Introduction to Road Surface Management

University of New Hampshire Technology Transfer Center

2012
Road Surface Management in NH

- RSMS Created by UNH T² in 1985

- Distribution reached ~5000 users internationally

- Reprogrammed in GIS format in partnership with PWS Solutions

- Summer 2011: T² works with over a dozen NH Communities with RSMS
Road Surface Management Goals

- Maximize Return on Investment (ROI) for each dollar spent on road maintenance
- Maintain highest possible town-wide road quality
- Create a transparent, systematic, and non-biased methodology for road repairs
- Generate long term budgetary estimates and work plans
**Lifecycle of a Road**

- **Very Good**: 75% of Lifespan
- **Good**
- **Fair**
- **Poor**
- **Very Poor**

- **Routine**
- **Preventive**
- **Rehabilitate**
- **Rebuild**

- **40% Condition Loss**

- **Years**
- **Road Surface Management**

- **REPAIR LEVEL**
  - Defer
Effect of Road Repairs

Only Rebuilt Returns to Condition to 100%

- Very Good
- Good
- Fair
- Poor
- Very Poor

Routine
Preventive
Rebuild
Guiding Principals

- Use Money As Efficiently As Possible
  - Keep good roads maintained (action at PCI = 70)
  - Prioritize roads based on Traffic, Importance, & Condition Assessment

- Make repair decisions based on road condition surveys
  - Uses well established decision trees (i.e. low severity alligator cracks = crack seal)

- Avoid “worst first” methodology

- Avoid arbitrary repair selection

- Prepare multi-year road maintenance plan
Steps to Complete RSMS Analysis

- Generates GIS Road centerline inventory file for the Town
- Town confirms all Town Maintained Roads are included
- Town Adds Traffic and Importance Factors to each road
- Conduct road condition survey
- Software analyzes data and Town generate 10 year work plan with:
  - Recommended yearly repairs & associated cost estimates
  - Network and Individual road “Pavement Condition Index” tables over time
- Review plan and customize to reflect preferences and budget constraints
What is GIS?

Characteristics of Geographic Information Systems

- Digital Format
- Spatially Referenced Map
  - Uses common coordinate system
- Contains Data Related to Map Objects
  - Road Width
  - Traffic Counts
  - Surface Type
  - Maintainer
Preparation of GIS Centerline File

- Begin with NHDOT Centerline (available at granit.unh.edu) or town GIS file
- Eliminate State and private roads
- Convert longer road segments to be intersection to intersection
- Not familiar with GIS? T² will prepare the file for you!
## Important Data Within The GIS Centerline

<table>
<thead>
<tr>
<th>Section Name</th>
<th>Segment Length</th>
<th>Paved Width</th>
<th>Surface Type</th>
</tr>
</thead>
</table>

*Optional: Traffic & Importance (1-5 Scale)*
Now... Sit Back and Relax....

T² Will do all of this setup work for you on request!
Begin with PWS RSMS

- Open PWS RSMS
  - Start Menu -> All Programs
  - PWS Solutions Folder
  - Click PWS RSMS

- Click “New” in upper left
Create a New Project: Step 1

- Select Project.mdb
- Name your project with your townname_RSMS
- Click Next
Create a New Project Step 2

- Do not add any data at this time.
- Click Finish to create the project file with no data.
- Next we will put your roads file into a data folder.
Copy GIS Data to Project Folder

- Open windows explorer and browse to C:\PWS Projects\Townname_RSMS folder
- Create a new Data Folder (right click-> New -> Folder)
- Copy your GIS centerline and any background files to this folder:
  - Parcels
  - Water bodies
  - Road Right of Ways
  - Call T2 for Background GIS Files
Add Shape files to RSMS

- Click Edit-> Attach a layer

- Select your GIS centerline layer from the data folder you just copied it to & Select Okay
Attach All your layers in this manner
Optional: Double Click on Layer to Style

- RSMS_Highways
- RSMS_ROADS
- towns
- pp_C36

- Water

Vector: Water
- Layer
- Section
- Renderer
- Area
- Label
- Chart

Pattern: SOLID
Color
Symbol
Symbol Gap
Symbol Rotate
Symbol Size

Include in legend
Ignore shape parameters
Import Shape file to Asset Layer

- Tools Import Shape file to Asset Layer
- Select your road Layer
- Select Parent Category “Transportation”
- Click “Map Fields”
Now Map The Shape File Data Fields

![Image of Maptool](image)

<table>
<thead>
<tr>
<th>SHP File Data Field</th>
<th>Asset Layer Data Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJECTID:</td>
<td>Road_ID</td>
</tr>
<tr>
<td>UNIQUE_ID:</td>
<td>Road_Section_ID</td>
</tr>
<tr>
<td>SRI:</td>
<td></td>
</tr>
<tr>
<td>MP_START:</td>
<td>Start_Milepost</td>
</tr>
<tr>
<td>MP_END:</td>
<td>End_Milepost</td>
</tr>
<tr>
<td>STREET:</td>
<td>Road_Section_Name</td>
</tr>
<tr>
<td>TOWN_ID:</td>
<td></td>
</tr>
<tr>
<td>TOWN_NAME:</td>
<td></td>
</tr>
<tr>
<td>SECT_LENGTH:</td>
<td>Length</td>
</tr>
<tr>
<td>NODE_1:</td>
<td></td>
</tr>
<tr>
<td>NODE_2:</td>
<td></td>
</tr>
</tbody>
</table>
A Few More Fields to Map

- SURF_TYPE: Surface_Type
- PAVE_WIDTH: Road_Width
- NO_LANES: Lanes

Select SHP File Layer: RSMS_ROADS
Select Asset Type Layer to Import Data Into:
- Parent category: Transportation
- Subcategory: Roads
- Asset Type: RSMS_Highways
Ready to Collect & Analyze

You’re now ready to begin putting in Traffic, Importance, & Condition Data

Remember T² Can Prep this data for you
Section END: GIS Data Prep & Import

- Summary
Assigning Importance Factors

- Important Roads
  - School Bus Routes
  - Hospitals
  - Evacuation Routes
  - High Traffic Roads
  - Schools
  - Municipal Services

<table>
<thead>
<tr>
<th>RSMS Road Importance</th>
<th>4 – Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – High</td>
<td></td>
</tr>
<tr>
<td>2 - Medium</td>
<td></td>
</tr>
<tr>
<td>1 – Low</td>
<td></td>
</tr>
</tbody>
</table>
## Assigning Traffic Factors

<table>
<thead>
<tr>
<th>Functional Road Classification</th>
<th>RSMS Traffic Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 – Arterial</td>
<td>5 – Critical</td>
</tr>
<tr>
<td>4 – Major Collector</td>
<td>4 – High</td>
</tr>
<tr>
<td>3 – Feeder</td>
<td>3 - Medium</td>
</tr>
<tr>
<td>2 – Urban Residential</td>
<td>2 – Low</td>
</tr>
<tr>
<td>1 – Rural Residential</td>
<td>1 - Minimal</td>
</tr>
</tbody>
</table>
Traffic and Importance Data Entry

- May be entered into GIS data prior to import
  - Must map in traffic and importance when converting to asset layer

- May be entered in RSMS
  - Using Select tool (button on top center of screen) select a road segment
  - Click Inventory button (top right of screen)
Check Traffic and Importance?

- Create a custom report to check Traffic & Importance Values
- Click Reports -> Inventory

1. Create Title
2. Select category/subcategory/name

3. Select:
   “Road_Section_Name” “Length” “Traffic_Volume” & “Importance”

4. Click double arrows then save & exit - Finally select your new report and click View Data
Section END: GIS Data Prep & Import

- Summary
Pavement Condition Survey

- Visual “Windshield Survey”
  - Analysis of visual distress manifestation
    - Pot holes
    - Alligator cracking
    - Edge cracking
  - Decision Trees determine what repair category is appropriate for recorded positions
## Condition Survey Parameters

### ALLIGATOR CRACKING:

<table>
<thead>
<tr>
<th>Severity</th>
<th>None</th>
<th>Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Med</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>High</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

### LONGITUDINAL/TRANSVERSE CRACKING:

<table>
<thead>
<tr>
<th>Severity</th>
<th>None</th>
<th>Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Med</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>High</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

### ROUGHNESS:
- Uneven Surface
- Corrugations
- Sags
- Humps
- Frost Heaves

<table>
<thead>
<tr>
<th>Severity</th>
<th>Smooth</th>
<th>Somewhat Rough</th>
<th>Rough</th>
<th>Very Rough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Med</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### RUTTING:

<table>
<thead>
<tr>
<th>Severity</th>
<th>0-1&quot;</th>
<th>1-2&quot;</th>
<th>&gt;2&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Med</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Condition Survey Parameters

**Edge Cracking**

<table>
<thead>
<tr>
<th>Severity</th>
<th>Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>1</td>
</tr>
<tr>
<td>MED</td>
<td>4</td>
</tr>
<tr>
<td>HIGH</td>
<td>7</td>
</tr>
</tbody>
</table>

**Drainage**

<table>
<thead>
<tr>
<th>Severity</th>
<th>LOW</th>
<th>MED</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>POOR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAIR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GOOD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXCELLENT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Patching/Potholes**

<table>
<thead>
<tr>
<th>Extent</th>
<th>GOOD</th>
<th>FAIR</th>
<th>POOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Field Notes**

- 
- 
- 

Condition Survey Steps

Step 1:
Identify Distress = What am I looking at?

Step 2:
Determine Severity = How Bad is it?

Step 3:
Determine Extent = How much is There??
Condition Survey Accuracy

- **Be Consistent**
  - Establish guidelines & use them

- **Be Objective**
  - Count or Measure

- **Minimize Subjectiveness**
  - “Eyeball” or “Guestimate”
Asphalt Road Surface Distresses

- Alligator Cracking
- Longitudinal/Transverse Cracking
- Edge Cracking
- Patching/Potholes
- Roughness
- Rutting
Alligator Cracking

- Interconnected or interlaced cracks forming connected irregular shapes

- Causes
  - Repeated Heavy Loads
  - Poor Drainage
# Alligator Cracking - Severity

<table>
<thead>
<tr>
<th>Severity Description</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Cracks Just Visible</td>
</tr>
<tr>
<td>Medium</td>
<td>Crack Width &lt;1/8” &amp; No Pop Outs</td>
</tr>
<tr>
<td>High</td>
<td>Crack Width &gt;1/8” &amp; Pop Outs</td>
</tr>
</tbody>
</table>
Alligator Cracking – Low Severity

Low Severity

Cracks Just Visible
Alligator Cracking – Medium Severity

Medium Severity

Crack Width <1/8” & No Pop Outs
Alligator Cracking – High Severity

High Severity

Crack Width >1/8” & Pop Outs
## Alligator Cracking - Extent

<table>
<thead>
<tr>
<th>Extent Description</th>
<th>Indication (% of Surface Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Medium</td>
<td>10%-30%</td>
</tr>
<tr>
<td>High</td>
<td>30%+</td>
</tr>
</tbody>
</table>
Alligator Cracking – Low Extent

Low Extent

<10% Surface Area
Alligator Cracking – Medium Extent

Medium Extent

10%-30% Surface Area
Alligator Cracking – High Extent

High Extent

30% + Surface Area
Longitudinal Cracking

- Cracks or Breaks Parallel to Centerline

- Causes
  - Poorly Constructed Joints
  - Shrinkage/Temperature Reflection (from below)
  - Settlement
Transverse Cracking

- Cracks or Breaks Across Roadway

- Causes
  - Culverts
  - Shrinkage/Temperature
  - Reflection (Concrete below)
  - Utility Cuts
## Longitudinal/Transverse Cracking - Severity

<table>
<thead>
<tr>
<th>Severity Description</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>None or Very Narrow</td>
</tr>
<tr>
<td>Medium</td>
<td>Crack Width ¼”</td>
</tr>
<tr>
<td>High</td>
<td>Crack Width ¼” or Larger</td>
</tr>
</tbody>
</table>


Longitudinal/Transverse – Low Severity

Low Severity

None or Very Narrow
Longitudinal/Transverse – Medium Severity

Medium Severity

Crack Width 1/4”
Longitudinal/Transverse – High Severity

High Severity

Crack Width >1/4”
## Longitudinal Cracking - Extent

<table>
<thead>
<tr>
<th>Extent Description</th>
<th>Indication (% of Surface Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Medium</td>
<td>10%-30%</td>
</tr>
<tr>
<td>High</td>
<td>30%+</td>
</tr>
</tbody>
</table>
# Transverse Cracking - Extent

<table>
<thead>
<tr>
<th>Extent Description</th>
<th>Indication (% of Surface Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Cracks &gt; 50’ Apart</td>
</tr>
<tr>
<td>Medium</td>
<td>Cracks 25’ to 50’ Apart</td>
</tr>
<tr>
<td>High</td>
<td>Cracks &lt; 25’ Apart</td>
</tr>
</tbody>
</table>
Longitudinal / Transverse Cracking

- **Deciding Extent**
  - **Low** – if both occur & *crack sealing* is the best solution
  - **Medium** – If both occur & *surface treatment* is the best solution
  - **High** – If Both occur & *rehabilitation* is the best solution
Longitudinal / Transverse – Low Extent

Low Extent

<10%
Cracks > 50’ Apart
Longitudinal / Transverse – Medium Extent

Medium Extent

Cracks 25’ to 50’ Apart
10%-30%
Longitudinal / Transverse—High Extent

High Extent

30% + Surface Area
Cracks < 25’ Apart
Edge Cracking

- Cracking and/or Loss of pavement Edges

- Causes
  - Loads on Edge of Pavement
  - Lack of Shoulder Support
  - Materials
  - Moisture
  - Thermal (snow piles)
## Edge Cracking - Severity

<table>
<thead>
<tr>
<th>Severity Description</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Thin Cracks &lt;12” from pavement edge</td>
</tr>
<tr>
<td>Medium</td>
<td>Larger Cracks &lt;24” from Pavement Edge</td>
</tr>
<tr>
<td>High</td>
<td>Breakup &gt;24” from pavement edge</td>
</tr>
</tbody>
</table>
Edge Cracking – Low Severity

Low Severity

Thin Cracks <12” from pavement edge
Edge Cracking – Medium Severity

Medium Severity

Larger Cracks <24” from Pavement Edge
Edge Cracking – High Severity

High Severity

Breakup >24” from pavement edge
# Edge Cracking - Extent

<table>
<thead>
<tr>
<th>Extent Description</th>
<th>Indication (% of Surface Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Medium</td>
<td>10%-30%</td>
</tr>
<tr>
<td>High</td>
<td>30%+</td>
</tr>
</tbody>
</table>
Edge Cracking – Low Extent

Low Extent

<10% Surface Area
Edge Cracking – Medium Extent

Medium Extent

10%-30% Surface Area
Edge Cracking – High Extent

High Extent

30% + Surface Area
Patching

- Isolated small areas of new paving material placed over previous distress or removed materials

- Causes
  - Repairs
  - Utility Cuts
Potholes

- Bowl shaped voids in pavement surface full or partial depth

- Causes
  - Loads
  - Water in base
  - Materials/Construction
## Patching/Potholes - Extent

<table>
<thead>
<tr>
<th>Severity Description</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None Present</td>
</tr>
<tr>
<td>Low</td>
<td>Potholes: &lt;5 per 100 ft.</td>
</tr>
<tr>
<td></td>
<td>Patching: &lt;10%</td>
</tr>
<tr>
<td>Medium</td>
<td>Potholes: 5-10 per 100 ft.</td>
</tr>
<tr>
<td></td>
<td>Patching: 10% - 30%</td>
</tr>
<tr>
<td>High</td>
<td>Potholes: 10+ per 100 ft.</td>
</tr>
<tr>
<td></td>
<td>Patching: 30%+</td>
</tr>
</tbody>
</table>
Patching/Potholes – Low Severity

Low Severity

Potholes: <5 per 100 ft.
Patching: <10%
Patching/Potholes – Medium Severity

Medium Severity

Potholes: 5-10 per 100 ft.
Patching: 10% - 30%
High Severity

Potholes: 10+ per 100 ft.
Patching: 30%+
Roughness

- Anything that affects a smooth ride

- Causes
  - Shoulders
  - Ditch depth and slope
  - Erosion and obstructions
  - loading
## Roughness – Ride at Posted Speed

<table>
<thead>
<tr>
<th>Severity Description</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth</td>
<td>Completely Smooth Pavement</td>
</tr>
<tr>
<td>Somewhat Rough</td>
<td>Cup of water on Dash: ripples</td>
</tr>
<tr>
<td>Rough</td>
<td>Cup of water on Dash: Splashes Within Glass</td>
</tr>
<tr>
<td>Very Rough</td>
<td>Cup of water on Dash: Splashes out of Glass</td>
</tr>
</tbody>
</table>
Roughness – Somewhat Rough

Somewhat Rough

Cup of water on Dash: ripples
Roughness – Rough

Rough

Cup of water on Dash:
Splashes Within Glass
Roughness – Very Rough

Very Rough

Cup of water on Dash: Splashes out of Glass
Rutting

- Longitudinal depressions in one or both wheel path

- Causes
  - Loads
  - Improper compaction
  - Poor subgrade

  *More visible when wet*
## Rutting

<table>
<thead>
<tr>
<th>Severity Description</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Rut Depth 0” - 1”</td>
</tr>
<tr>
<td>Fair</td>
<td>Rut Depth 1” – 2”</td>
</tr>
<tr>
<td>Poor</td>
<td>Rut Depth &gt; 2”</td>
</tr>
</tbody>
</table>

---

[Diagram showing rutting depth and severity]
Rutting - Good

Good

Rut Depth 0” - 1”
Rutting - Fair

Fair

Rut Depth 1” – 2”
Rutting - Poor

Poor

Rut Depth 1” – 2”
## Severity Summary

<table>
<thead>
<tr>
<th>Distress</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alligator Cracks</td>
<td>1/16”</td>
<td>1/8”</td>
<td>1/8”+</td>
</tr>
<tr>
<td>Long/Tran Cracks</td>
<td>&lt;1/8”</td>
<td>&lt;1/4”</td>
<td>1/4” +</td>
</tr>
<tr>
<td>Edge Crack</td>
<td>&lt;1/8”</td>
<td>&lt;1/4”</td>
<td>&gt; 1/4”</td>
</tr>
<tr>
<td></td>
<td>&lt; 12” from edge</td>
<td>&lt; 24” from edge</td>
<td>&gt; 24” from edge + Breakup</td>
</tr>
</tbody>
</table>
## Extent Summary

<table>
<thead>
<tr>
<th>Distress</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cracks but Transverse</td>
<td>&lt; 10%</td>
<td>10% - 30%</td>
<td>30%+</td>
</tr>
<tr>
<td>Transverse Cracks</td>
<td>&gt;50’</td>
<td>25’ - 50’</td>
<td>&lt;25’</td>
</tr>
<tr>
<td>Patching</td>
<td>&lt; 10%</td>
<td>10% - 30%</td>
<td>30%+</td>
</tr>
<tr>
<td>Potholes</td>
<td>&lt;5 Per 100 ft.</td>
<td>5-10 Per 100 ft.</td>
<td>10+ Per 100 ft.</td>
</tr>
<tr>
<td>Roughness</td>
<td>Water Ripples</td>
<td>Water Splash</td>
<td>Water Spills</td>
</tr>
</tbody>
</table>
Asset Condition Tips

- After conditions are entered – condition screen will be blank again.
- To check data select the road and select condition history
- OR Check on an inventory Report:
  - Report Pull Down -> Inventory
  - Select RSMS Road Conditions Asphalt
  - Click View Data Button
Using Inventory Report to Check Data
Displays All Roads With Conditions

<table>
<thead>
<tr>
<th>Dust Control</th>
<th>Edge Cracking (12/24n)</th>
<th>Longitudinal / Transverse Crack (1/4n)</th>
<th>Loose Aggregate</th>
<th>Patching / Potholes</th>
<th>Potholes</th>
<th>Roughness</th>
</tr>
</thead>
<tbody>
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<td>1 - Smooth</td>
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<td>2 - Somewhat Rough</td>
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Condition Forecasting Analysis

- Reports -> Repair Priority
- Select RSMS Forecasting
- Select Edit Button
More to Come with Forecasting

- Loading Assets
- Calculating Priority
- Selecting Repairs and Creating 10 Year Budgets
Notable Points

- Plan accuracy diminishes after 3-5 years i.e. years 6-10 are *rough* estimates

- Condition surveys *should be conducted every 2 years to update plan*

- Condition surveys are “windshield surveys” *not* detailed engineering or subsurface investigations
  - An RSMS analysis is a cost effective network level budgetary planning tool
  - An RSMS analysis *does not* provide project level engineering plans
Thank You

Questions?