The Hybrid of Base Modification and Stabilization for Rural Roads

Grant County Road 12 Project

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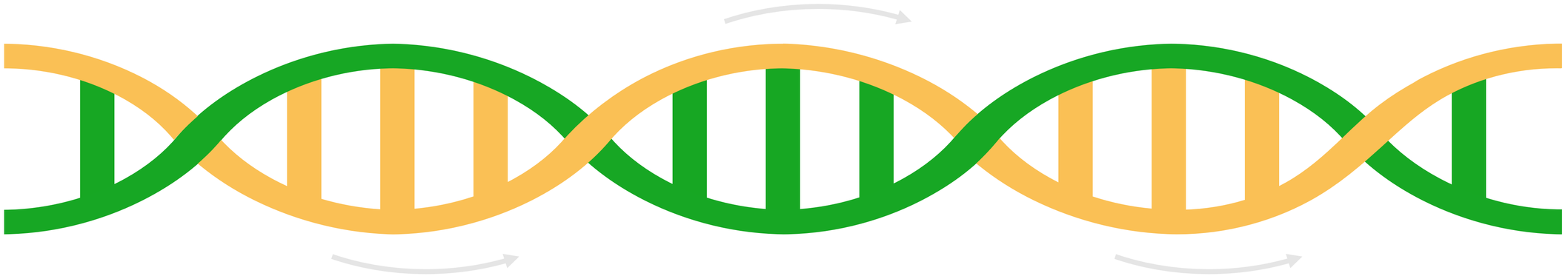
The Hybrid of Base Modification and Stabilization for Rural Roads

2) The Need

4) County Feedback



1) Introduction

3) Project, Testing & Observations

5) Questions

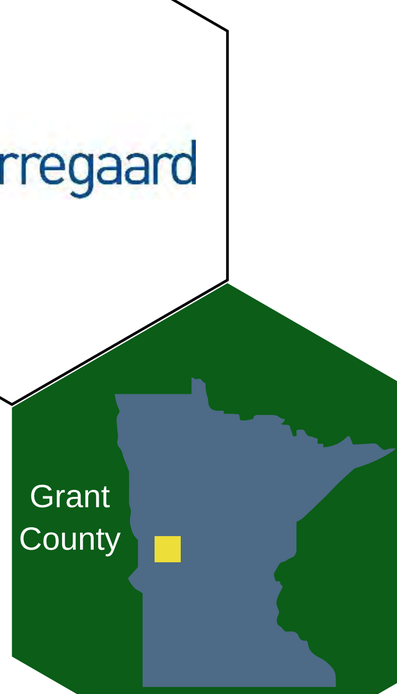
Borregaard

How Did This Happen?

- Borregaard is a leading bio-refining company with massive capabilities.
- Grant County has a Need for a better way.
- Braun has critical geotechnical knowledge
- Adventus has a track record for knowledge transfer into diverse markets

Borregaard

Grant County



BRAUN INTERTEC
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The Project

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Borregaard has proven stabilization technology that has been used for decades in Scandinavia and wanted to expand into the US

1) Introduction

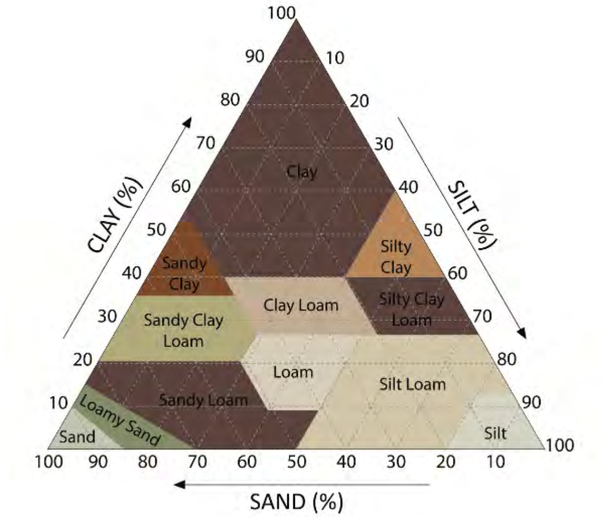
Borregaard

- Biorefining company that is focused on value added products.
- Strong Innovation group with approaching 89 employees dedicated to Research
- Production facilities in Norway and a major facilities in Wisconsin and Florida. Additionally Borregaard has manufacturing in three other countries
- Over 1,000 Employees worldwide
- Major business focus in numerous construction segments

Borregaard

Market Validation of Norwegian know how in Minnesota - Is the Biopolymer a The Hybrid of Base Modification and Stabilization for Rural Roads

1. **Determine biopolymer use in terms of:**
   - *Soil*
   - Climate
   - *Application*
2. **Determine Engineering Properties**
   - Strength Numbers
   - Product Limitations
   - *Correct Placement*
3. **Develop Marketing & Use Guidelines:**
   - Value Proposition
   - *Contractor Use - Dosing, Mixing, Compaction, Quality*



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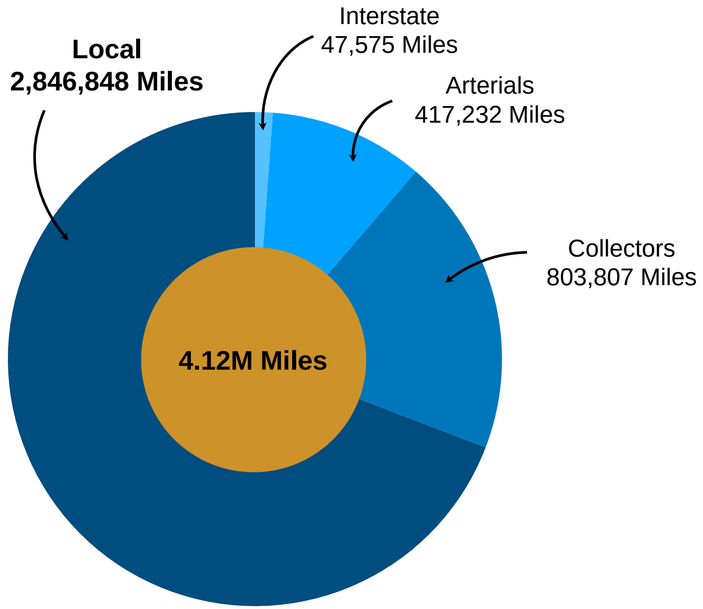
2) The Need

US Market In Miles



US Road Market Spending Breakdown

State & Local	Federal
$84.8B	$40.3B

Insights Confirmed in the Market:

- **Our market focus are local roads & collectors. This represents almost 90% of the total US road miles in the network.**
- These roads have significant need for rehabilitation and need creative solutions
- **Discovery: US (and Arguably the World Market) Has a significant technical and product gap in sub-grade modification and stabilization**

Grant County, Minnesota Case Study

- The Highway Department is responsible for 460 miles of roadways:
- 170 miles are bituminous surfaced,
- **290 miles gravel surfaced**
- 22 bridges.
- 16 Employees
- Department budget of $5.5 million
- County Population of 6,289
- 2,534 Households
- Interesting Point: 41.2% of the population is of Norwegian Descent

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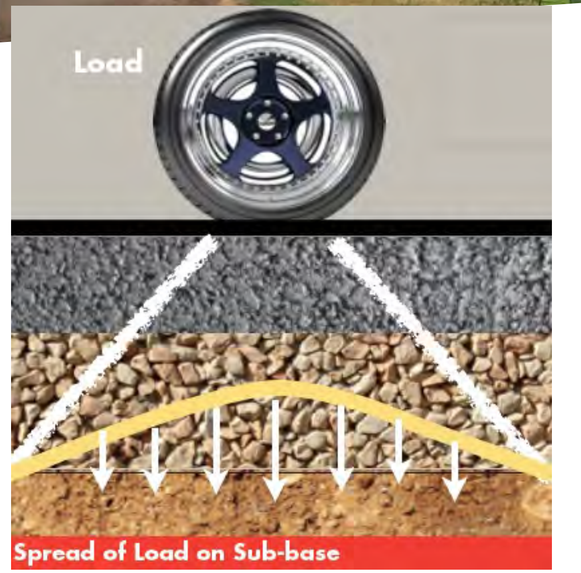
2) The Need

Initial Market & Technical Focus

Full Depth Reclamation

Stabilization



Stabilization refers to base/sub-grade soil improvement that includes:

- Long-term reactions which result in a bound layer.
- A laboratory mix design is recommended
- Performance requirements/tests vary between stabilization processes and stabilization additives.
- Performance tests are used to assure the material placed in the field is represented by the mix.

Modification refers to base/subgrade improvements:

- Usually as a compaction aid during construction or for strength improvement that occurs… after mixing.
- Base modification, the stabilized base layer will remain unbound.
- Soil/base modification currently requires no laboratory mix design or performance testing.

Modification

There is a major gap in the market to have a technology that modifies contaminated base in a manner that allows compaction and provides a stronger base that has flexibility to move with seasonal weather and traffic load.

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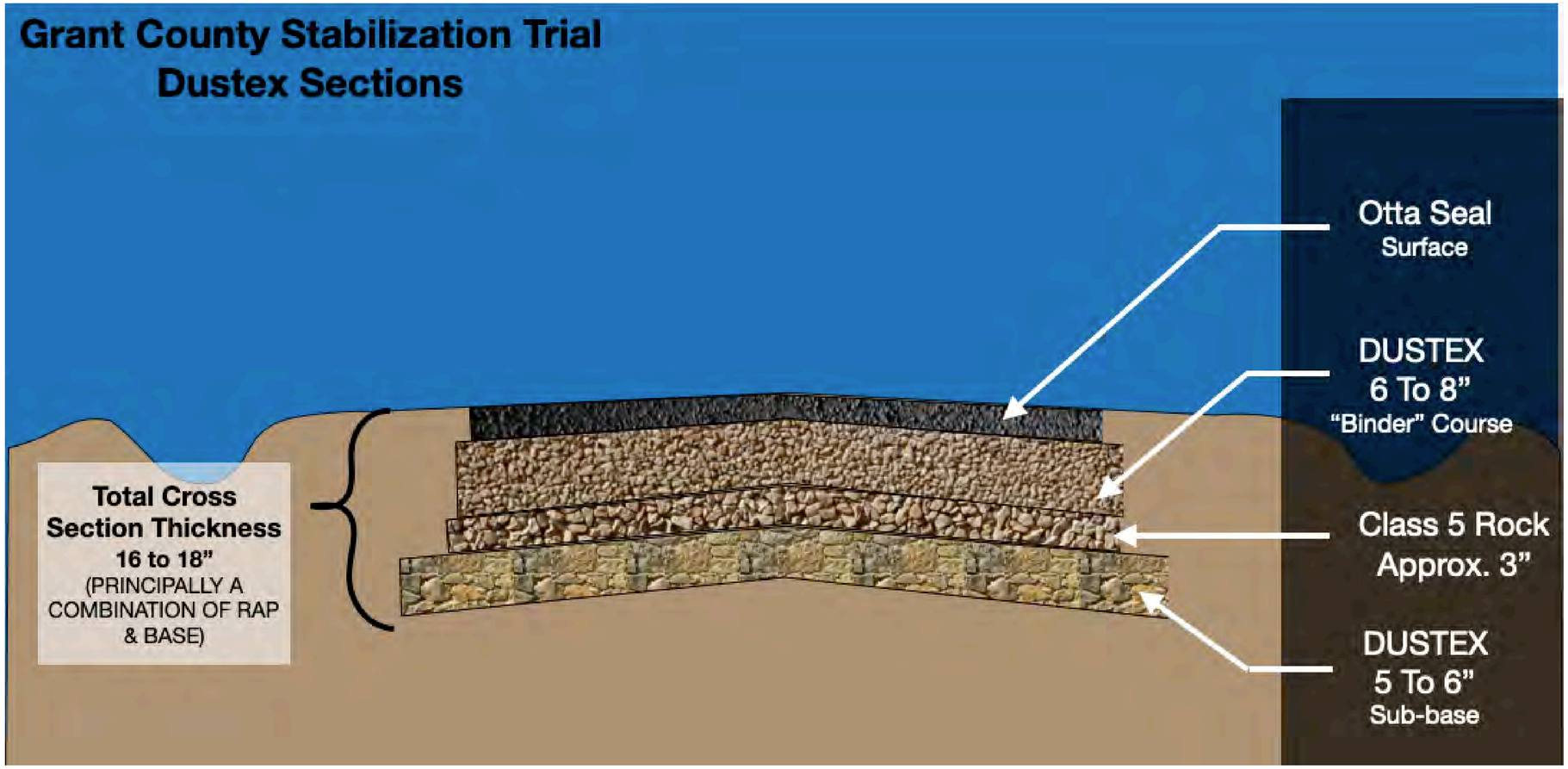
Road Use and Initial Design

- A gravel road principally used for agriculture
- Low traffic with tremendously high axle weight used by farmers to get in and out of the fields
- Sub-grade (Sub-base) improvement along with add rock and a base stabilization
- A final flexible asphalt seal was initially designed, but due to high bidding costs, the county chose not to cap the pavement



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Grant County CR 12

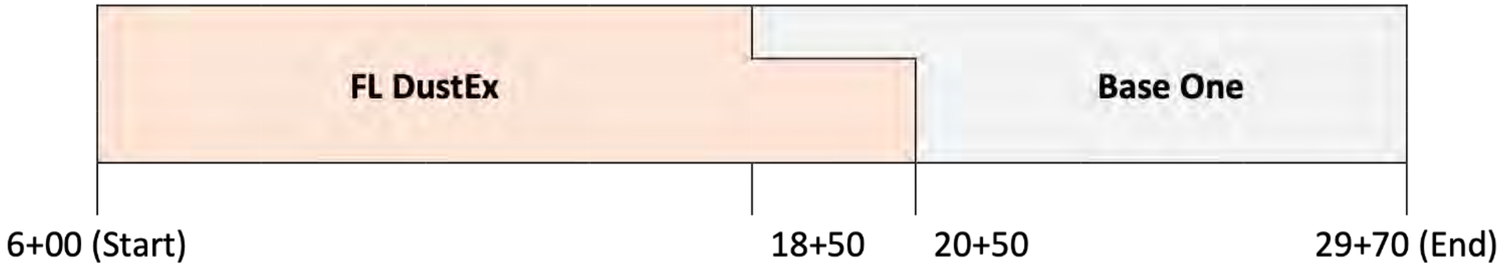
- Test section for subgrade and base modification/stabilization

Project Phases

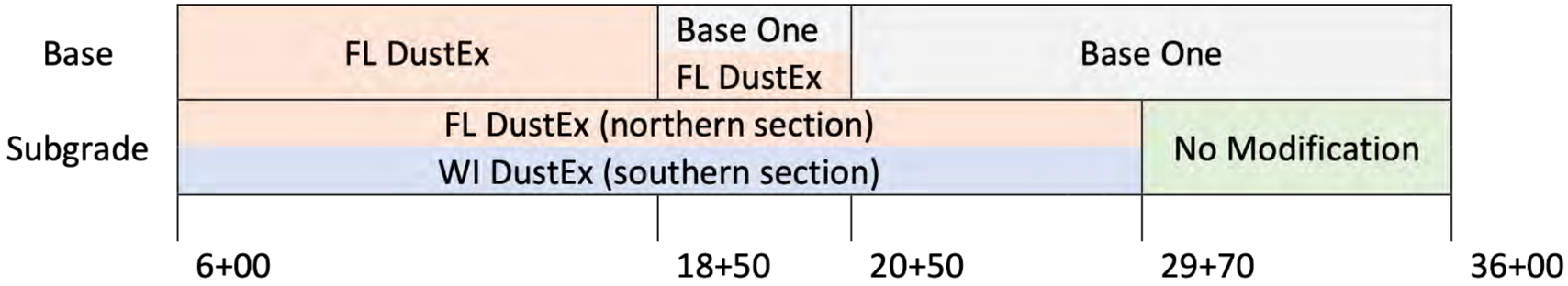
- DCP testing before injection and right after compaction
- Project Phases:
  - Phase I – subgrade modification
  - Phase II – base stabilization/modification
  - Phase III – long term assessment

Base Modification

- Top view:

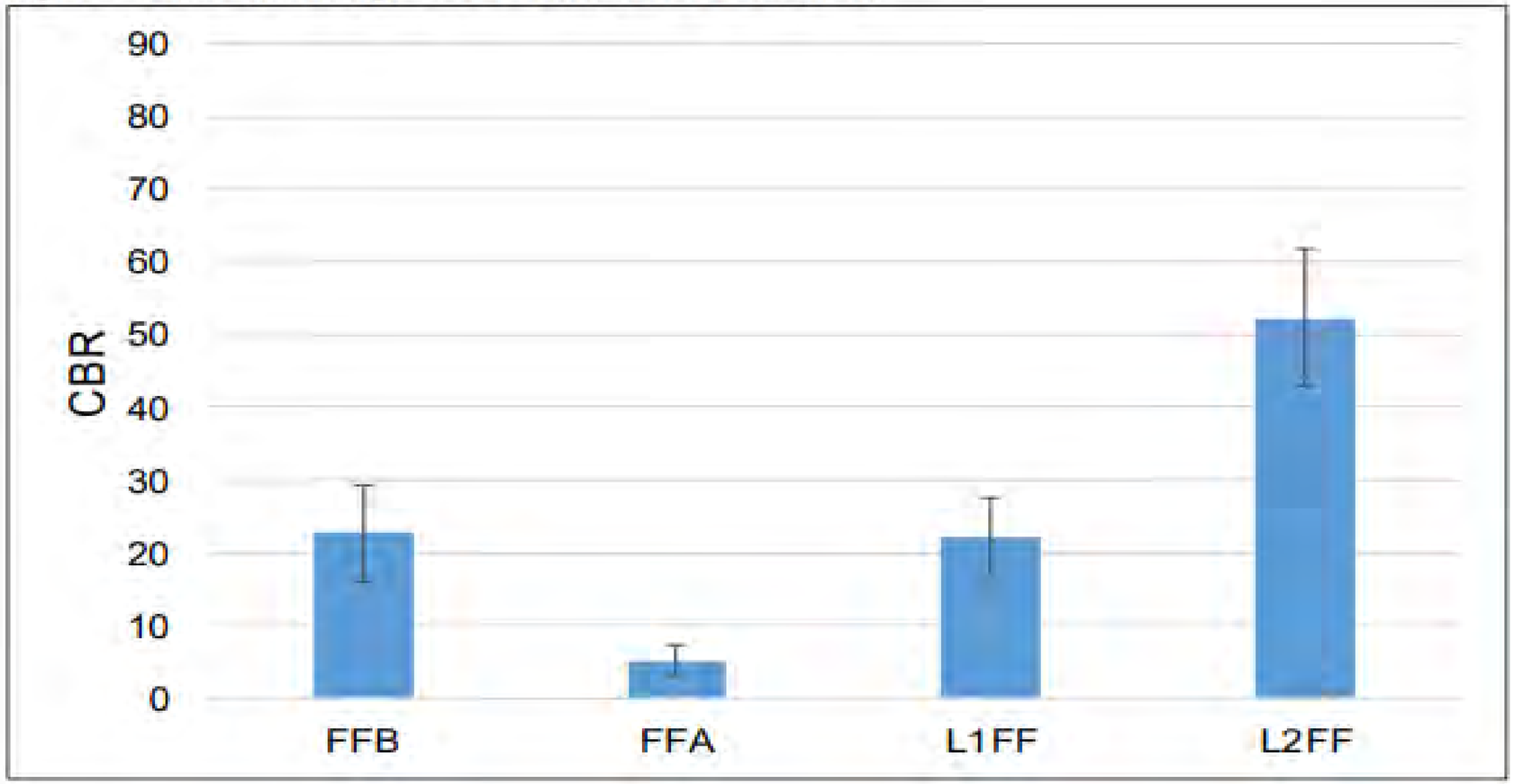


- Cross Section:



Strength Gain with Time

Figure 12. CBR Change Over Time for FF Section



Cross Section CBR Values

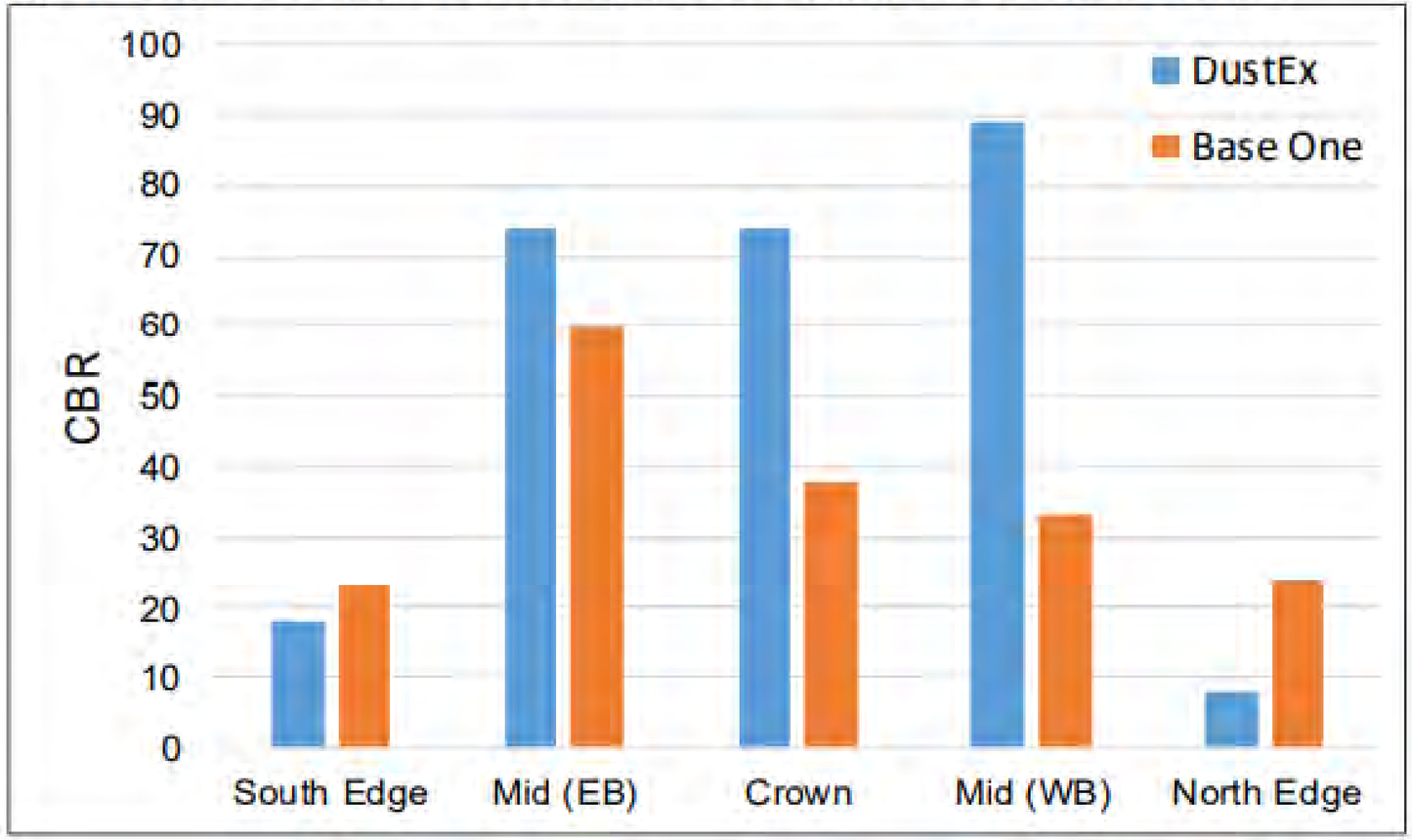
Figure 17. Cross-Section Testing in DustEx Modified Section (D1 through D5)

Cross Section CBR Values

Figure 18. Cross-Section Testing in Base One Modified Section (B1 through B5)

Cross Section CBR Values

Figure 19. Cross-Section CBR Values for Both DustEx and Base One Sections



4) County Feedback

Sub-Grade Modification

Example of Initial Road Condition

1) Reclaimer & Injection

2) Compaction with a Pad Foot Roller

3) Grooming with a Motor Grader

4) Finish Compaction with a Pneumatic Roller

Base Stabilization

5) Add Rock (Reclaimed Asphalt Pavement - RAP)

6) Reclaimer & Injection

7) Compaction with Pad Foot Roller

8) Motor Grader Grooming

9) Finish Compaction & Construction Completion

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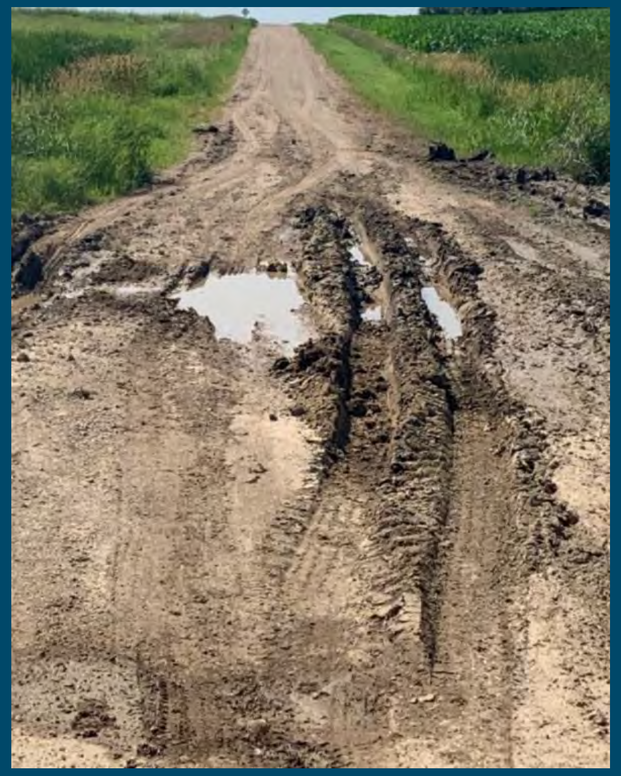
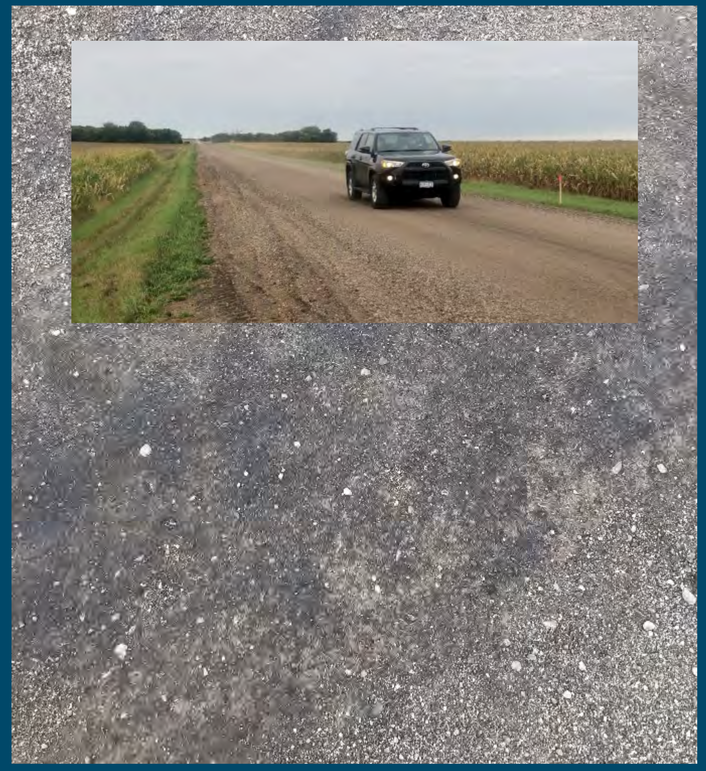
3) County Feedback





The Past

The Present

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Questions

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