

# Full-Depth Recycling (FDR)

## INDOT Perspectives, Lessons Learned and Future

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# Outline

- Very Brief INDOT FDR History
- INDOT Pavement Situation & FDR Business Case
- 'Restart' of FDR Pavement Approach
- Lessons Learned
- Future of INDOT FDR



# Very Brief INDOT FDR History

- SR 38, E of Dayton
- 1980s or 1990s?
- Appears to be lost to history at this time
  - Research continuing



# Very Brief INDOT FDR History

- SR 1, NW of Portland, IN
- CY2009
  - 2-lift HMA overlay on FDR layer
  - Included 3R-4R upgrade (Super 2?)
  - Performed as well as 2-lift HMA overlay
  - Expensive for what we needed vs. got
  - Cost more than I expected
    - Maybe should have?



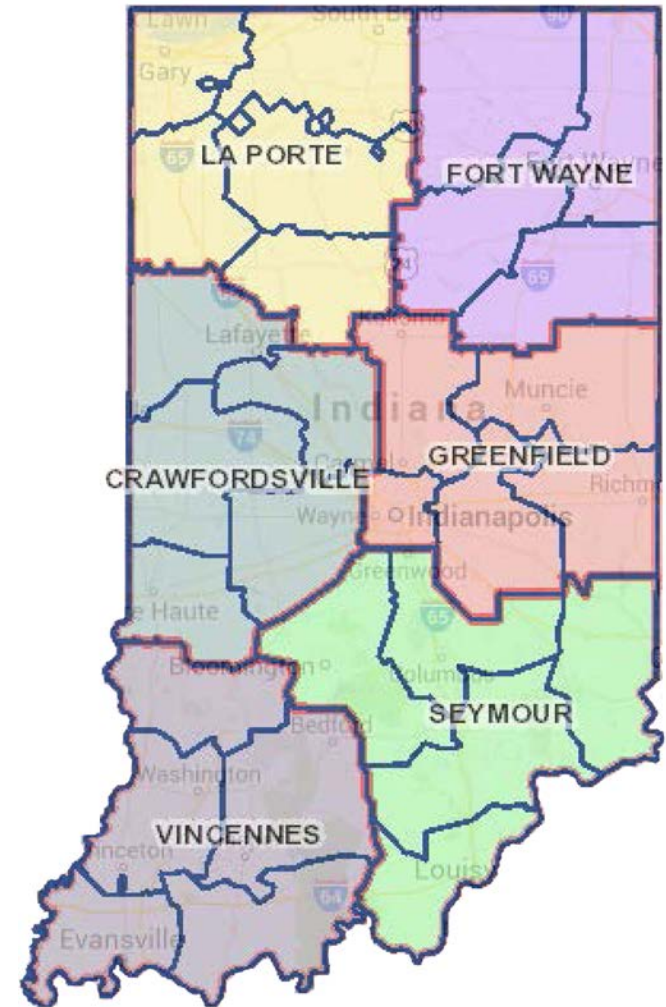
# INDOT Mission

**INDOT will plan, build, maintain and operate a superior transportation system enhancing safety, mobility, and economic growth.**



# INDOT Profile

- Six district offices
- 3,400 employees
- \$1 billion/annual capital expenditures
- 28,400 total roadway lane miles
- 5,300 INDOT-owned bridges
- Assists 42 railroads in planning & development of more than 3,880 miles of active rail lines
- Supports 69 Indiana State Aviation System Plan airports



# INDOT VALUES



## The Value of Values

- 1. Respect** — Treat others fairly. Value the individual skills, experience, diversity and contributions of fellow employees.
- 2. Teamwork** — Share information and seek input from co-workers and agency partners to achieve goals.
- 3. Accountability** — Take personal responsibility for actions and decisions.
- 4. Excellence** — Provide exceptional customer service through individual initiative, innovation and delivery of quality results.

Values are the core behaviors that all employees, as an organization, will support, promote and exhibit to achieve agency goals.



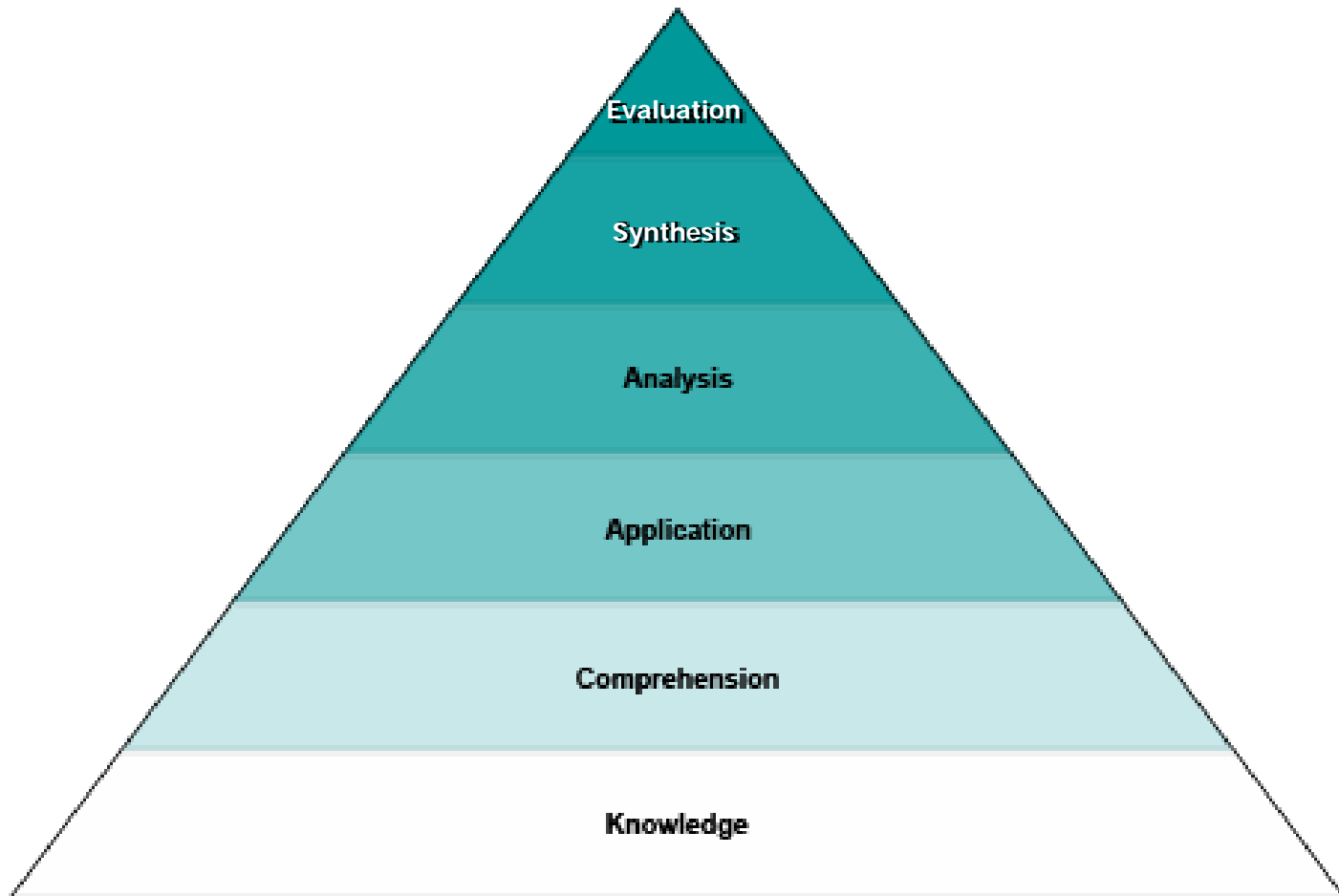
# INDOT FY 2015-16 GOALS

- **21st Century,** **One INDOT Results**
  
- **On-time and On-budget**
  - Deliver projects in accordance with key performance indicators and INDOT performance measures.
  - Deliver quality services according to identified work plans and within financial targets.
  
- **Take Care of What We Have**
  - Implement a plan that maintains steady improvement in pavement and bridge quality.
  - Ensure a commitment to safety.
  - Implement a talent management system that links strategy and operations to results.
  - Establish a culture of continuous improvement.
  
- **Customer Satisfaction**
  - Improve internal and external customer satisfaction.
  - Take an outside in view to ensure the highest level of customer service.





# Introductory concepts & framework



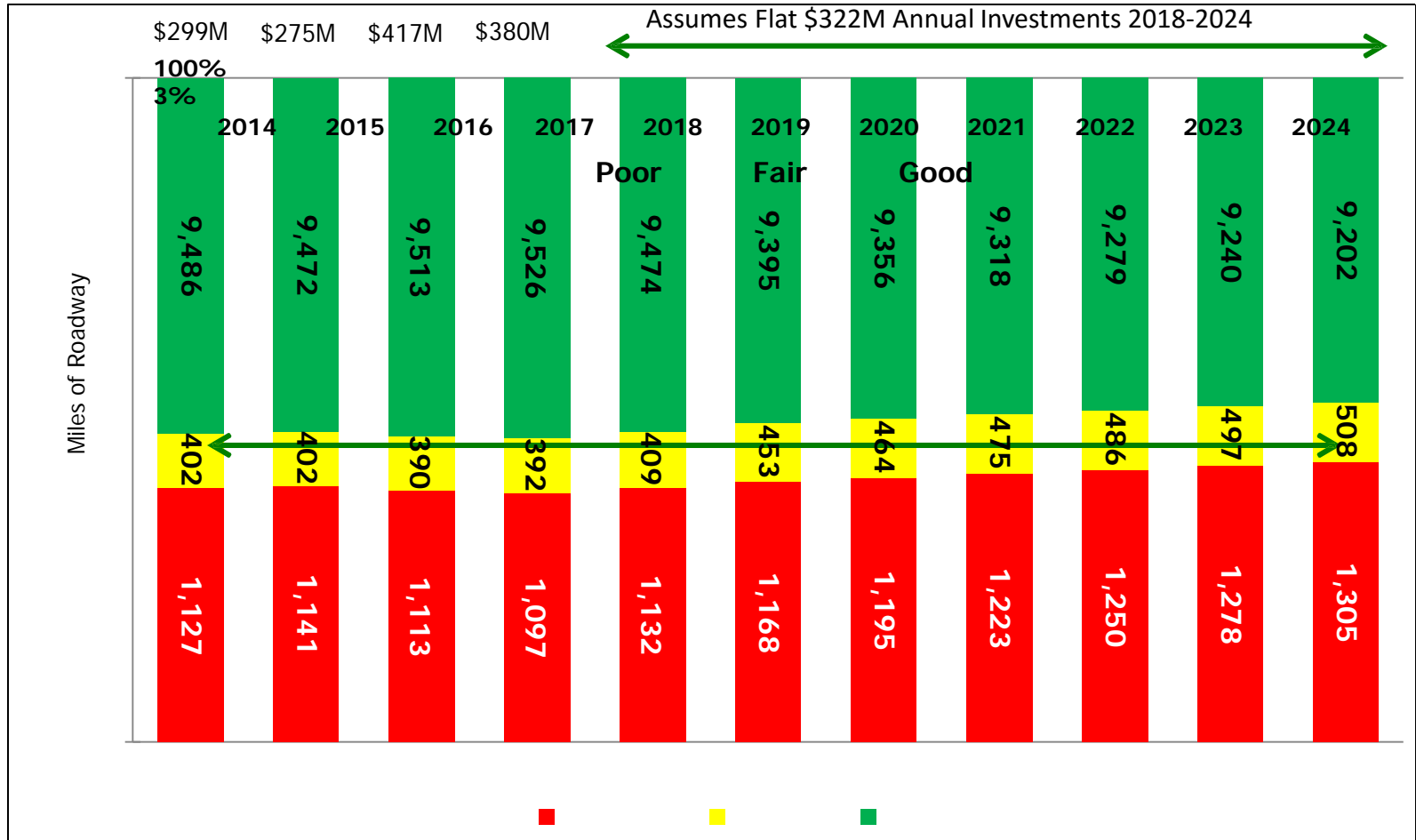
Bloom's Taxonomy of learning. Adapted from: Bloom, B.S. (Ed.) (1956) Taxonomy of educational objectives: The classification of educational goals. Handbook I, cognitive domain. New York ; Toronto: Longmans, Green.



# INDOT Pavement Situation



## Pavement Surface Conditions Over 10-Years for Current Funding Trends



Pavement condition should remain relatively static at the current investment levels.



# INDOT Pavement Situation



## Current Service Level

**11.4% Poor  
in 2024**

10-Years

**\$394M Annual Investment  
1,305 Miles of Poor Pavement**

## INDOT's Target Service Level

**≤7.5 % Poor  
in 2024**

10-Years

**\$498M Annual Investment  
826 Miles of Poor Pavement**

## INDOT's Recommended Service Level

**≤4.75 % Poor  
in 2034**

20-Years

**\$561M Annual Investment  
533 Miles of Poor  
Pavement**

What is the acceptable result for the taxpayer?



# Business Case

- **Home furnace repair/replacement**
  - Contractor #1:
    - Good service life and reliability
    - \$5,000
  - Contractor #2:
    - Good service life and reliability
    - \$3,400
  - Contractor #3:
    - Good service life and reliability
    - \$1,600



# Business Case

- **Home furnace repair/replacement**
  - Vote for which one would you use?
    - Contractor #1:
    - Contractor #2:
    - Contractor #3:



# Business Case

- **Why would a project's pavement scale of work be any different than home furnace repair/replacement**
  - Taxpayer funded?
  - \$170K, \$250K, \$450K, \$675K, \$950, or \$1.25 Million / Lane-mile of construction cost?
  - Assumed roughly similar service life and future maintenance cycles?



# Business Case

- **So which engineer's recommendation would you use?**
  - \$170K      Oops! Can't do it for this?
  - \$250K      Okay
  - \$375K      Even better!
  - \$675K      Same result, just more expensive
  - \$950K      Ditto, but even more expensive
  - \$1,250K    If only I won the Lottery



# Project Situations

- SR 1 W of Portland, IN & SR 227 NW of Richmond, IN
- CY2014
  - \$170K option
    - Not including significant cost increases
  - 150 psi FDR stress capacity
  - 2-lift HMA overlay





# Project Situations

- Tricky subgrade conditions?
- May have not withstood construction loads?
- Significant risk w/low bid vs. necessary FDR 'mix' design supplemental materials
- Neither contractor, nor INDOT may have fully understood issues and consequences
- Significantly redone (mostly?) at my cost
- Proof of Concept/relearning & refining technological approach



# Project Situations

- I-74
- FY2014-15
  - \$11 Million (total project)
    - FDR for MOT shoulder only
  - Revised Specification
  - 1-lift HMA overlay



# Project Situations

- Supplemental aggregate types & quantities vs. low bid generated challenges
  - Lots of contractor risk
  - Increased cost to me
- FDR shoulder performed well w/MOT traffic loads
- Improve & refine technological approach and bidding approach
- Much less expensive than shoulder

reconstruction

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A Success!



# Owner's Considerations

## ■ Informed Owner's Considerations

- What we want:
  - Not necessarily cheapest construction cost
  - Best operating-owning cost/service life ratio (\$s/Yr)
    - Acceptable service level(s) & service life
    - Least cost to own/operate highway facility
  - True partnership with our partners



# Project Situations

- SR 59 vic. Waveland, IN

CY2015

- \$325K option
- 500 psi FDR stress capacity
- 2-lift HMA overlay



# Project Situations

- 1-year AAR: looks good (so far)
- Still learning corrective aggregate and stabilizing agent bidding balance
- A little bit expensive, but less than alternatives
  - Within acceptable costs (if performs as expected)
- Success, at least at 1-yr



# Project Situations

- SR 14 W of US 41
- CY2015
  - \$210K option
  - 400 (variable) psi FDR stress capacity
  - 1-lift HMA overlay



# Project Situations

- Appears to not be performing well
- Risk w/low bid vs. necessary FDR 'mix' design supplemental materials
- Construction loads?
- Relatively thin overlay
  - Maybe 2&1/2" surface?
  - Overloaded truck route?
- Forensic assessment to be accomplished
- Refining technological approach





# FDR Concept Issues

- FDR processed materials mix ultimate strength?
  - FDR layer mix design
    - Allow for designed-planned vs. actual (post-bid field calibration)
- Cement vs. Asphalt Emulsion
  - Unique Soils May Determine Stabilization Material
  - Maybe contractor preference in some cases
    - Two different specification subsections



# FDR Concept Issues

- FDR layers, planned vs. actual
  - 14" mixing layer effectiveness?
  - 14" vs. 2 x 7" layer compaction
- More extensive project design testing
- Corrective aggregate estimate in design
- Variable stabilizing agent quantities
- IDM Pavement Design Chapter update
- MOT Loads



# FDR Concept Issues

- Construction traffic loads
  - Shear and bending of bonded layers
    - Extreme fiber stress equals  $MC/I$
    - Moment of Inertia equals  $bh^2/12$
- Not sure this was fully understood by all parties in earlier projects
  - Still not sure fully understood



# FDR Concept Issues

- Competent Contractor concept
  - Contractor is expert at what he/she does
    - Perhaps more than me/my staff
    - Knows how to do what is being done perhaps better than me/my staff
  - Should know potential consequences of actions relative to finished product and its life-cycle costs
    - Pre-damaging FDR layer?
  - Capping layer(s) make-up and thickness?



# FDR Concept Issues

- Stress of extreme fiber under various loading?
  - During FDR operations?
  - During capping/paving operations?
    - Triaxles? **My observations!**
  - Ramifications for conventional paving operations?



# Future of INDOT FDR

- INDOT will continue to better develop and utilize Full-Depth Recycling
  - Lots of lessons learned already in very short period of time
  - Lots of challenges still ahead
  - Still appears to be best option available in many highway project situations
  - Other options will be used when better able to effectively and efficiently achieve project objective



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