PORTABLE WEIGH-IN-MOTION
FIELD EVALUATION

Minnesota Local Road Research Board
Acknowledgments

- LRRB: Joe Triplett, Chisago County
- MnDOT Technical Liaison: Ben Timerson
- MnDOT ORS Project Coordinator: Nelson Cruz
• Existing WIM technologies are permanent, expensive, and intrusive.

• Portable Weigh-in-Motion (PWIM) offers cost-effective means for Gross Vehicle Weight (GVW) data collection at various locations.

• Prototype system allows for software modifications to match data collection needs.
Project Goals

1. Evaluate System Installation/Removal Process & Procedures
   A. Implement/Evaluate suggested installation/removal procedure under varying environmental conditions
   B. Evaluate required resources for installation and opportunities for efficiency
   C. Evaluate safety considerations and traffic control requirements
   D. Identify maximum duration for system deployment
Project Goals

2. Determine System Performance
   A. Determine appropriate calibration procedure and identify proper data sets for baseline comparison
   B. Determine procedure for a high-level accuracy check
   C. Test/Troubleshoot system to resolve unanticipated prototype issues
3. **Analyze Data & Evaluate System Accuracy**
   
   A. Document ease of data collection
   B. Review & compare data to baseline
   C. Evaluate data accuracy
   D. Evaluate system potential as new means of data collection
Test Locations – Phase 1 (2013)

<table>
<thead>
<tr>
<th>ATR</th>
<th>County</th>
<th>Closest City</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>233</td>
<td>Sibley</td>
<td>Arlington</td>
<td>CSAH 9, 0.7 MI N OF 226TH ST, N OF ARLINGTON</td>
</tr>
<tr>
<td>229</td>
<td>McLeod</td>
<td>Hutchinson</td>
<td>CSAH 18, 4.3 MI W OF CSAH7, SW OF HUTCHINSON</td>
</tr>
<tr>
<td>230</td>
<td>Rice</td>
<td>Lonsdale</td>
<td>CSAH 2, 3.4 MI W OF TH19, W OF LONSDALE</td>
</tr>
<tr>
<td>407</td>
<td>Hennepin</td>
<td>Orono</td>
<td>CSAH 15, NE OF SPATES AVE IN ORONO</td>
</tr>
<tr>
<td>232</td>
<td>Grant</td>
<td>Norcross</td>
<td>CSAH 11, 0.6 MI S OF CSAH12, NE OF NORCROSS</td>
</tr>
<tr>
<td>231</td>
<td>Wadena</td>
<td>Nimrod</td>
<td>CSAH 12, 1.6 MI E OF CSAH18, E OF NIMROD</td>
</tr>
<tr>
<td>228</td>
<td>Itasca</td>
<td>Hibbing</td>
<td>CSAH 7, N OF CR339, W OF HIBBING</td>
</tr>
</tbody>
</table>
### Test Locations – Phase 2 (2014)

<table>
<thead>
<tr>
<th>Site Number</th>
<th>Closest City</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Nessel Twp</td>
<td>CSAH 2 between County Line &amp; CSAH 4</td>
</tr>
<tr>
<td>2</td>
<td>Harris</td>
<td>CSAH 30 south of CR 59</td>
</tr>
<tr>
<td>3</td>
<td>Harris</td>
<td>CSAH 10 between CR 65 &amp; CR 64</td>
</tr>
<tr>
<td>4</td>
<td>Harris</td>
<td>CSAH 10 between I-35 &amp; CSAH 30</td>
</tr>
<tr>
<td>5</td>
<td>Harris</td>
<td>CSAH 30 between 415th St. &amp; CSAH 10</td>
</tr>
<tr>
<td>6</td>
<td>Stacy</td>
<td>CSAH 30 between CSAH 19 &amp; CSAH 30</td>
</tr>
<tr>
<td>7</td>
<td>Chisago City</td>
<td>CSAH 24 between Stinson Ave &amp; CSAH 23</td>
</tr>
<tr>
<td>8</td>
<td>Fraconia Twp</td>
<td>CSAH 25 between CSAH 23 &amp; CR 86</td>
</tr>
<tr>
<td>9</td>
<td>Fraconia Twp</td>
<td>CSAH 26 between TH 8 &amp; CSAH 21</td>
</tr>
<tr>
<td>10</td>
<td>Fraconia Twp</td>
<td>CSAH 26 between CSAH 21 &amp; TH 95</td>
</tr>
</tbody>
</table>
System Overview

- Data Capabilities:
  - Volume
  - Speed
  - Axle Spacing
  - Axle Spacing-based Classification
  - Weight-based Classification
  - Individual Axle Weights
  - Gross Vehicle Weight
System Installation/Removal

- Typical installation/removal requires two people – approximately 30 minutes.
- Single lane closure – flagging operation.
- Materials Required:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Quantity</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct Tape Rolls (Gorilla Brand)</td>
<td>4</td>
<td>Hammer</td>
</tr>
<tr>
<td>Sleeve Anchor Screws</td>
<td>30</td>
<td>Drill</td>
</tr>
<tr>
<td>Industrial Strength Drill Bit</td>
<td>1</td>
<td>Generator/Source of Power</td>
</tr>
<tr>
<td>Washers</td>
<td>30</td>
<td>Broom</td>
</tr>
</tbody>
</table>
System Calibration

- Several settings are configurable in the system software.
- Standard weight calibration procedure was developed during Phase 2 using different vehicle types:
  - Pick-up Truck (5 kips)
  - County Dump Trucks (25 kips)
  - County Maintenance Vehicles (100 kips)
  - MnROAD Calibration Truck (80 kips)
Data Results

Average Percent Difference from Baseline:

- **Volume**
  - ATR (Phase 1) = 22.0%
  - ATR (Phase 2) = 3.3%
  - Traffic Tubes = 13.6%

- **Speed**
  - ATR (Phase 1) = 1.3%
  - ATR (Phase 2) = 0.9%
  - Traffic Tubes = 3.6%
Accuracy Results - Pickup

<table>
<thead>
<tr>
<th></th>
<th>Actual GVW: 5.16</th>
<th>Average GVW: 4.74</th>
<th>Standard Deviation: 1.20</th>
<th>Average % Error: 8.14%</th>
</tr>
</thead>
</table>

**Pick-up Truck**

Actual GVW: 5.16 kips

6% Accuracy Shaded Area

15% Accuracy Shaded Area
Accuracy Results – Overloaded Semi

Actual GVW: 104.85 kips
Average GVW: 109.06
Standard Deviation: 8.71
Average % Error: 4.02%

County Truck

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual GVW</td>
<td>104.85</td>
</tr>
<tr>
<td>Average GVW</td>
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</tr>
<tr>
<td>Standard Deviation</td>
<td>8.71</td>
</tr>
<tr>
<td>Average % Error</td>
<td>4.02%</td>
</tr>
</tbody>
</table>

6% Accuracy Shaded Area
15% Accuracy Shaded Area
Accuracy Results – 80 kip semi (MnROAD)

Actual GVW: 80.00 kips
Average GVW: 83.15
Standard Deviation: 5.30
Average % Error: 3.94%

MnROAD Truck

- Actual GVW: 80.00
- Average GVW: 83.15
- Standard Deviation: 5.30
- Average % Error: 3.94%
Evaluation Results

- ASTM E-1318-09 Standard Specifications for Highway WIM Systems

- Percent of calibration runs that fell within the ASTM WIM standards:

<table>
<thead>
<tr>
<th></th>
<th>Accuracy Standard</th>
<th>Half-Ton Pickup</th>
<th>Class 6 Dump Truck</th>
<th>Class 9 (MnROAD) Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM Type II</td>
<td>15%</td>
<td>56%</td>
<td>90%</td>
<td>93%</td>
</tr>
<tr>
<td>ASTM Type III</td>
<td>6%</td>
<td>24%</td>
<td>49%</td>
<td>58%</td>
</tr>
</tbody>
</table>
Lessons Learned

- Install system under optimal conditions – sunny & dry.
- 48-hour maximum data collection periods.
- Extra tape!
- Vandalism is a threat.
Lessons Learned

• Many software revisions.

• PWIM Prototype 2.0 hardware improvements.

• Designed for rural deployments – not good with excessive traffic.

• Estimated pad useful life of 50-100 installations.
Next Steps

• Outreach to counties promoting system data collection capabilities – improve pavement design
Contact

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