DeIDOT Bridge Management Program

Jason Arndt, P.E.
DeIDOT Bridge Management Engineer
## Agenda

1. Background

2. Current State of Bridge Inventory

3. Key Issues Affecting Our Bridge Inventory

4. Bridge Asset Management
   - A. Deficiency Formula Prioritization Process
   - B. Bridge Preservation Mechanisms
   - C. Performance Measures
   - D. Effectiveness of Bridge Program
Maintain approximately 13,268 lane miles

~90% of all roads and 98% of bridges are State-owned

Bridge Structural Deficiency Percentage is in the top 5 in the nation among states

Manage 1,626 state-owned bridges

Inspect, maintain and manage:
- 37 dams
- 500 overhead sign structures
- 150 high mast lighting structures
- one parking garage
Bridge Management Section Core Functions

- Inspect Bridge, Dam, Cantilevered Traffic Signals, High Mast Lighting and Overhead Sign Structures
- Maintain Bridge, Cantilevered Traffic Signals, High Mast Lighting and Overhead Sign Structure Databases
- Maintain Bridge Load Ratings
- Process Overweight Vehicle Permits
- Maintain Pontis Bridge Preservation/Deterioration Models
- Prioritize Bridge Preservation Needs
- Respond to High Priority Reports
As of 1/1/15, we have 1,626 bridges in our inventory.
DeIDOT Bridge Management Program

Current State of Bridge Inventory

Condition of Bridge Inventory

Total of 1626 Bridges
2014 Bridge Performance

6.8% of Bridge Inventory is Structurally Deficient (SD)

25.6% of Bridge Inventory is Fair & Structurally Deficient (74.4% Good)
Key Issues Affecting Our Bridge Inventory

1. Corrugated Metal Pipes (CMP’s)
2. R/C Decks
3. Scour
4. Paint of Steel Bridges
5. Substructure Deterioration (Joints)
Key Issues Affecting Our Bridge Inventory

SD Breakdown of Key Issues

- CMP's: 80
- R/C Deck Issues: 9
- Scour: 7
- Paint of Steel Bridges: 7
- Substructure Deterioration: 5
- Misc.: 2
Key Issues Affecting Our Bridge Inventory

1. Corrugated Metal Pipes (CMP’s):

CMP Bridges account for ~14.5% of our inventory, but they account for ~72.3% of the number of Structurally Deficient bridges in our inventory.
Key Issues Affecting Our Bridge Inventory

1. Corrugated Metal Pipes (CMP’s):

Factors Affecting Past, Current & Future Condition of Our CMP Inventory

A. Dropped Bridges
   - Roughly 160 CMP Bridges Removed from Inventory in 80’s & 90’s

B. Found Bridges
   - 24 CMP Bridges Found in 2014 / 16 are SD
   - 12 CMP Bridges Found in 2015 / 8 are SD

C. Expected Design Life vs. Average Age of CMP Inventory
Key Issues Affecting Our Bridge Inventory

1. Corrugated Metal Pipes (CMP’s):
Factors Affecting Past, Current & Future Condition of Our CMP Inventory

![Bar chart showing expected design life and average age of inventory for different materials: Concrete, Steel CMP, HDPE, Aluminum CMP.](chart.png)
Key Issues Affecting Our Bridge Inventory

SD Breakdown of Key Issues

- CMP's: 80
- R/C Deck Issues: 9
- Scour: 7
- Paint of Steel Bridges: 7
- Substructure Deterioration: 5
- Misc.: 2
Key Issues Affecting Our Bridge Inventory

2. R/C Decks:

Factors Affecting Current & Future Condition of Our R/C Deck Inventory

A. Harsh Winters
   - Freeze/Thaw Cycles
   - Use of Deicing Agents
   - Snow Plow Damage

B. Inspection Limitations
   - Traffic Volume
   - Nighttime Vs. Daytime Lane Closures
   - Sound

C. Interstate Deck Bubble
   - Ten Year Outlook

D. Past Project Decisions
   - Repair Methods & Decisions
   - Material Selection
Deficiency Formula Prioritization Process

1. Bridge Inspections
   - Element Level Breakdown of Bridge
   - Condition State Assignment for Each Element
## DelDOT Bridge Management Program
### Bridge Inspections

#### Sample Bridge Element Data - Bridge 1-229B

<table>
<thead>
<tr>
<th>Elements</th>
<th>ID</th>
<th>ENV</th>
<th>UNITS</th>
<th>TOTAL</th>
<th>CS1</th>
<th>CS2</th>
<th>CS3</th>
<th>CS4</th>
<th>CS5</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Deck - Base</td>
<td>12</td>
<td>2</td>
<td>SF</td>
<td>35670</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Concrete Deck - Protected w/ Coated Bars</td>
<td>26</td>
<td>1</td>
<td>SF</td>
<td>860</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Reinforced Concrete Sidewalk</td>
<td>56</td>
<td>2</td>
<td>LF</td>
<td>1082</td>
<td>989</td>
<td>57</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Delineators/Drainpipes/Scuppers</td>
<td>68</td>
<td>2</td>
<td>EA</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Painted Steel Open Girder/Beam</td>
<td>197</td>
<td>2</td>
<td>LF</td>
<td>4720</td>
<td>0550</td>
<td>467</td>
<td>201</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Painted Steel Pin and/or Pin and Wanger Assembly</td>
<td>141</td>
<td>2</td>
<td>EA</td>
<td>40</td>
<td>0</td>
<td>16</td>
<td>22</td>
<td>21</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Reinforced Concrete Column of Pile</td>
<td>208</td>
<td>2</td>
<td>LF</td>
<td>114</td>
<td>115</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Reinforced Concrete Abutment</td>
<td>218</td>
<td>2</td>
<td>LF</td>
<td>150</td>
<td>24</td>
<td>68</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Reinforced Concrete Flex Cap</td>
<td>294</td>
<td>2</td>
<td>LF</td>
<td>940</td>
<td>929</td>
<td>9</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Strip Seal Expansion Joint</td>
<td>300</td>
<td>2</td>
<td>LF</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Compression Joint Seal</td>
<td>302</td>
<td>2</td>
<td>LF</td>
<td>140</td>
<td>130</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Open Expansion Joint</td>
<td>306</td>
<td>2</td>
<td>LF</td>
<td>77</td>
<td>98</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Elastomeric Bearing</td>
<td>310</td>
<td>2</td>
<td>EA</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Fixed Bearing</td>
<td>315</td>
<td>2</td>
<td>EA</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Reinforced Concrete Approach Slab w/ or w/o AC Only</td>
<td>301</td>
<td>2</td>
<td>EA</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Bridge Railings - Metal Decked</td>
<td>330</td>
<td>2</td>
<td>LF</td>
<td>1180</td>
<td>1182</td>
<td>10</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Bridge Railings - Reinforced Concrete</td>
<td>341</td>
<td>2</td>
<td>LF</td>
<td>800</td>
<td>589</td>
<td>157</td>
<td>0</td>
<td>412</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Bridge Railings - Metal Coated</td>
<td>344</td>
<td>2</td>
<td>LF</td>
<td>569</td>
<td>157</td>
<td>0</td>
<td>0</td>
<td>412</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Steel Fatigue</td>
<td>356</td>
<td>2</td>
<td>EA</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Deck Deterioration</td>
<td>357</td>
<td>2</td>
<td>EA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Deck Cracking</td>
<td>358</td>
<td>2</td>
<td>EA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Soffit (or Under Surface) of Concrete Deck or Slab</td>
<td>359</td>
<td>2</td>
<td>EA</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Soot</td>
<td>361</td>
<td>1</td>
<td>EA</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Section Loss</td>
<td>363</td>
<td>1</td>
<td>EA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Erosion</td>
<td>364</td>
<td>1</td>
<td>EA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Painted Steel Diaphragm</td>
<td>365</td>
<td>1</td>
<td>EA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
<tr>
<td>Reinforced Concrete Wingwalls</td>
<td>366</td>
<td>2</td>
<td>LF</td>
<td>72</td>
<td>71</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>For Notes See MSPE Report</td>
</tr>
</tbody>
</table>

Total Elements: 27
Deficiency Formula Prioritization Process

2. Preservation Actions (Work) & Costs
   - Preservation & Deterioration Models
   - Lowest Long-Term Cost
   - Applied to Each Condition State for Each Element

3. Recommended Work & Associated Cost
   - Cost for recommended work is calculated for each bridge
   - Deficiency List $1,500 Threshold
Deficiency Formula Prioritization Process

4. Deficiency Formula
   - Calculated for each bridge on Deficiency List
     - Bridges ranked by Deficiency Points

5. Deficiency Formula Factors
   - Conditional Deficiencies (50%)
   - Functional Importance (50%)
Deficiency Formula Prioritization Process

- Hist Sign/FC: 10%
- Func Obsolete: 0%
- Truck AADT: 10%
- AADT: 0%
- Detour Length: 10%
- Functional Class: 10%
- Load Capacity: 10%
- Sour Critical: 5%
- Structurally Deficient: 15%
- Benefit-Cost Ratio: 5%
- Health Index: 25%
### DelDOT Bridge Management Program

#### Delaware Department of Transportation

#### Delaware Deficiency Points - 2016 Del Formula

<table>
<thead>
<tr>
<th>#</th>
<th>Bridge #</th>
<th>Dist</th>
<th>Descript</th>
<th>Des-City</th>
<th>NBI</th>
<th>Length</th>
<th>Gage</th>
<th>Suffix</th>
<th>Benefit</th>
<th>Cost</th>
<th>Health</th>
<th>PGI</th>
<th>Scour</th>
<th>Critical</th>
<th>Flood</th>
<th>Debris</th>
<th>History</th>
<th>Yrs</th>
<th>Practic</th>
<th>Track</th>
<th>A/DT</th>
<th>Item</th>
<th>DF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>240-1819</td>
<td>1.6</td>
<td>1/22/12</td>
<td>DelDOT Ditching</td>
<td>S</td>
<td>12.5</td>
<td>140066</td>
<td>145083</td>
<td>NA</td>
<td>11</td>
<td>1.96</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>267-195</td>
<td>3</td>
<td>1/22/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>35260</td>
<td>35260</td>
<td>NA</td>
<td>11</td>
<td>0.99</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>267-197</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>61650</td>
<td>61650</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>267-199</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>110000</td>
<td>110000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>267-201</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>150000</td>
<td>150000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>267-203</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>180000</td>
<td>180000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>267-205</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>180000</td>
<td>180000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>267-207</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>180000</td>
<td>180000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>267-209</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>180000</td>
<td>180000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>267-211</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>180000</td>
<td>180000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>267-213</td>
<td>3</td>
<td>1/27/12</td>
<td>Beam Steel Bridge</td>
<td>S</td>
<td>12.5</td>
<td>180000</td>
<td>180000</td>
<td>NA</td>
<td>11</td>
<td>1.31</td>
<td>NA</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **DF:** Deficiency Factor
- **Bridge #:** Bridge Identification Number
- **Dist:** Distance from Beginning of Bridge
- **Descript:** Description of Bridge
- **Des-City:** Description of City
- **NBI:** National Bridge Inventory Number
- **Length:** Length of Bridge
- **Gage:** Number of Gages
- **Suffix:** Suffix of the Bridge
- **Benefit:** Benefit of the Bridge
- **Cost:** Cost of the Bridge
- **Health:** Health Rating of the Bridge
- **PGI:** Performance Grade Index
- **Scour:** Scour Vulnerability Index
- **Critical:** Critical Vulnerability Index
- **Flood:** Flood Vulnerability Index
- **Debris:** Debris Vulnerability Index
- **History:** History of the Bridge
- **Yrs:** Years Since Last Inspection
- **Practic:** Practic Rating of the Bridge
- **Track:** Track Rating of the Bridge
- **A/DT:** ADT Rating of the Bridge
- **Item:** Item Rating of the Bridge
- **DF:** Deficiency Factor

**Notes:**
- The table above outlines the deficiencies and ratings for various bridges in Delaware, providing critical information for maintenance and prioritization.
- Each bridge is rated on various factors such as NBI, Length, Gage, Suffix, Benefit, Cost, Health, PGI, Scour, Critical, Flood, Debris, History, Years Since Last Inspection, Practic, Track, A/DT, Item, and DF.
- The DF column indicates the level of deficiency, with higher numbers indicating higher deficiencies.
- This data is crucial for bridge management planning and prioritization efforts.
Bridge Preservation Mechanisms

1. In-House Maintenance
   A. CMP Culvert Replacements
   B. Minor Concrete Repairs
   C. Minor scour or erosion repairs

2. Structure Maintenance Contracts (SMC’s)
   A. Deck Patching
   B. Joint repair/replacement
   C. Minor Bridge Rehab Work
   D. Emergency Bridge Repair Work

3. Bridge Design
   A. Major Bridge Rehab Work
   B. Bridge Replacement
DelDOT Bridge Performance Goals

<5% of Bridge Inventory is Structurally Deficient (SD)

<25% of Bridge Inventory is Fair & Structurally Deficient (>75% Good)
**Effectiveness of Bridge Program**

**2014 Bridge Performance**

- 6.8% of Bridge Inventory is Structurally Deficient (SD)
- 25.6% of Bridge Inventory is Fair & Structurally Deficient (74.4% Good)

**DelDOT Bridge Performance Standards**

- <5% of Bridge Inventory is Structurally Deficient (SD)
- <25% of Bridge Inventory is Fair & Structurally Deficient (>75% Good)
Effectiveness of Bridge Program

Improving the Bridge Program

Need to address bridges in Fair Condition sooner and more efficiently before they become SD

Possible Options:

A. Modifications to the prioritization process
B. More emphasis on Preventative Bridge Maintenance
C. Addressing CMP’s Quicker
D. Corridor/Zone bridge rehab projects
E. Review of other DOT’s Processes
F. Review of Inspection Procedures
Conclusion:

Need a defined Bridge Management process
- Systematic process w/ results that are reproducible
- Allow for some flexibility
- Funds are limited - A successful Bridge Management process will aid in justifying and maximizing bridge funding
- Using a defined process allows for less political intervention and scrutiny
- Need performance measures to track progress and evaluate the effectiveness of the Bridge Management Program
- Periodically review & evaluate effectiveness of the prioritization process
Questions?

Contact Info:
Jason Arndt, P.E.
Bridge Management Engineer
Delaware Department of Transportation
(302) 760-2309
Jason.Arndt@state.de.us