Gravel Road Research

Wednesday, October 13, 2021
WDEA Annual Meeting

Research conducted by the North Dakota Local Technical Assistance Program (NDLTAP), a Program of the Upper Great Plains Transportation Institute, in partnership with the Western Dakota Energy Association (WDEA) and the North Dakota Department of Transportation (NDDOT).
Wise Roads

‘Weather Information System to Effectively Reduce Oilfield Delays and Disruptions’
Problem:

Muddy Gravel Roads Can’t Carry Loads

When inclement weather strikes, local governments impose weight restrictions on gravel roads that prohibit the movement of oilfield truck traffic until road conditions improve.
How can technology turn this into a Smart Road?
Wise Roads Project

✓ Work with research partners, agriculture, and Industry to maximize benefit

✓ Install research-grade weather stations in areas with heavy oilfield traffic

✓ Make data publicly available through NDAWN, LoadPass and other sites

✓ Provide training to road managers through LTAP
Toward 365
History

• Watford City Western Energy Roundtable
• Industrial Commission Funds Wise Road Launch
• 2019 – 18 weather stations added
• 2020 – 14 weather stations, 2 road probes added
• 2021 – 10 weather stations, 1 road probe added to date
Rain Events are often isolated.
The new stations can be identified by the precipitation numbers on the map. The names are either related to a nearby community or the township in which the station is located.
EXPECTEDATIONS OF THE PROJECT

- County Road Departments can use the weather data to determine the area of impact for weight restrictions.
- County Road Departments use weather station locations to create/modify road “zones” for issuing restrictions.
- Forecast and weather accessible from:
  - Ndenergy.org and LoadPassPermits.com
  - NDAWN (ndawn.ndsu.nodak.edu)
  - County Websites
  - UGPTI - GRIT
Roadway Condition Assessments
Figure 1: The components of the roadway cross section.
Gravel Depth
Roadway Slope
4% Slope on Gravel
Float – Loose Rock
Float
Corrugations = Wash Boarding
Gravel
Material Assessment
**Sieve Analysis Of Aggregate**

**Sample Information**

- **Sample Number:** 317316
- **Alternative Id:** G-01
- **Sample From:** Unknown
- **Sampled By:** Client
- **Location Details:** Handays #1
- **Sampled Date:** 08/13/2020
- **Received Date:** 08/13/2020
- **Tested Date:** 08/19/2020
- **Lab:** 620 10th Street NE, Suite 340, West Fargo, ND
- **Tested By:** Lage, Andrew

**Laboratory Data**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Passing %</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in)</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>19 mm (3/4 in)</td>
<td>97</td>
<td>78-100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in)</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>9.5 mm (3/8 in)</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>6.35 mm (1/4 in)</td>
<td>88</td>
<td>38-74</td>
</tr>
<tr>
<td>4.75 mm (No. 10)</td>
<td>81</td>
<td>22-48</td>
</tr>
<tr>
<td>4.00 mm (No. 16)</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>3.15 mm (No. 20)</td>
<td>34</td>
<td>12-45</td>
</tr>
<tr>
<td>3.00 mm (No. 20)</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>3.15 mm (No. 100)</td>
<td>18</td>
<td>12-45</td>
</tr>
<tr>
<td>2.00 mm (No. 200)</td>
<td>15.3</td>
<td>18-77</td>
</tr>
</tbody>
</table>

**Test Method:** Single Sieve Set

**Results:** The test is for informational purposes.

**Remarks:** Afterberg Limits Not Found.
Gravel Quality – Gradation and Binder
Traffic Counts
<table>
<thead>
<tr>
<th>Location</th>
<th>Start Date Time</th>
<th>End Date Time</th>
<th>Day 1 ADT</th>
<th>Day 2 ADT</th>
<th>Ave ADT</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
<th>Class 6</th>
<th>Class 7</th>
<th>Class 8</th>
<th>Class 9</th>
<th>Class 10</th>
<th>Class 13</th>
<th>Total</th>
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<tbody>
<tr>
<td>Medicine Hole, Dunn Co 115th Ave. NW</td>
<td>8/5/2020 0:00</td>
<td>8/5/20 N/A</td>
<td>162</td>
<td>162</td>
<td>5</td>
<td>93</td>
<td>2</td>
<td>17</td>
<td>7</td>
<td>0</td>
<td>28</td>
<td>2</td>
<td>1</td>
<td>6162</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hawkeye WISE Road site 43rd St. NW Co. #55</td>
<td>8/5/2020 0:00</td>
<td>8/7/20 0:00</td>
<td>219</td>
<td>157</td>
<td>188</td>
<td>1115</td>
<td>11</td>
<td>2</td>
<td>13</td>
<td>9</td>
<td>0</td>
<td>19</td>
<td>5</td>
<td>4</td>
<td>11188</td>
<td></td>
<td></td>
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<tr>
<td>Epping WISE road] Williams Co. Road #6</td>
<td>8/5/2020 15:00</td>
<td>8/6/20 15:00</td>
<td>132</td>
<td>149</td>
<td>281</td>
<td>206</td>
<td>38</td>
<td>1</td>
<td>15</td>
<td>7</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>3281</td>
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Vehicle classes
Subgrade Strength
Subsurface probes – moisture and temperature

Jonathan Rosencrans - Meteorologist
EPPING PROBE
INSTALLATION 2020
EPPING PROBE INSTALLATION
McKenzie Location
Banks 2021
<table>
<thead>
<tr>
<th>County</th>
<th>Road</th>
<th>Restriction</th>
<th>Rainfall</th>
<th>Date</th>
<th>Time</th>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>McKenzie</td>
<td>All gravel roads</td>
<td>20,000 GVW</td>
<td>5/9/2021</td>
<td>3:00 PM</td>
<td></td>
<td>5/9/2021</td>
<td>4:00 PM</td>
</tr>
<tr>
<td>Dunn</td>
<td>All gravel roads</td>
<td>12,000 GVW</td>
<td>5/21/2021</td>
<td>9:00 AM</td>
<td></td>
<td>5/22/2021</td>
<td>8:30 AM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>Liberty Township roads</td>
<td>20,000 GVW</td>
<td>5/21/2021</td>
<td>9:00 AM</td>
<td></td>
<td>5/22/2021</td>
<td>8:30 AM</td>
</tr>
<tr>
<td>Divide</td>
<td>All gravel roads</td>
<td>12,500 GVW</td>
<td>5/21/2021</td>
<td>Noon</td>
<td></td>
<td>5/23/2021</td>
<td>Noon</td>
</tr>
<tr>
<td>McKenzie</td>
<td>CR 55 from ND 23 to ND 1806</td>
<td>Closed</td>
<td>5/22/2021</td>
<td>1:00 PM</td>
<td></td>
<td>5/24/2021</td>
<td>Noon</td>
</tr>
<tr>
<td>Dunn</td>
<td>28th St SW from Hwy 22 to 98th Ave SW</td>
<td>12,000 GVW</td>
<td>5/22/2021</td>
<td>2:00 PM</td>
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<td>5/24/2021</td>
<td>2:30 PM</td>
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<tr>
<td>Divide</td>
<td>CR 32</td>
<td>12,500 GVW</td>
<td>5/23/2021</td>
<td>8:30 AM</td>
<td></td>
<td>5/27/2021</td>
<td>6:00 PM</td>
</tr>
<tr>
<td>Dunn</td>
<td>All gravel roads</td>
<td>12,000 GVW</td>
<td>5/23/2021</td>
<td>6:00 PM</td>
<td></td>
<td>5/24/2021</td>
<td>8:00 PM</td>
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<tr>
<td>Billings</td>
<td>All gravel roads</td>
<td>12,000 GVW</td>
<td>5/23/2021</td>
<td>7:30 PM</td>
<td></td>
<td>5/24/2021</td>
<td>8:00 PM</td>
</tr>
<tr>
<td>McKenzie</td>
<td>All gravel roads</td>
<td>20,000 GVW</td>
<td>5/23/2021</td>
<td>10:00 PM</td>
<td></td>
<td>5/24/2021</td>
<td>Noon</td>
</tr>
<tr>
<td>McKenzie</td>
<td>CR 55 from ND 23 to ND 1806</td>
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<td>5/24/2021</td>
<td>Noon</td>
<td></td>
<td>5/28/2021</td>
<td>Noon</td>
</tr>
<tr>
<td>Divide</td>
<td>All gravel roads</td>
<td>12,500 GVW</td>
<td>5/24/2021</td>
<td>Noon</td>
<td></td>
<td>5/24/2021</td>
<td>Noon</td>
</tr>
<tr>
<td>Williams</td>
<td>All gravel roads and chip seal roads</td>
<td>20,000 GVW</td>
<td>6/11/2021</td>
<td>6:00 AM</td>
<td></td>
<td>6/12/2021</td>
<td>6:00 AM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>All gravel roads</td>
<td>No Over Weight</td>
<td>6/11/2021</td>
<td>6:45 AM</td>
<td></td>
<td>6/14/2021</td>
<td>8:30 AM</td>
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<tr>
<td>Divide</td>
<td>All gravel roads</td>
<td>12,500 GVW</td>
<td>6/11/2021</td>
<td>7:45 AM</td>
<td></td>
<td>6/12/2021</td>
<td>10:00 AM</td>
</tr>
<tr>
<td>Williams</td>
<td>Strandahl Township roads</td>
<td>No Over Weight</td>
<td>6/11/2021</td>
<td>8:00 AM</td>
<td></td>
<td>6/15/2021</td>
<td>7:30 AM</td>
</tr>
<tr>
<td>Burke</td>
<td>All gravel roads</td>
<td>12,500 GVW</td>
<td>6/11/2021</td>
<td>9:00 AM</td>
<td></td>
<td>6/12/2021</td>
<td>1:00 PM</td>
</tr>
<tr>
<td>Burke</td>
<td>93rd St NW between 75th &amp; 76th Ave NW</td>
<td>Closed</td>
<td>6/11/2021</td>
<td>9:20 AM</td>
<td></td>
<td>6/18/2021</td>
<td>1:00 PM</td>
</tr>
<tr>
<td>McKenzie</td>
<td>All gravel roads</td>
<td>20,000 GVW</td>
<td>6/11/2021</td>
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<td></td>
<td>6/12/2021</td>
<td>10:00 AM</td>
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<tr>
<td>Williams</td>
<td>70th St NW from 112th to 110th Ave NW (Co 19)</td>
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<td>6/11/2021</td>
<td>12:30 PM</td>
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<td>3:15 PM</td>
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<tr>
<td>McKenzie</td>
<td>45th St NW between US 80 and 148 T Ave NW</td>
<td>Reduced Speeds</td>
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<tr>
<td>McKenzie</td>
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<td>4:00 PM</td>
<td></td>
<td>6/21/2021</td>
<td>4:00 PM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>65th Street between 93rd Ave and 94th Ave</td>
<td>Closed</td>
<td>6/11/2021</td>
<td>4:30 PM</td>
<td></td>
<td>6/14/2021</td>
<td>10:30 AM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>CR4 (74th St) at CR7 (81st Ave) to CR5 (87th Ave)</td>
<td>12,000 GVW</td>
<td>6/11/2021</td>
<td>5:30 PM</td>
<td></td>
<td>6/14/2021</td>
<td>5:30 PM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>96th Ave between ND1804 and 81st Street</td>
<td>8 Ton/axle</td>
<td>6/14/2021</td>
<td>8:30 AM</td>
<td></td>
<td>6/16/2021</td>
<td>8:30 AM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>CR29 between ND22 and 36th Street</td>
<td>8 Ton/axle</td>
<td>6/14/2021</td>
<td>8:30 AM</td>
<td></td>
<td>6/16/2021</td>
<td>8:30 AM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>99th Ave from US 2 to 51st St</td>
<td>20,000 GVW</td>
<td>6/28/2021</td>
<td>2:00 PM</td>
<td></td>
<td>6/29/2021</td>
<td>4:00 PM</td>
</tr>
<tr>
<td>Mountrail</td>
<td>CR4 (74th Street) from CR7 (81st Ave) East to CR5 (87th Ave)</td>
<td>12,000 GVW</td>
<td>7/5/2021</td>
<td>9:30 AM</td>
<td></td>
<td>7/12/2021</td>
<td>10:30 AM</td>
</tr>
</tbody>
</table>

* Culvert washed out
* Power lines over the road
* Soft and washed out road shoulders
* Culvert washed out
* Downed trees across roadway
* Culvert collapsed
Data Driven Decisions

WISE Roads Decision Tree for post spring thaw period after >= ½” rain in 24 hrs.

- **Road Condition**
  - Good condition roads
  - Fair condition roads
  - Poor condition roads

- **Drying next day PET>0.2”+ wind >10mph**
  - N: .2”+Average Wind<10mph in next 24 hr.
    - Y: Restrict weights for 48 hrs., if width <=24” add 24 hrs. (48 total)
  - Y: Restrict for 24 hrs., if width <=24” add 24 hrs. (48 total)

- **Drying next day PET>0.2”+ wind >10mph**
  - N: .2”+Average Wind<10mph in next 24 hr.
    - Y: Restrict weights for 48 hrs., if width <=24” add 24 hrs. (48 total)
  - Y: Restrict for 72 hrs., if width <=24” add 24 hrs. (72 total)

- **Drying next day PET>0.2”+ wind >10mph**
  - N: .2”+Average Wind<10mph in next 24 hr.
    - Y: Restrict weights for 96 hrs., if width <=24” add 24 hrs. (96 total)
  - Y: Restrict for 96 hrs., if width <=24” add 24 hrs. (120 total)
Gravel Roadway Properties

plus

Rainfall Event Data

Equates to refined roadway condition data:

TOWARD 365 Prediction Model
Poster

(Available at the NDLTAP booth)

WISE ROADS
(Weather Information System to Effectively Reduce Oilfield Delays and Disruptions)

Protecting Roads and Keeping Traffic Moving in Oil Country

Township and county gravel roads are the backbone of the ND economy, particularly its western oil counties. Oil production is a 365-days-per-year effort and can be hampered by roadway structural deficiencies resulting from moisture. Gravel surfacing and subgrade may become so saturated that any trucks quickly damage or destroy the roadway. Consequently, timely placement and removal of road weight restrictions balances the need to prevent costly road rebuilding with road users' needs. WISE Roads weather stations (https://wiseroads.nd.gov) with sub-surface probes provides detailed weather conditions and forecasts along with sub-surface moisture and temperatures to help roadway owners make more refined decisions.

Toward 365 Project

Toward 365 Project allows counties to use site-specific weather and roadway information to limit loads only on roads impacted by weather while allowing full use of non-impacted roads.

Enhancing NDDOT’s Transportation Management System

In 2018, the NDDOT began implementing a TMC (Transportation Management System) to manage and create a "one-stop shop" for transportation data. NDLTAP and NDDOT are integrating WISE Road and NDWMM weather information with NDDOT’s Road Weather Information System, resulting in a quantum leap forward for the TMC. The integrated information is available on NDDOT’s ND Roads webpage at https://travel.dot.nd.gov and expand the Weather link.

WISE ROADS was developed in a partnership between the Western Dakota Energy Association, NDLTAP and the ND Agricultural Weather Network (NDWMM) at NDSU. Another energy based improvement, designed to benefit all of North Dakota.
WISE ROADS 2021

Weather Information System to Effectively Assess Rain Influenced Gravel Road Conditions

Project is funded and supported by: NDAWN, WDEA/LoadPass, UGPTI/NDLTAP and a grant from the Oil and Gas Research Council

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