MEPDG & HIP, CIR and FDR Recycling

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Project Situation & Business Case

- **Cancer Treatment Protocols**
  - How often do they change?
  - How current do you want your treatment to be?
- **Bridge Design Methods**
  - WS, LF, LRF, FE, etc., how often did they change?
  - How well do you want your bridge designed?
- **Pavement**
  - How cost-effective do you want your pavements?
  - How much more $ are you willing to pay for laxity?
  - How much service life & reliability do you want?

Project Situation & Business Case

- **Cancer Treatment Protocols**
  - Maybe every 5-years(+/-)
  - As current as can be to improve survival %!
- **Bridge Design Methods**
  - 1982-WS? Today-LRF, FE, etc.
  - As well as can be!
- **Pavement**
  - As cost-effective as can be!
  - I suspect $0
  - As much as can be effectively obtained

Project Situation & Business Case

- **Pavement**
  - Is a long-term consumable, i.e., it wears out
  - Designed to be consumed as cost-effectively as possible
  - Designed to provide acceptable levels of serviceability
  - Designed to obtain least cost to own/operate
  - Designed to be maintainable at relatively low cost
  - Almost infinite variability of applications
  - Any other goals?

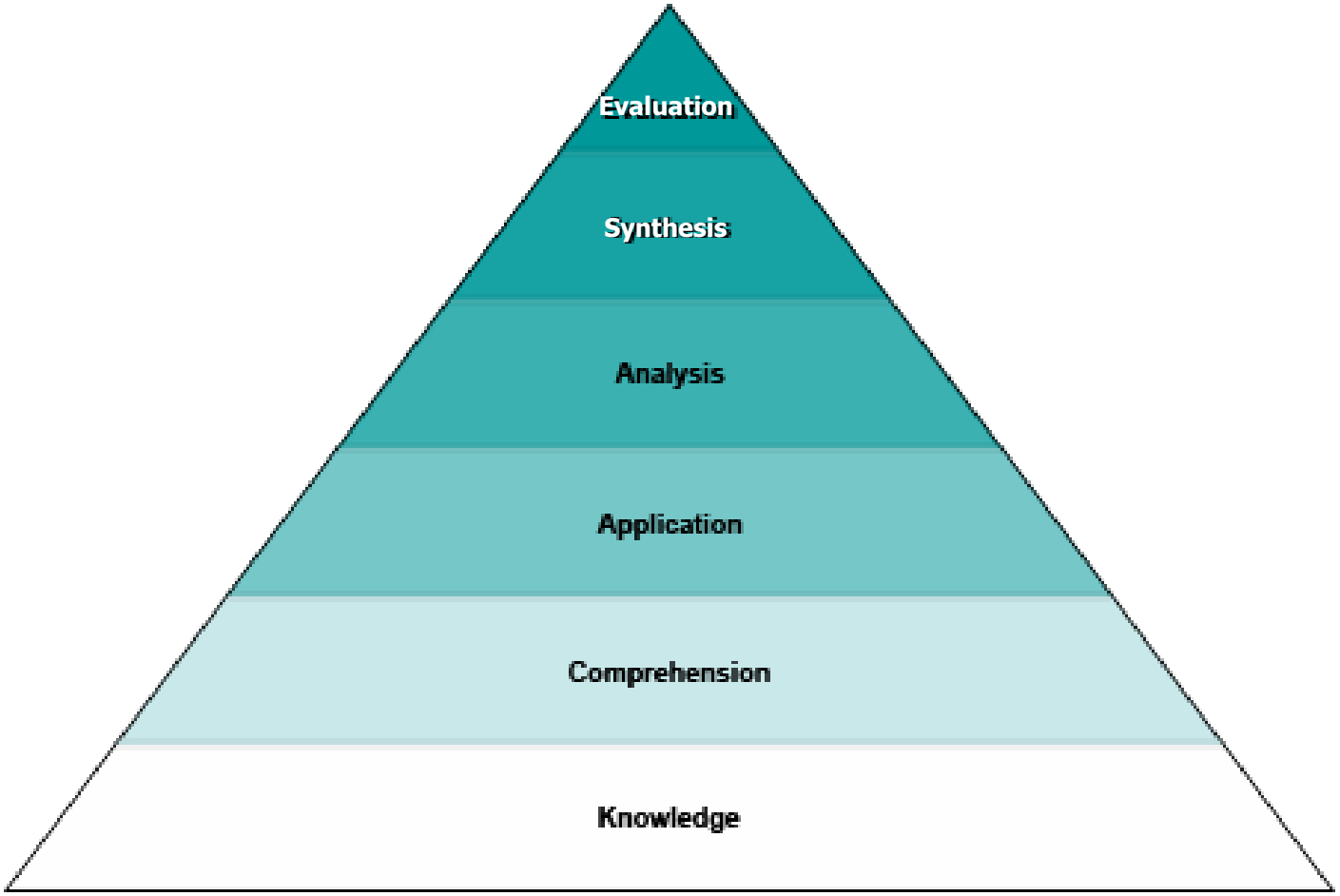
Project Situation & Business Case

- **To obtain what those goals;**
- **A Pavement Design Engineer**
  - Must possess broad pavement knowledge
  - Must possess great depth of pavement knowledge
  - Must possess well-honed critical reasoning skills
  - Must present a well-reasoned position
  - Must possess broad understanding of other related issues, i.e., materials, construction techniques, hydraulics, et al.

Indiana
A State that Works

  - Any other requirements?

The Stage



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.

Universal Intellectual Standards

- Clarity
- Accuracy
- Precision
- Relevance
- Depth
- Breadth
- Logic
- Significance
- Fairness

Testing the quality of your thinking. .

.

A good start…

What standards might you add for your discipline?

Project Situation & Business Case

- **INDOT Project Situation & Business Case … … … Mr. Holtz**

INDOT Mission

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

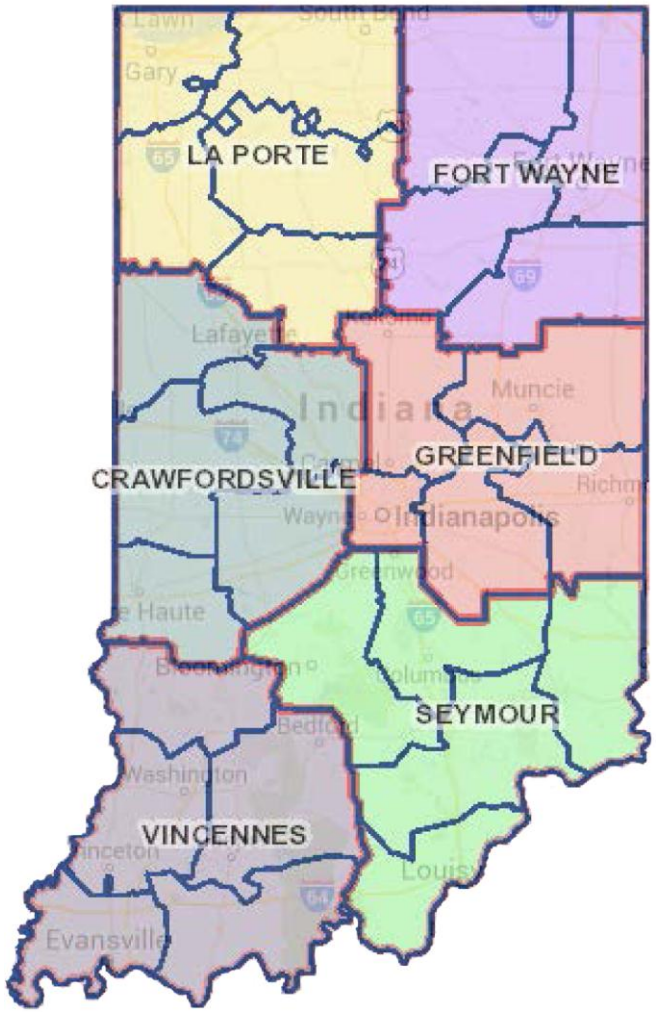
INDOT FY 201516 GOALS

- **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.

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.

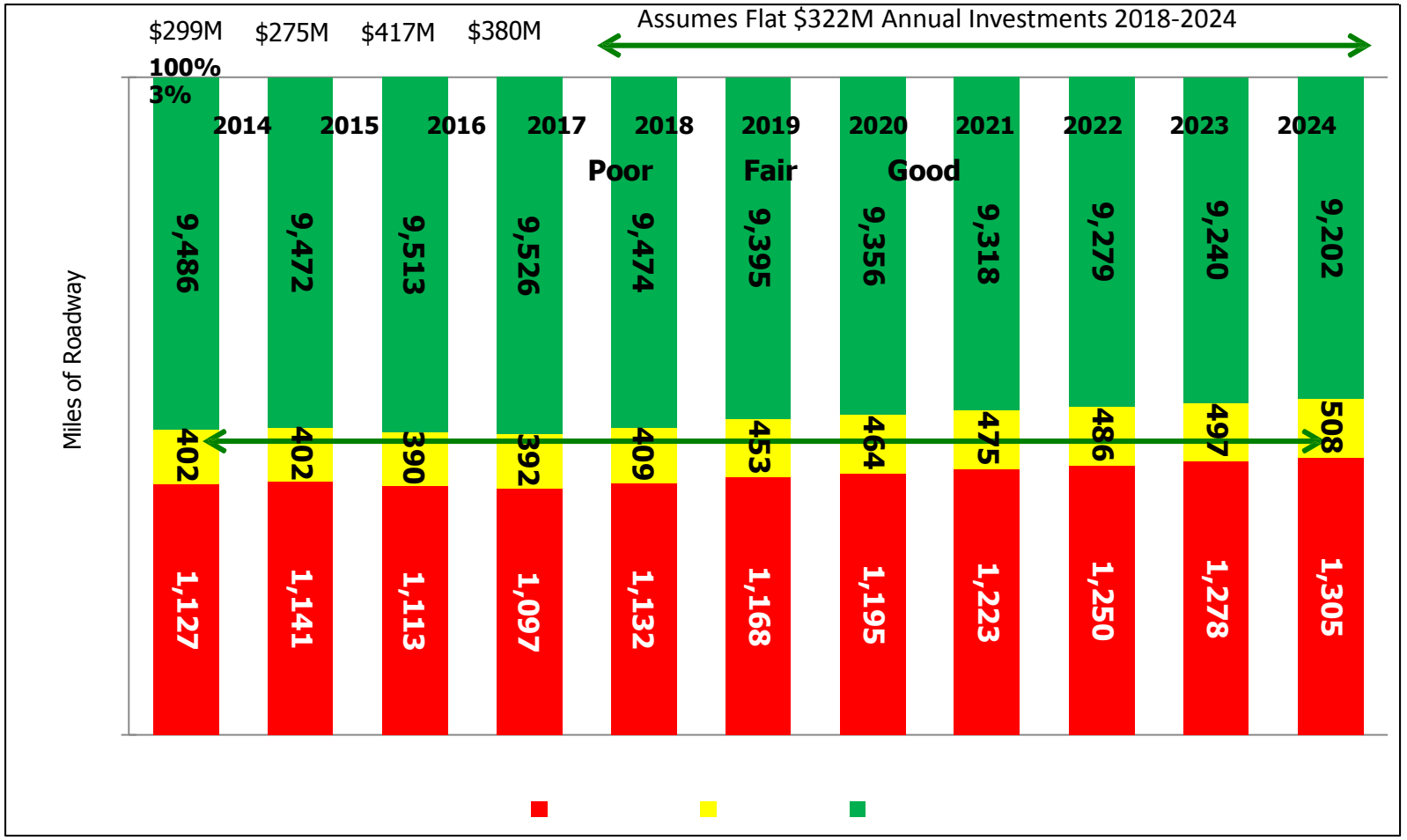
3. Accountability — Take personal responsibility for actions and decisions.

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.

RESULTS: ROADWAYS

Pavement Surface Conditions Over 10-Years for Current Funding Trends



IN policy for CAFR reporting, minimum requirement (12.2%)

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

ROADWAYS: PRIORITIES

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?

Project Situation & Business Case

- Owner Expectations
- & Our Professional Obligation to Provide
  - More with less
  - Best Option
  - Clear Communication
  - Well & Thoroughly Reasoned
  - BEST VALUE!

Current Pavement Asset

- **COA screening and evaluation**
  - Engineering economics intervention point optimization
    - Echelons of treatments

Routine maintenance	<$1K/ln-mi/svc yr?
Reactive maintenance	? / TBD
Preventative maintenance	$5K/ln-mi/svc yr?
Functional/smoothness treatments	$7-15K/ln-mi/svc yr?
Structural minor rehab treatments	$10-25K/lm-mi/svc yr(?)
Structural major rehab treatments	$25-35K/ln-mi/svc yr(?)
Structural pavement replacement	$1Mil/ln-mi/svc yr(+)(?)

Project Situation & Business Case

- **So which solution recommendation would you use?**
  - A Non-substantiated Solution?
  - A Singularly Presented Solution?
  - A Best Guess Solution?

Project Situation & Business Case

All else equal,

- **which engineer's recommendation would you use?**
  - A $33 Million Solution?
  - A $22 Million Solution?
  - A $9 Million Solution?

Owner's Considerations

- **Owner's Desired Outcome**
  - Best Service Life/Cost ratio
  - Acceptable Service Level
  - Least Cost to Own/Operate
  - BEST VALUE!

Project Situation & Business Case

- **HIR, CIR, FDR may be viable options to achieve my desired outcomes!**
  - INDOT's technical state of knowledge
  - INDOT's practical experiences to-date

Hot In-Place Recycling (HIR)

HIR Description

- Asphalt Stabilization

  asphalt rejuvenator
- Maximum depth: ~ 2.0”
- Reclaimed asphalt pavement (RAP) mixed with additives
- Resurfacing is required

Hot In-Place Recycling (HIR)

Re-Heat Process

Pavement Condition

Before 08/2012

After 08/2012


08/29/2012


08/29/2012


08/29/2012


08/29/2012


08/29/2012


08/29/2012


08/29/2012


08/29/2012


08/29/2012

Pavement Condition

08/2012

06/2014

Hot In-Place Recycling (HIR)

Heater-Scarification Process


08/30/2012

Attempted Contract

- R-34719 in LaPorte District
- SR-16 from US 231 to US 421

  (heater-scarification process)
- Project did not sell and surface treatment was changed to a PM HMA overlay
- No HIR projects programmed at present

Cold In-Place Recycling (CIR)

B-34291

US-40

Crawfordsville District

CIR Description

- Asphalt Stabilization
  - emulsified asphalt
  - expanded (foamed) asphalt
- Maximum depth: ~ 5.0”
- Reclaimed asphalt pavement (RAP) mixed with additives
- Resurfacing is required

Pavement Condition

- Aged surface
- Minor rutting
- Heavy patching due to stripped HMA layer

Pavement Milling

- Milling operation will cut up to 5” depth and windrow material
- Can incorporate virgin aggregate during milling operation

Stabilization

- Water, additives and stabilizing materials are incorporated into the windrow material
- The windrow is re-milled to mix the materials

Spreading

- The stabilized material is picked up by a windrow elevator
- The paver spreads the material
- Compaction is achieved using steel drum and pneumatic tire rollers

Overlay Preparation

- The CIR is tacked prior to the HMA overlay
- Paving commences
  - US-40 had a 165 lb/sys 9.5 mm surface atop the CIR base

Lessons Learned

- Insufficient number of pavement cores.
  - One per mile for mainline *and* shoulder
- Consideration of in-place shoulder thickness for MOT
- Option of asphalt emulsion as a stabilizer choice
- Inclusion of profile milling to assist in achieving overlay smoothness

CIR Project Summary

- Past (asphalt emulsion stabilizer)

  1986: RS-16019 (SR-38) in Crawfordsville District

- Present (asphalt emulsion stabilizer)

  2014: B-34291 (US-40) in Crawfordsville District

- Future

  No CIR projects programmed at present

Full-Depth Reclamation (FDR)

R-30185

SR-1 and SR-227

Greenfield District

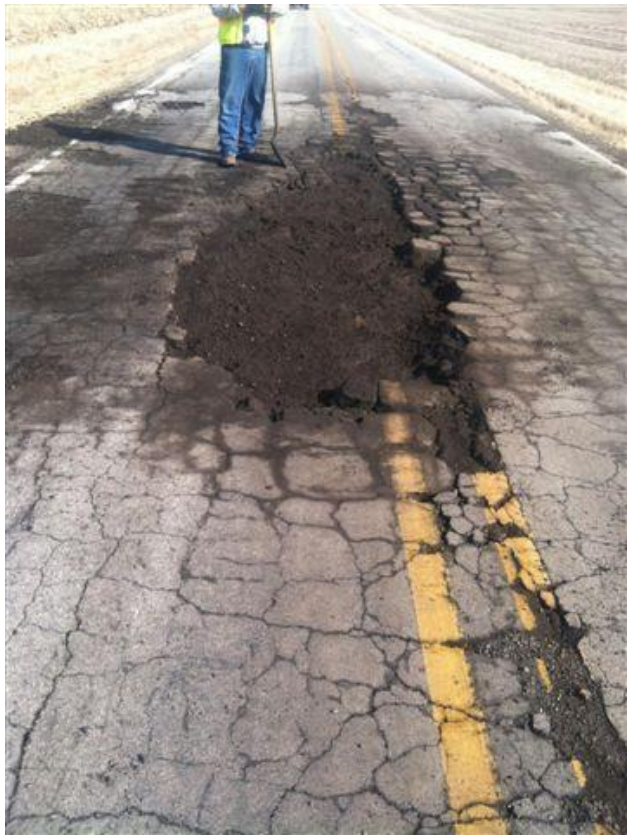
FDR Description

- Asphalt Stabilization
  - emulsified asphalt
  - expanded (foamed) asphalt
- Chemical Stabilization
  - Portland cement, slag cement, lime or fly ash
- Maximum depth: ~ 14.0”
- Reclaimed Base Course (RBC) mixed with additives
- Resurfacing is required

Pavement Condition

SR-1 Before

SR-227 Before



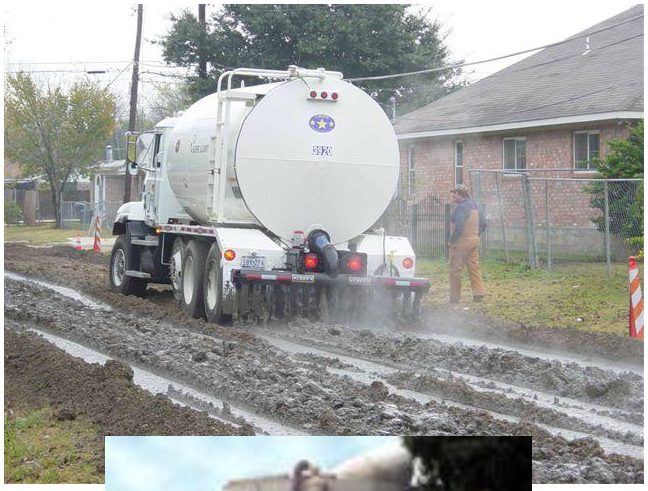
Pavement Pulverization

- Reclaimer pulverizes the pavement up to 14” depth
- 100% passing the 2” sieve and 55% passing the #4 sieve
- Can incorporate virgin aggregate during pulverization operation

RBC Stabilization

- Water, additives and stabilizing materials are incorporated into the RBC
- The RBC is re-pulverized to mix the materials
- The stabilized RBC is compacted

RBC Stabilization



- Fugitive dust control can be an issue with cement
- Slurry or use of curtains can limit dust exposure
- Asphalt stabilizers include asphalt emulsion or foamed asphalt cement


10/17/2014

Compaction

- Vibratory pad-foot rollers are used to compact the stabilized RBC
- Steel drum rollers are used to "seal" the stabilized RBC after having been shaped

Overlay Preparation

- The compacted RBC is shaped by a motor grader
- The RBC is cured and proof-rolled
- A profile mill is applied to provide texture and improve the overlay smoothness

Overlay Preparation

- The milled RBC base is lightly swept
- A tack coat is applied
- Paving commences
  - SR-1 had 4” HMA atop 150 psi cement stabilized FDR
  - SR-227 had 1.5” HMA atop 250 psi cement stabilized FDR

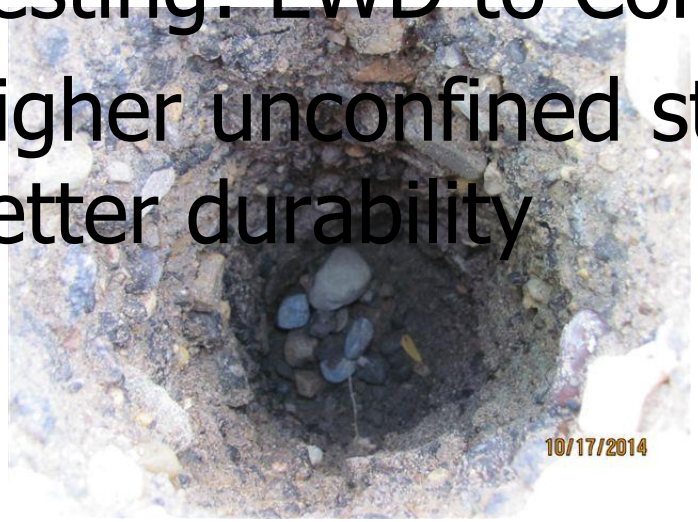
Pavement Condition

SR-1 After (poor subgrade)

SR-227 After (poor subgrade)

Lessons Learned

- Insufficient number of pavement cores
  - One per mile for mainline *and* shoulder
- Geotechnical considerations
- Corrective aggregate
- Testing: LWD to Cores to Proof-Roll.
- Higher unconfined strengths to provide better durability



FDR Project Summary

- Past (asphalt emulsion stabilizer)
  - 2007: M-29456 (SR-1) in Greenfield District
- Present (cement stabilizer)
  - 2014: RS-31502 (I-74) in Crawfordsville District
  - 2014: R-30185 (SR-1, SR-227) in Greenfield District
- Future
  - 2015: R-34351 (SR-14) in LaPorte District
  - 2015: RS-38002 (SR-59) in Crawfordsville District

Mechanistic-Empirical Pavement Design Guide (MEPDG)

Design Considerations

What are the properties?

- The biggest question that we have is how to represent the recycled layer within M-EPDG.
- Every application and situation is different.
- Partner with the industry to gather enough information to perform an initial analysis.

Industry Provided Info

Table 1

HIP Effectiveness

ARA 1P

6/22/2011

	Average		
	Cores	Heated	Treated
Bulk	2.329	2.291	2.381
Max	2.536	2.549	2.504
AV	8.2	10.1	4.9
Density	91.9	89.9	95.1
Stability	2155	4258	3967
Flow	26	11.7	12.7
% Bit	4.8	4.8	5.9
Vis	90,735	>200,000	71,667
Pen	14	10	17
Hamburg Rut*			3.56mm
TSR	N/A	79.6	85.8

*20,000 Cycles

Industry Provided Info (cont.)

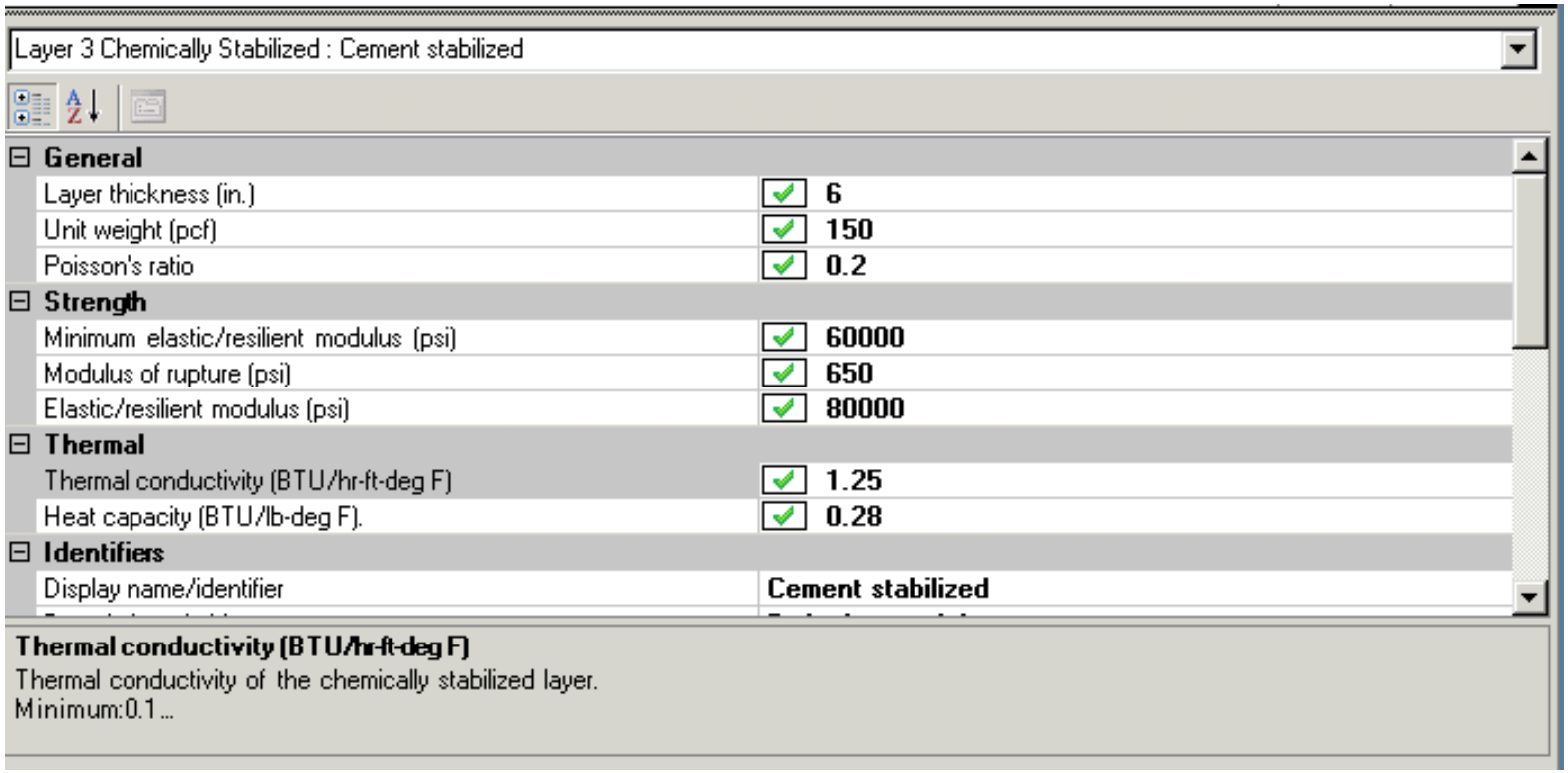
- **Make an effort to get independent 3rd party testing from the industry, that gives enough information to model in AASHTOWare PavementME©.**
- **Use the information that we have available from INDOT research, technical experts, Purdue, etc.**

Modeling in ME

- **HIR, CIR – Model as an existing HMA layer, entering the air voids, unit weight, gradation, etc. from the representative testing sample. Dynamic Modulus is level 3 entry.**
- **FDR – Model as a stabilized layer (aggregate, asphalt or cement) using the resilient modulus for the representative testing sample.**

ME inputs - FDR

Modeled as a Cement Stabilized Layer

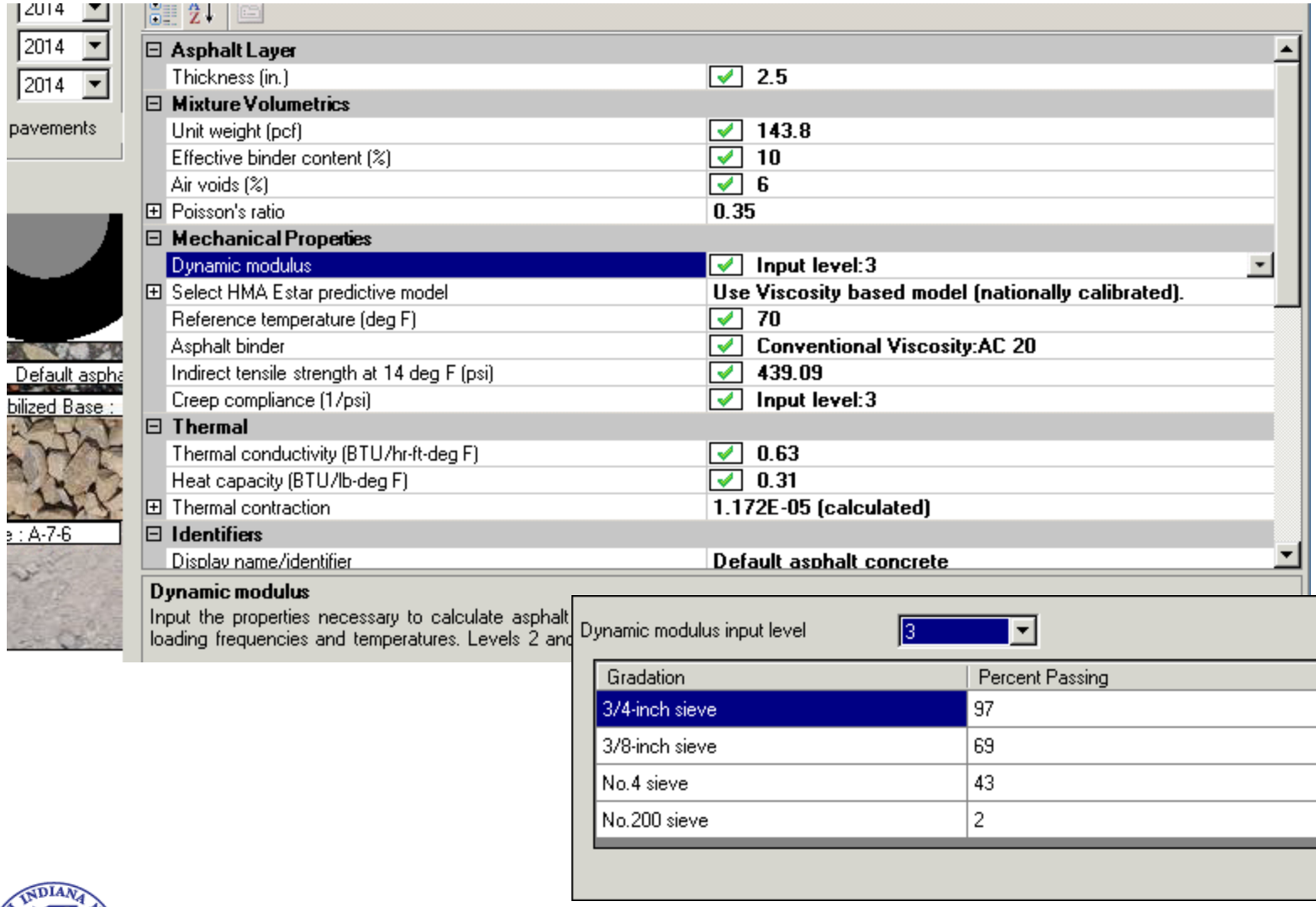


ME inputs - FDR

Modeled as a Asphalt Stabilized Layer

- **How do you analyze a foamed asphalt or emulsion based option?**
- **These options have not been completed on INDOT projects.**
- **Propose something with good engineering judgment and INDOT will work with you.**

ME inputs – HIR and CIR



Limitation to ME analysis

- **Since the software only allows one existing layer, you may have to enter a new flexible layer in order to analyze the CIR and HIR options.**
- **FDR should be looked at for cement stabilization and foamed asphalt or emulsion. The asphalt and emulsion options are not easily modeled in the software.**

Other issues that have effect

- **Is you pavement section more than 14” thick? If yes, then FDR is not an option if you cannot mill off asphalt material to make the section less than 14”.**
- **Do you have a high water table issue? Work with INDOT Geotechnical Engineers to see how this can be dealt with and still recycle the pavement.**

Other issues that have effect

- **Do you have a unique specification ready? Should it be modified for your project? Be prepared to be part of this process.**
- **Be ready to explain the data that you used, the assumptions that you made, the processes that you used.**
- **Take ownership of your design.**

Questions?

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