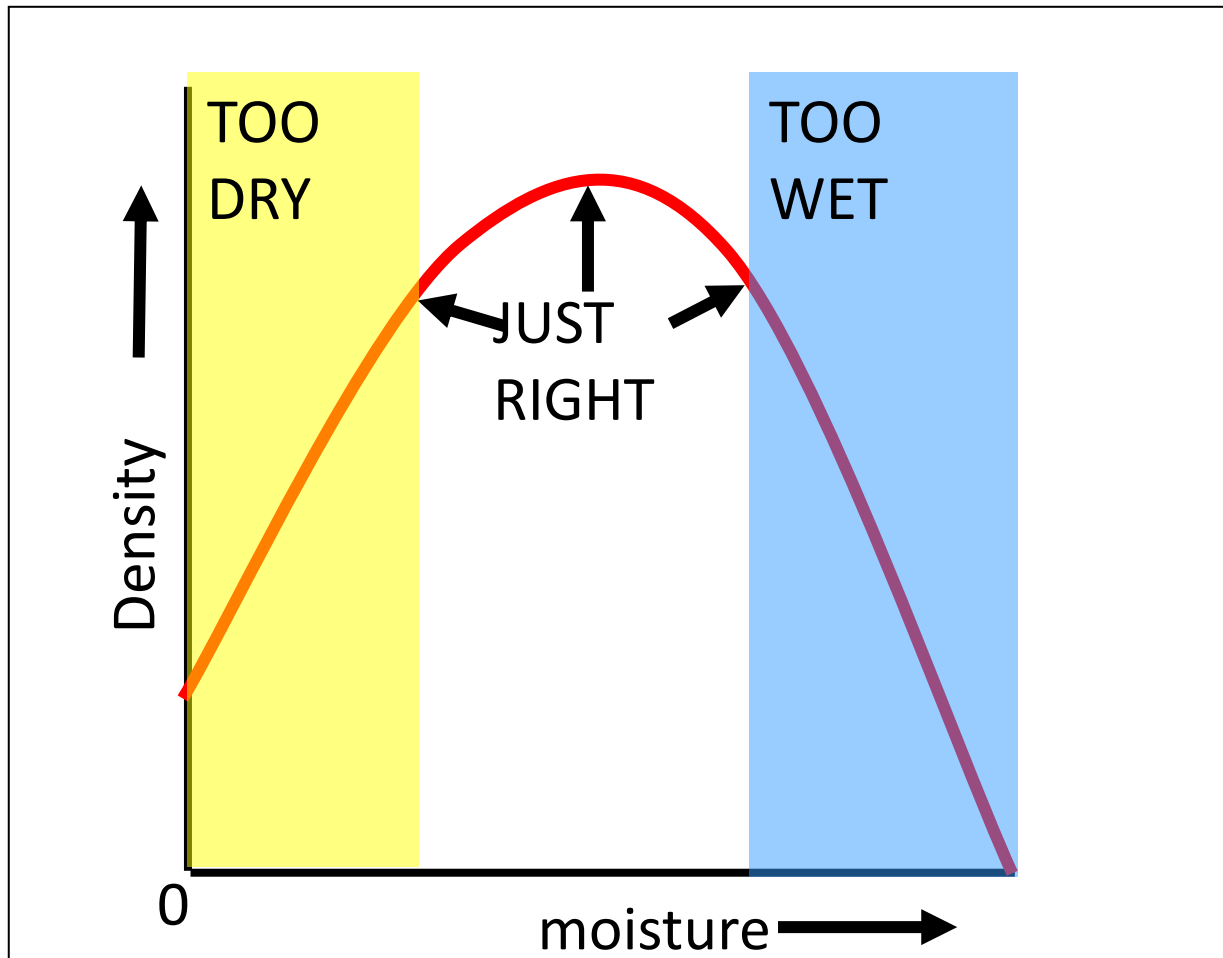


An Sodium Sulfate Soundness test costs about \$375



# DSA Spec: Moisture

- Must be delivered at or up to 2% below optimum moisture
- No Moisture = No Compaction



# DSA Spec: Testing

- We test every pile of DSA used by the Program (120,000 tons last year)



# DSA Spec: Testing

- We test every pile of DSA used by the Program (120,000 tons last year)

- Size or Gradation

- Plasticity Index

- Moisture

- Resistance to Abrasion

- Soundness

- pH

Lot dependent: we test every DSA pile

Source dependent: we test annually



## Driving Surface Aggregate (DSA)

- DSA need and development
- DSA Specification
- **DSA Placement**
- Research
- Maintenance



# DSA Placements

- How do you place unbound aggregates?
- Traditionally, PA “tailgates” i.e. “dump and spread”
- Difficult to get uniform placement
- Every pass segregates the aggregate by size



# DSA Placements

- DSA placements over 500 tons are required to be placed with a Motor-Paver





CR561R

Grayhound

**HOLDERMAN**  
Trucking

MIFFLINTOWN, PA • 717-363-0008

CONSTRUCTION VEHICLE

TM SERVICES

PAZINER, PA  
570-274-0250

BEFORE SUDDEN STOP & TURNS



WARNING

# DSA Placements

- DSA placements over 500 tons are required to be placed with a Motor-Paver
- Places uniform lift, does not segregate
- Control depth
- Control width
- Control crown
- Can't be “overworked”

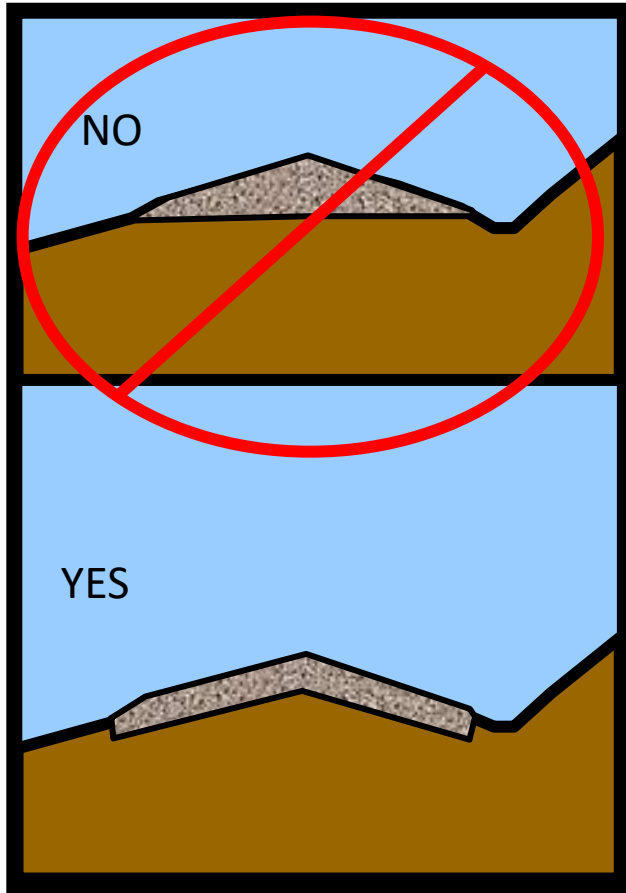


Note 4-6%  
crown



# DSA Placements

- Install drainage upgrades first
- Prep road to establish crown

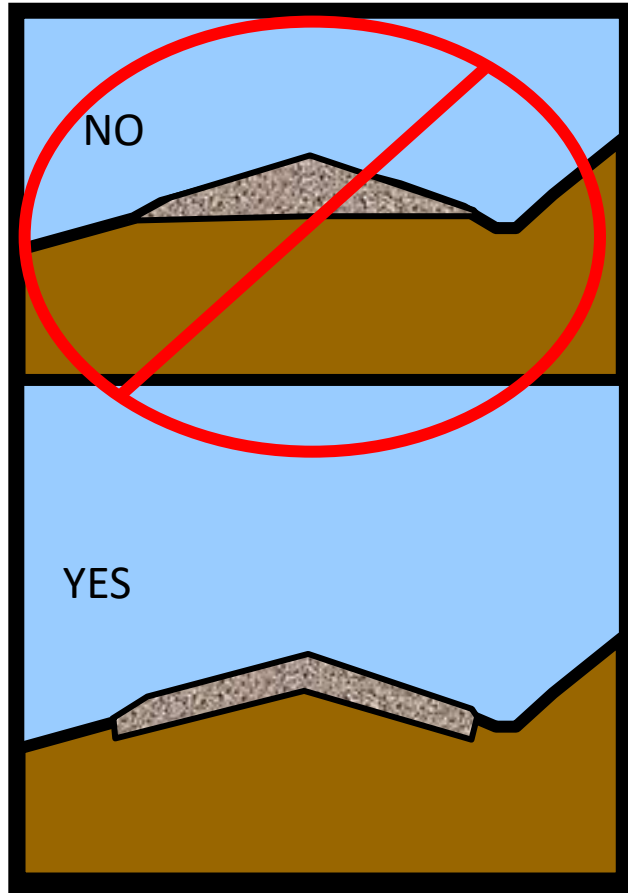


This road was graded in preparation for DSA placement

notice crown

# DSA Placements

- Install drainage upgrades first
- Prep road to establish crown



# DSA Placements

- Grading windrows can be used as “shoulder”



# DSA Placements

- Compaction is KEY: min 9-tonne vibratory roller



# DSA Placements

- Adequate fines and moisture = maximum compaction



# DSA Placements

- Maximum density = longer lasting surface



## Driving Surface Aggregate (DSA)

- DSA need and development
- DSA Specification
- DSA Placement
- **Research**
- Maintenance





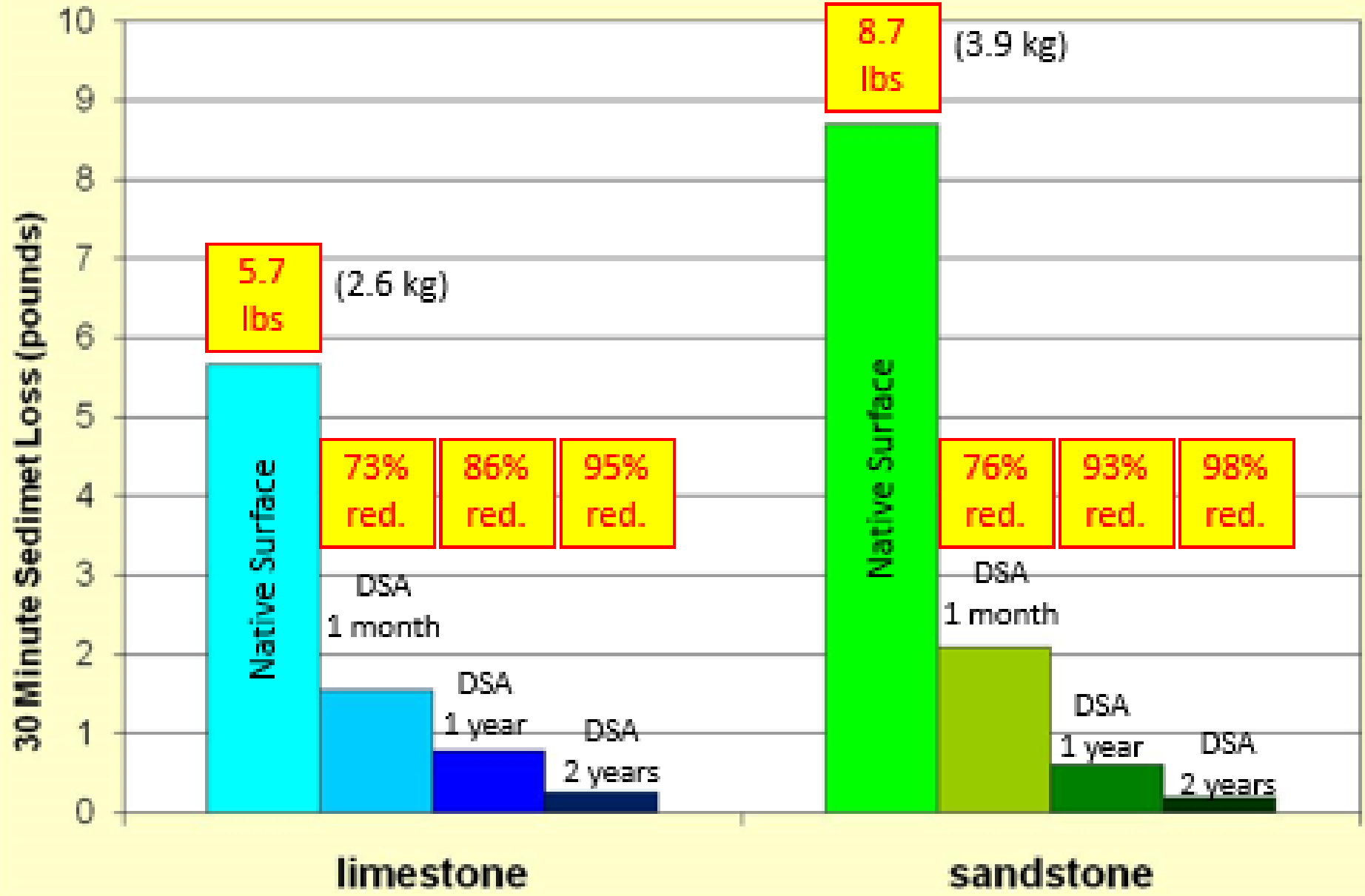
**Existing Surface**

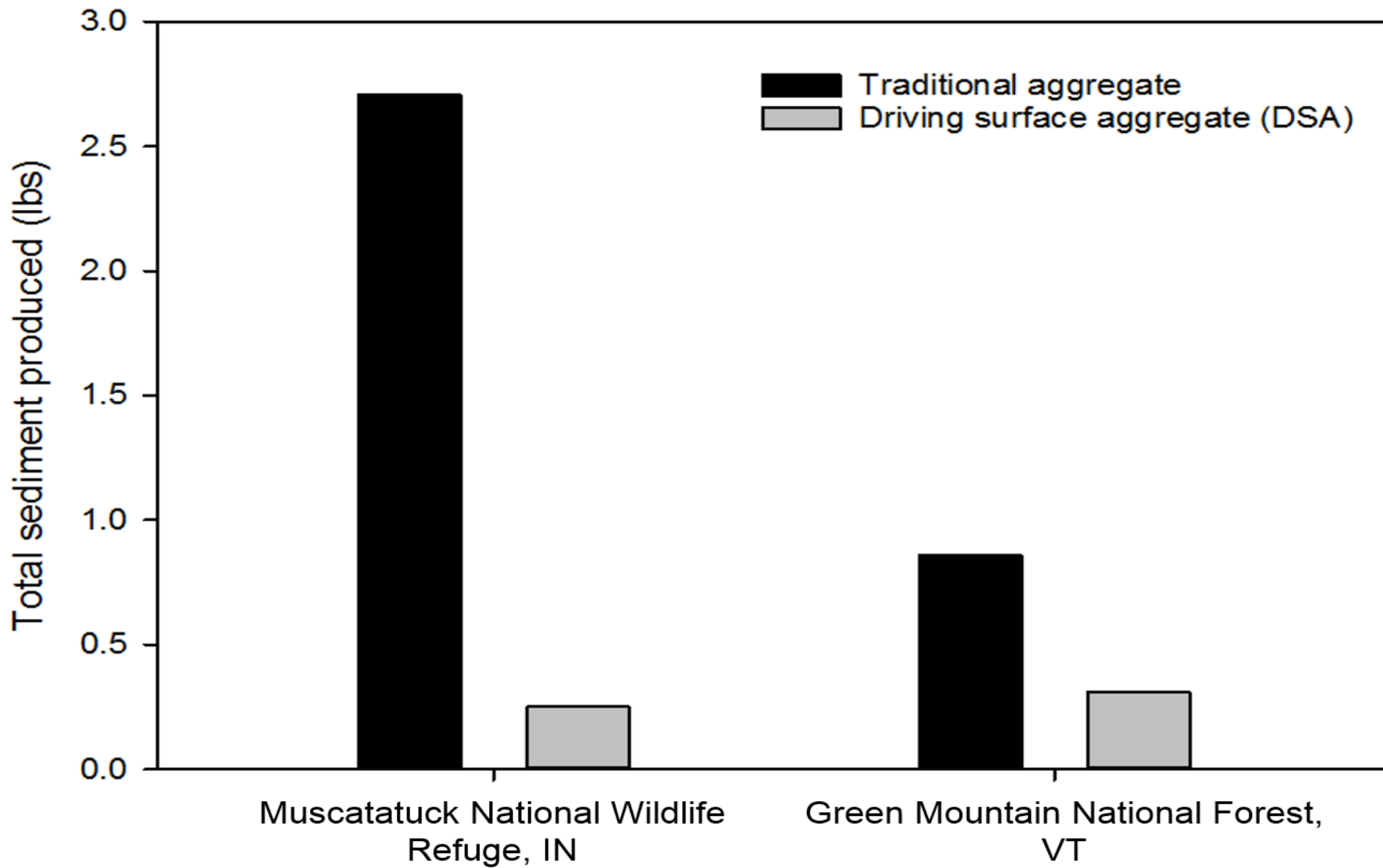


**Limestone DSA (1 month)**



# Total 30-Minute Sediment Loss (three run average)





# DSA Research

- Comparative Study
- DSA had less loose material and better rutting resistance



# DSA Research

- Comparative Study
- DSA had less loose material and better rutting resistance



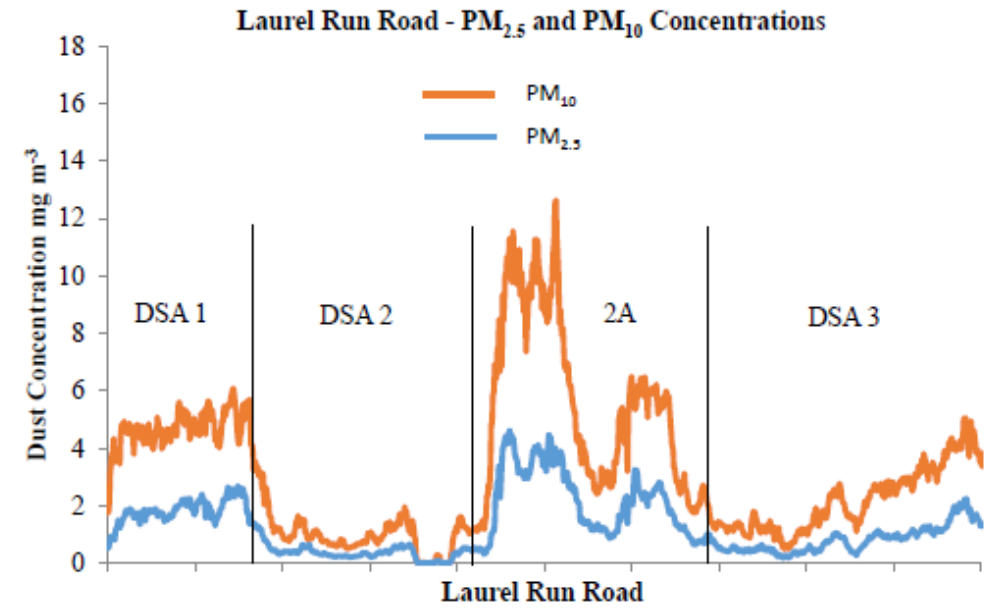
# DSA Research

- Lengthens grading cycles
- **Assuming you take care of any base and drainage issues:**
  - Will usually last ~3 years before initial grading
  - Graded every 2-3 years (varies)
  - Will last 15-20 years.
- In-situ sampling shows it retains gradation after 6 years and two gradings.



# DSA Research

- Dust reduction versus SAME AGGREGATE, just different gradation with less fines.



## Driving Surface Aggregate (DSA)

- DSA need and development
- **DSA Specification**
- DSA Placement
- Research
- **Maintenance**



# DSA Maintenance

- How often do you grade a road?



# DSA Maintenance

- How often do you grade a road?

**“Only as often as needed”**

*Don't grade a road based on a calendar.*

# DSA Maintenance

- Grading Considerations
  - Most DSA is so hard; you can't grade it in the summer without adding water or using a ripper.
  - Must grade in spring or add water.
  - Compaction after grading is critical!

**Surface aggregate is typically the most expensive aspect of road maintenance. Don't just call up and order "some rock".**

**A larger initial investment in quality aggregate usually as long-term cost benefits (if you address the base and drainage first).**

**2002**



**2017**



# Questions? Discussion?



**Steve Bloser**

[smb201@psu.edu](mailto:smb201@psu.edu)

[www.dirtandgravelroads.org](http://www.dirtandgravelroads.org)