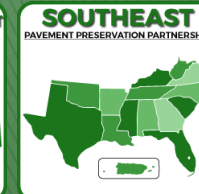
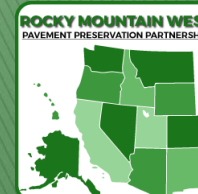


# Overview of ARRA Resources (Tool Box)

Stephen A (Steve) Cross, PhD, PE  
*S Cross & Associates, LLC*  
Technical Director  
Asphalt Recycling & Reclaiming Association



# ARRA Disciplines

- Cold Planing (CP)
- Hot In-place Recycling (HIR)
- Cold Recycling (CR)
  - Cold In-place Recycling (CIR)
  - Cold Central Plant Recycling (CCPR)
- Full Depth Reclamation (FDR)
  - Soil & Base Stabilization

# Why In-Place Recycling

- ▶ Reuses 90–100% of existing materials, in-place
- ▶ Costs 20–50% less than traditional methods
- ▶ Produces up to 90% less greenhouse gasses
- ▶ Reduces user delays
  - 20 to 40% faster construction
- ▶ Proven Performance

# Cold Planing

- ▶ Surface or grade preparation for other rehabilitation techniques
- ▶ Temporary driving surface
- ▶ Improving ride quality
- ▶ Fine & Micro Milling





# Hot In-place Recycling

- ▶ HIR uses heat to soften the existing asphalt pavement
- ▶ Scarifies the heated, softened pavement
- ▶ Add rejuvenating agent and additives (if desired)
- ▶ Mix and place rejuvenated mix
- ▶ Compact pavement in one continuous process.
- ▶ Usually requires surface course



# Types of Cold Recycling

- ▶ Cold Central Plant Recycling (CCPR)
- ▶ Cold In-Place Recycling (CIR)
  - Also called partial depth cold in-place recycling





# Cold Central Plant Recycling

## Clean Rap = New Pavement:

- Stockpiled and kept clean
- Crushed RAP to gradation
- Mixed with bituminous recycling agent in central plant
- Transported to lay down area
- Paved as a recycled mix
- Compacted to specified density
- Readied for surface treatment

*From RAP*



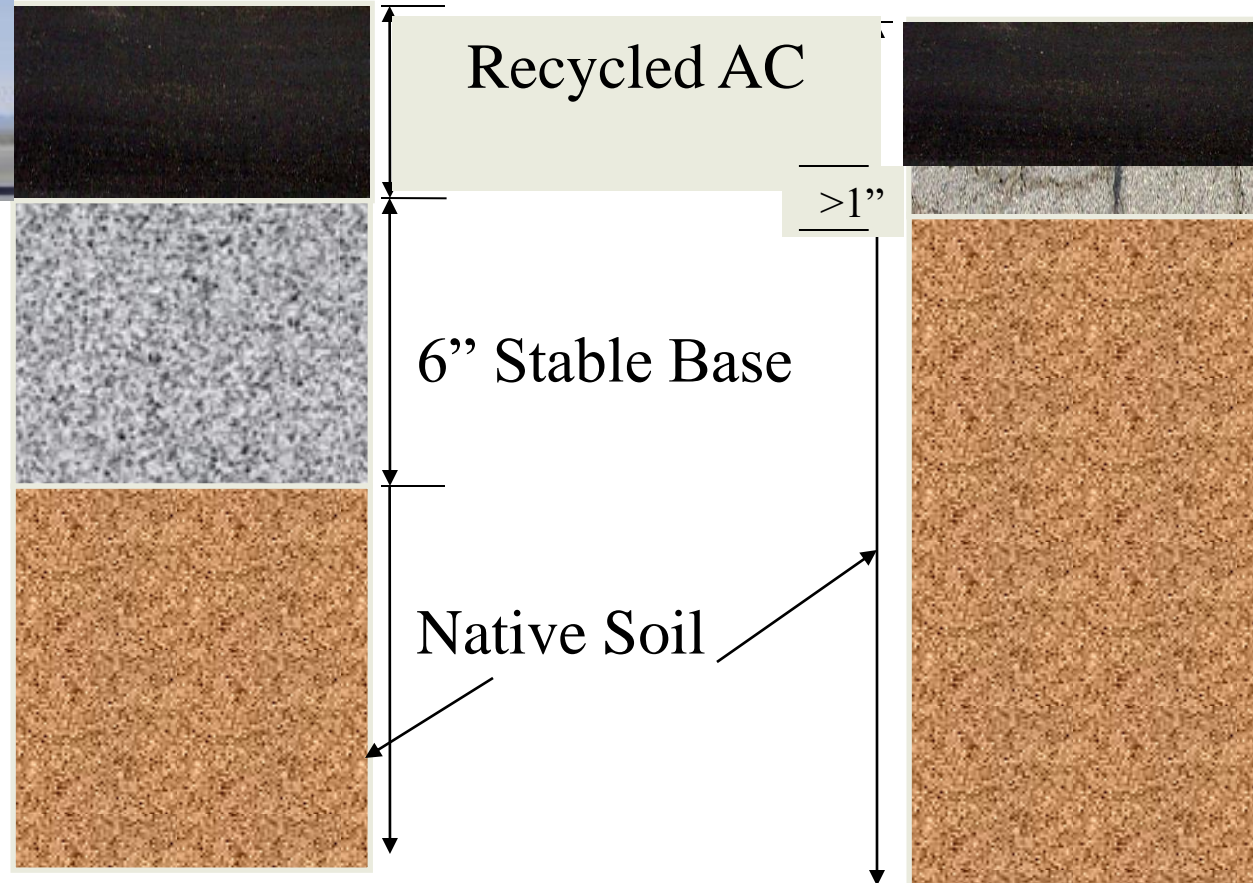
*to Pavement*

# Cold In-place Recycling



Recycle AC to:

- Stable Base
- Within 1" of less Supportive Material

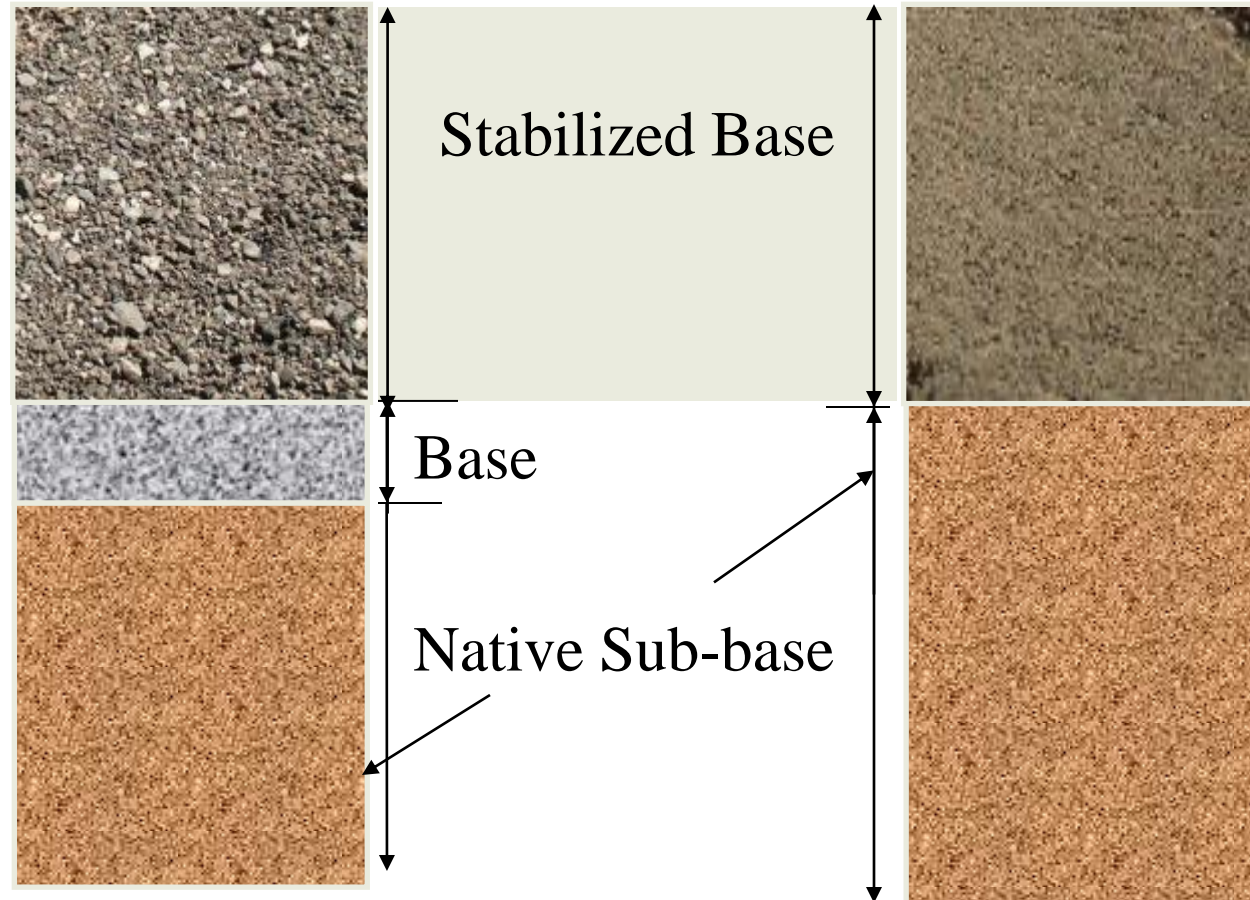




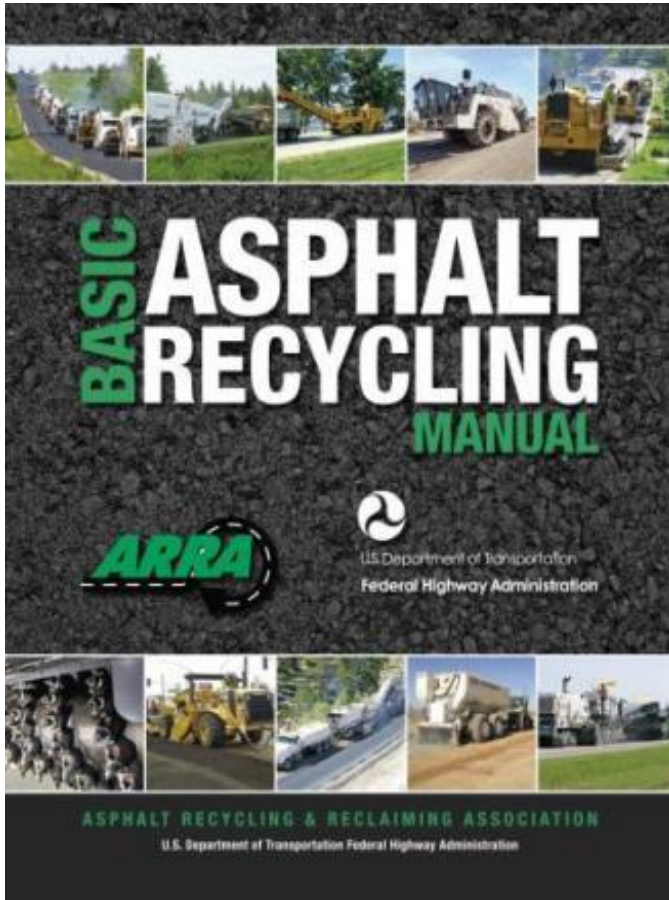
# Full Depth Reclamation



Improves existing materials in-place to provide greater structural support and reduction of imported material.



# ARRA's BARM



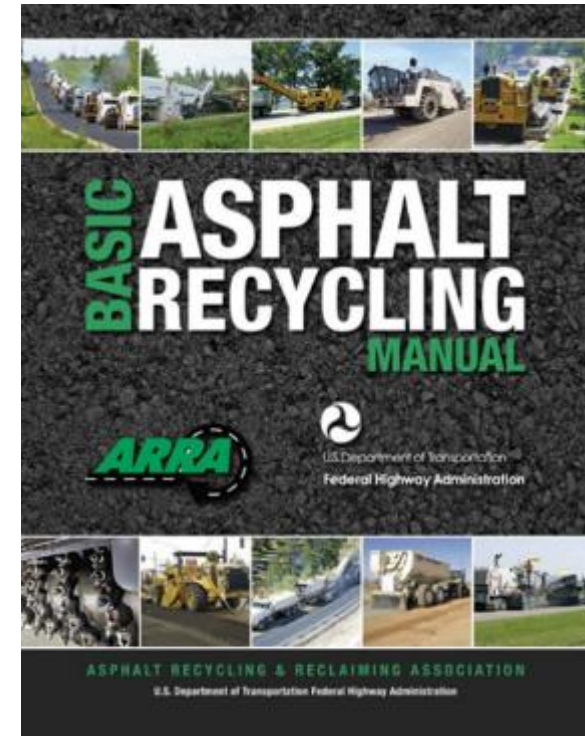
FHWA -HIF-14-001

- Cold Planing
- Hot In-place Recycling
- Cold Recycling
  - CIR & CCPR
- Full Depth Reclamation
- Detailed Project Analysis
- Mix Design
- Construction
- Project Specifications and Inspection

# HIR Applicability (Table 6-1)

Table 6-1: HIR Applicability

| Condition                    |                                    | Surface Recycling        | Remixing                 | Repaving                 |
|------------------------------|------------------------------------|--------------------------|--------------------------|--------------------------|
| Surface Defects              | Raveling                           | Yes                      | Yes                      | Yes                      |
|                              | Pot Holes                          | Yes                      | Yes                      | Yes                      |
|                              | Bleeding                           | No                       | Possible, see note a     | Possible, see note b     |
|                              | Skid Resistance                    | No                       | Possible, see note a     | Yes                      |
| Deformations                 | Shoulder Drop Off                  | No                       | No                       | No                       |
|                              | Rutting - Wear                     | Yes                      | Yes                      | Yes                      |
|                              | Rutting - Mix Instability          | No                       | Possible, see note a & c | Possible, see note d     |
|                              | Rutting - Deep Structural          | No                       | No                       | No                       |
|                              | Corrugations                       | Yes                      | Yes                      | Yes                      |
|                              | Shoving                            | No                       | Possible, see note a & c | Possible, see note d     |
| Load Associated Cracking     | Fatigue - Bottom Up                | No                       | No                       | No                       |
|                              | Fatigue - Top Down                 | Possible, see note e     | Possible, see note e     | Possible, see note e     |
|                              | Edge                               | Possible, see note b & f | Possible, see note b & f | Possible, see note b & f |
|                              | Slippage                           | Possible, see note g     | Possible, see note g     | Possible, see note g     |
| Non-load Associated Cracking | Block                              | Yes                      | Yes                      | Yes                      |
|                              | Longitudinal                       | Yes                      | Yes                      | Yes                      |
|                              | Transverse                         | Yes, see note d          | Yes, see note d          | Yes, see note d          |
|                              | Reflective                         | Yes, see note d          | Yes, see note d          | Yes, see note d          |
| Combined Cracking            | Joint Reflection                   | Possible, see note b     | Possible, see note b     | Possible, see note b     |
|                              | Discontinuity                      | Possible, see note b     | Possible, see note b     | Possible, see note b     |
| Base/Subgrade Deficiencies   | Swells, Bumps, Sags<br>Depressions | Unlikely, see note b     | Unlikely, see note b     | Unlikely, see note b     |
| Roughness                    | Ride Quality                       | Yes                      | Yes                      | Yes                      |
| Other Criteria               | All Levels of Traffic              | Yes, see note h          | Yes, see note h          | Yes, see note h          |
|                              | Rural                              | Yes                      | Yes                      | Yes                      |
|                              | Urban                              | Yes, see note i          | Yes, see note i          | Yes, see note i          |
|                              | Stripping                          | Possible, see note c & d | Possible, see note c & d | Possible, see note c & d |
|                              | Poor Drainage                      | No, see note j           | No, see note j           | No, see note j           |



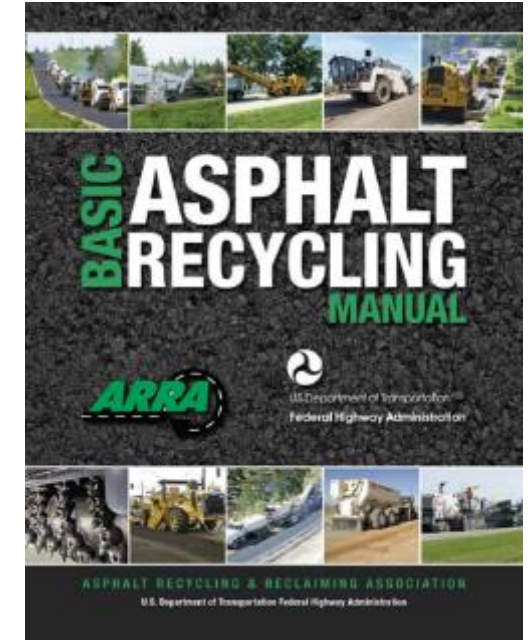
- ▶ Link to table: [www.roadresource.org](http://www.roadresource.org)
- ▶ Treatment Toolbox/Treatment Resource Center/HIR/Pre-Construction/Site Selection



# CR Applicability (Table 10-1)

Table 10-1: CR Applicability

| Condition                    |                                    | CR Applicability     |
|------------------------------|------------------------------------|----------------------|
| Surface Defects              | Raveling                           | Yes                  |
|                              | Pot Holes                          | Yes                  |
|                              | Bleeding                           | Yes                  |
|                              | Skid Resistance                    | Yes                  |
| Deformations                 | Shoulder Drop Off                  | No                   |
|                              | Rutting - Wear                     | Yes                  |
|                              | Rutting - Mix Instability          | Possible, see note a |
|                              | Rutting - Deep Structural          | Possible, see note b |
|                              | Corrugations                       | Yes                  |
|                              | Shoving                            | Possible, see note a |
| Load Associated Cracking     | Fatigue - Bottom Up                | Possible, see note c |
|                              | Fatigue - Top Down                 | Possible, see note c |
|                              | Edge                               | Possible, see note d |
|                              | Slippage                           | Possible, see note e |
| Non-load Associated Cracking | Block                              | Yes                  |
|                              | Longitudinal                       | Yes                  |
|                              | Transverse                         | Yes                  |
|                              | Reflective                         | Yes                  |
| Combined Cracking            | Joint Reflective                   | Possible, see note f |
|                              | Discontinuity                      | Yes                  |
| Base/Subgrade Deficiencies   | Swells, Bumps, Sags<br>Depressions | Possible, see note g |
| Roughness                    | Ride Quality                       | Yes                  |
| Other Criteria               | All Levels of Traffic              | Yes, see note h      |
|                              | Rural                              | Yes                  |
|                              | Urban                              | Yes, see note i      |
|                              | Stripping                          | Possible, see note a |
|                              | Poor Drainage                      | No, see note j       |



Link to table:

[www.roadresource.org](http://www.roadresource.org)

Treatment

Toolbox/Treatment

Resource Center/CIR or

CCPR/Pre-

Construction/Site Selection

# ARRA Best Practice Guidelines

- ▶ Series 100 Construction Best Practice Guidelines
  - Suggested Specification Language
- ▶ 200 Series Project Sampling & Mix Design Guidelines
- ▶ 300 Series QC Guidelines
  - Recommended Quality Control Checks and Remediation Actions
- ▶ Available for CP, CIR, CCPR, FDR
  - All Provide User Notes for More Information

Recommended Construction Guidelines  
For  
Cold In-place Recycling (CIR)  
Using Bituminous Recycling Agents  
CR101

Revised 11/02/2017



## NOTICE

It is not intended or recommended that these guidelines be used verbatim within a specification. Owner Agencies should use them to help establish their particular project specification. Owner Agencies should understand that all geographical areas and pavement rehabilitation/preservation projects are unique and the availability of materials and equipment may vary as well. ARRA assumes no liability for utilization of these guidelines by any individual or entity. Contact ARRA for answers to questions and for a list of ARRA member Contractors and Suppliers.

Asphalt Recycling & Reclaiming Association  
800 Roosevelt Road, Building C-312  
Glen Ellyn, IL 60137  
(630) 942-6578  
[www.ARRA.org](http://www.ARRA.org)

# Available ARRA Best Practice Guidelines

|                              |               | 100 Series<br>Const. | 200 Series<br>Mix Design | 300 Series<br>Quality<br>Control |
|------------------------------|---------------|----------------------|--------------------------|----------------------------------|
| Cold<br>Planing              | Milling       | X                    |                          |                                  |
|                              | Micro Milling | X                    |                          |                                  |
| Cold<br>Recycling            | CIR           | X                    | X                        | X                                |
|                              | CCPR          | X                    | X                        | X                                |
| Full<br>Depth<br>Reclamation | Bituminous    | X                    | X                        | X                                |
|                              | Cementitious  | X                    | X                        | X                                |
|                              | Lime          | X                    |                          |                                  |



# www.roadresource.org

**PPRA**  
Pavement Preservation & Recycling Alliance

*Better roads today. Stronger networks tomorrow.*

ABOUT US   TREATMENT TOOLBOX   NETWORK OPTIMIZATION   PAVEMENT PRESERVATION   RECYCLING   EMULSIONS   RESOURCES

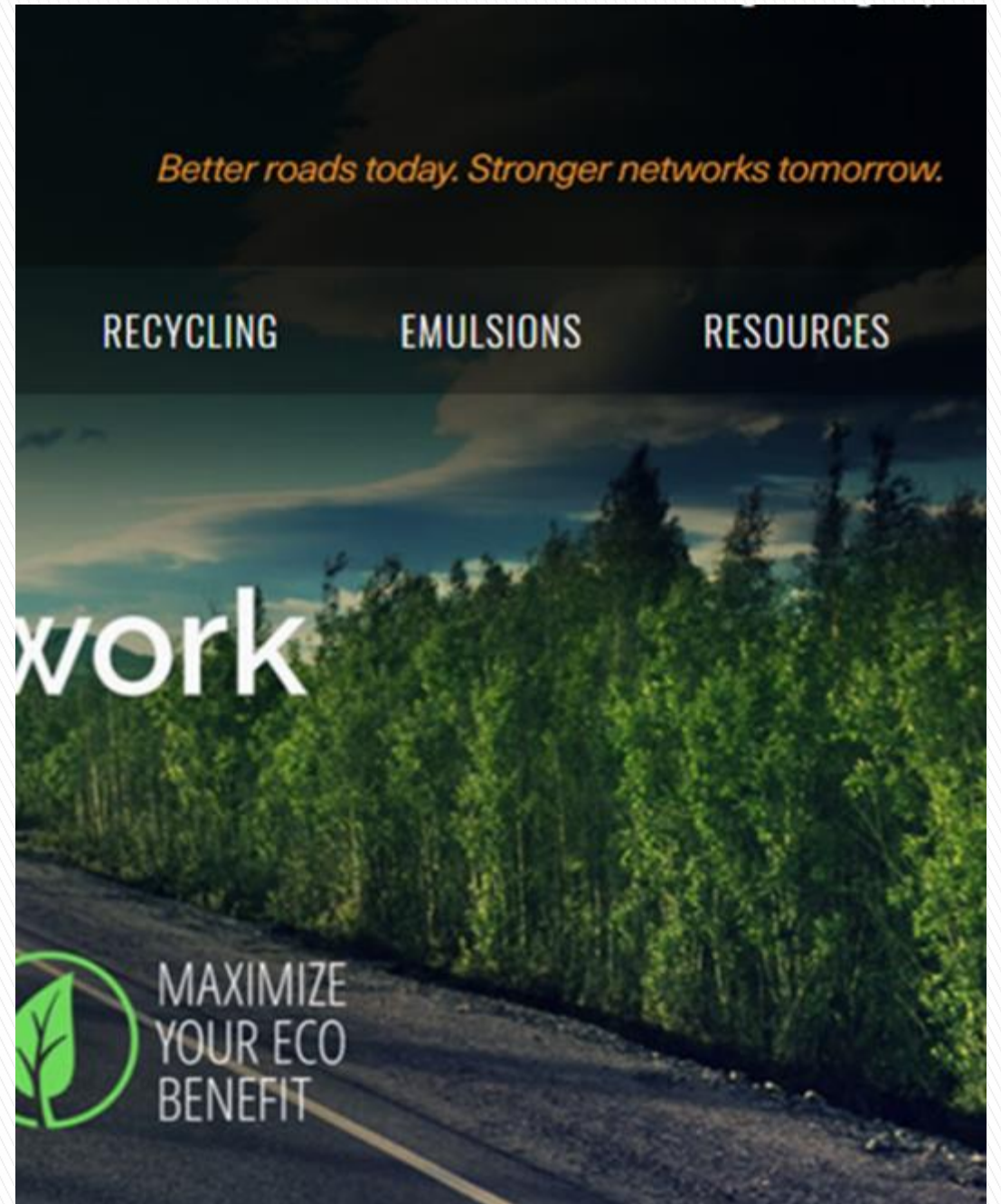
## Build A Better Network

With the Optimized Approach

-  IMPROVE YOUR OVERALL NETWORK CONDITION
-  GET THE LOWEST LIFE CYCLE COST PER ROAD
-  MAXIMIZE YOUR ECO BENEFIT

# Recycling Tab

- ▶ Why Recycling & Reclaiming
  - Lower Costs
  - Engineering Benefits
  - Environmental Benefits
  - Time Savings
- ▶ Structural Comparison Calculator
  - About
  - Calculator
- ▶ ARRA Publications
- ▶ About ARRA



# Approximately Equivalent Structural Number

Total Sq. Yards To Be Treated:

## Conventional Approach

VS.

## Optimized: Recycling First

 yd Export

| Layer Type          | Depth (in) | Coefficient ? | Unit Cost ? | SN ? |
|---------------------|------------|---------------|-------------|------|
| Hot Mix Asphalt     | 3.00       | 0.44          | 4.65 /SY/in | 1.32 |
| Cold Planing        | 2.00       | 0.00          | 1.00 /SY/in | 0.00 |
| Existing HMA        | 4.00       | 0.20          | 0.00 /SY/in | 0.80 |
| Existing Granular I | 6.00       | 0.10          | 0.00 /SY/in | 0.60 |

ADD ROW

 yd

| Layer Type          | Depth (in) | Coefficient ? | Unit Cost ? | SN ? |
|---------------------|------------|---------------|-------------|------|
| Hot Mix Asphalt     | 1.50       | 0.44          | 4.65 /SY/in | 0.66 |
| Cold In-Place Recy  | 3.00       | 0.36          | 1.90 /SY/in | 1.08 |
| Existing HMA        | 3.00       | 0.20          | 0.00 /SY/in | 0.60 |
| Existing Granular I | 6.00       | 0.10          | 0.00 /SY/in | 0.60 |

ADD ROW

Overall Structural Number: ? **2.72**  
 1 SY x **\$15.95** /SY = **\$16** total

Overall Structural Number: ? **2.94**  
 1 SY x **\$12.68** /SY = **\$13** total



# Network Optimization

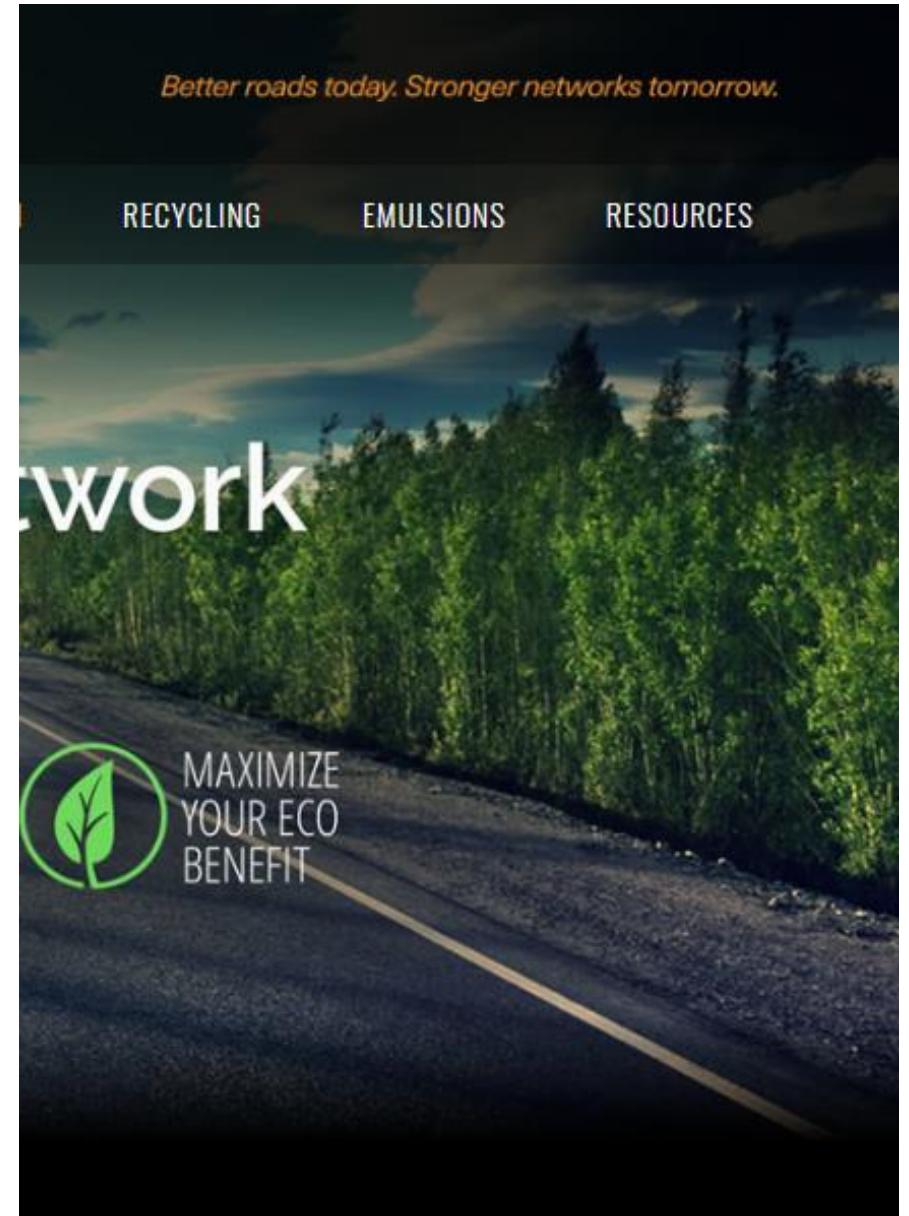


## ► Optimize Your Network

- Life Cycle Cost
- Equivalent Annualized Cost
- Remaining Service Life
- Cost Benefit Value

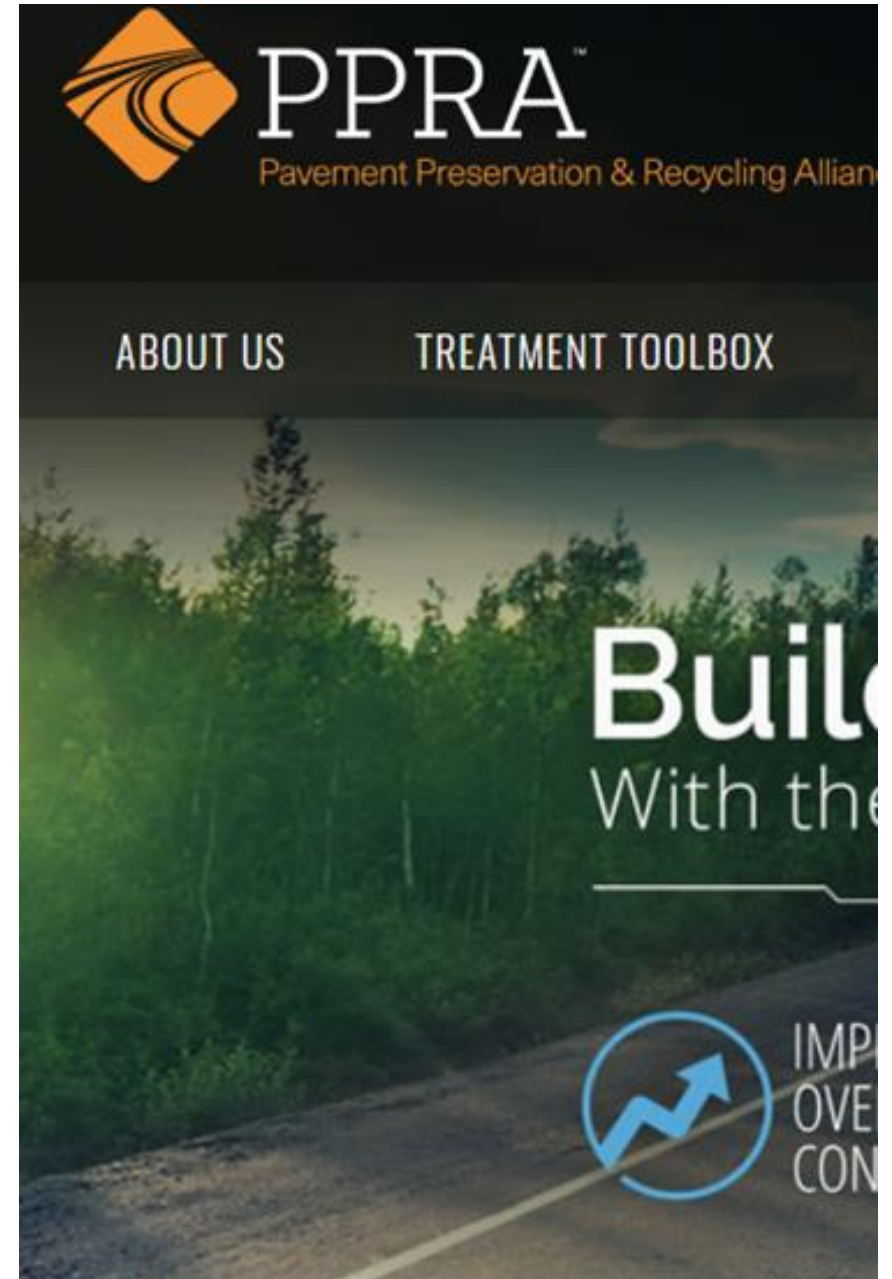
# Resources

- ▶ Search for Articles
- ▶ Featured Stories
- ▶ Training Resources
- ▶ Ask an Expert
- ▶ Contact Us
- ▶ Awareness Tools
- ▶ **Webinar Series**
  - 1 hour webinars on all of the calculators



# Treatment Toolbox

- ▶ Which Treatment is Best for my Road?
  - Explore by Pavement Criteria
  - Explore by Pavement Photos
- ▶ Treatment Resource Center
- ▶ Find a Contractor/Supplier





# Treatment Toolbox: Which treatment is right for my road? Pavement Condition

**PAVEMENT CONDITION** ⓘ  
B (PCI 70-84) ▼

**PRIMARY DISTRESS** ⓘ  
OXIDATION AND RAVELING - LOW ( $\geq 25\%$  TO  $< 50\%$  AGG L) ▼

**ROAD TYPE**  
URBAN: MAJOR COLLECT ▼

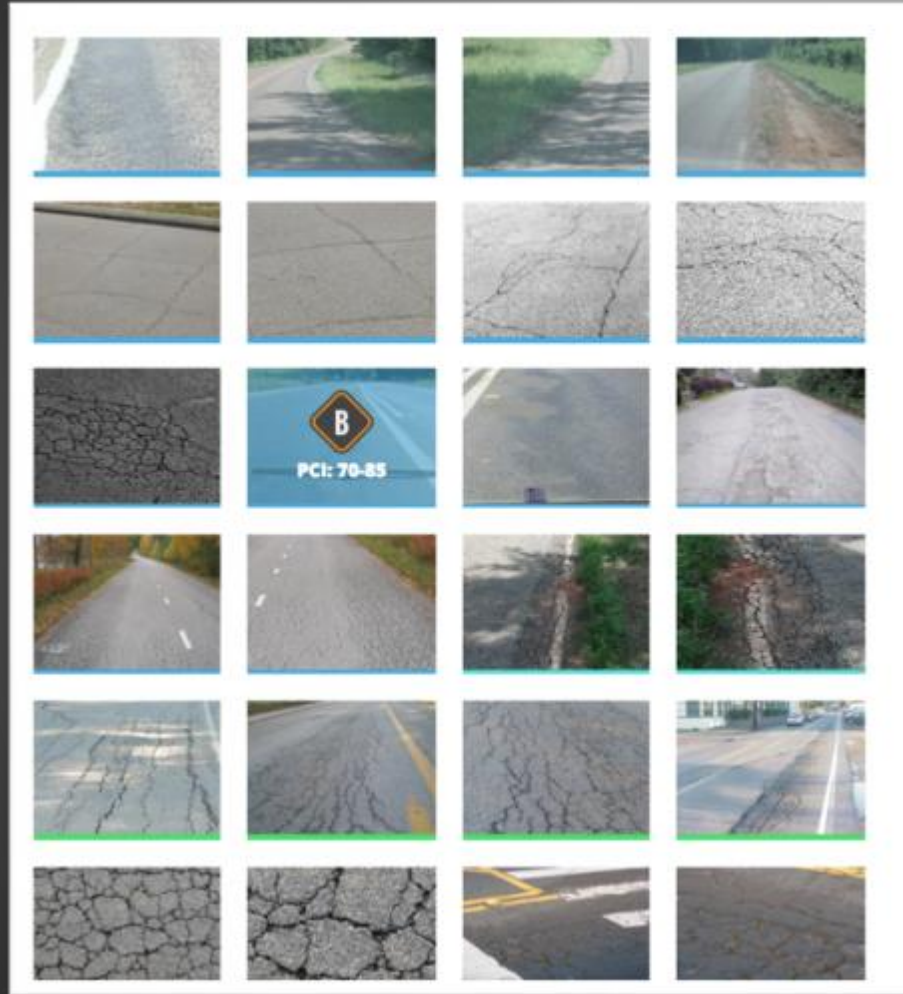
**SURFACE TYPE**  
DENSE GRADE HMA ▼

**OTHER FACTORS TO CONSIDER** ⚠

**Treatment Options:**

- FOG SEAL
- REJUVENATING FOG SEAL
- SLURRY SEAL
- MICRO SURFACING
- CAPE SEAL
- ULTRA THIN LIFT HMA
- CHIP SEAL
- CRACK SEAL
- SCRUB SEAL
- TACK COAT
- PRIME COAT
- COLD PLANING & MICRO MILLING
- HOT IN-PLACE RECYCLING
- COLD IN-PLACE RECYCLING
- COLD CENTRAL PLANT RECYCLING
- FULL DEPTH RECLAMATION
- BASE STABILIZATION
- SOIL STABILIZATION & SOIL MODIFICATION

# Photo Selector



**PAVEMENT CONDITION**  (PCI 40-54)

**PRIMARY DISTRESS:**  
FATIGUE CRACKING - HIGH

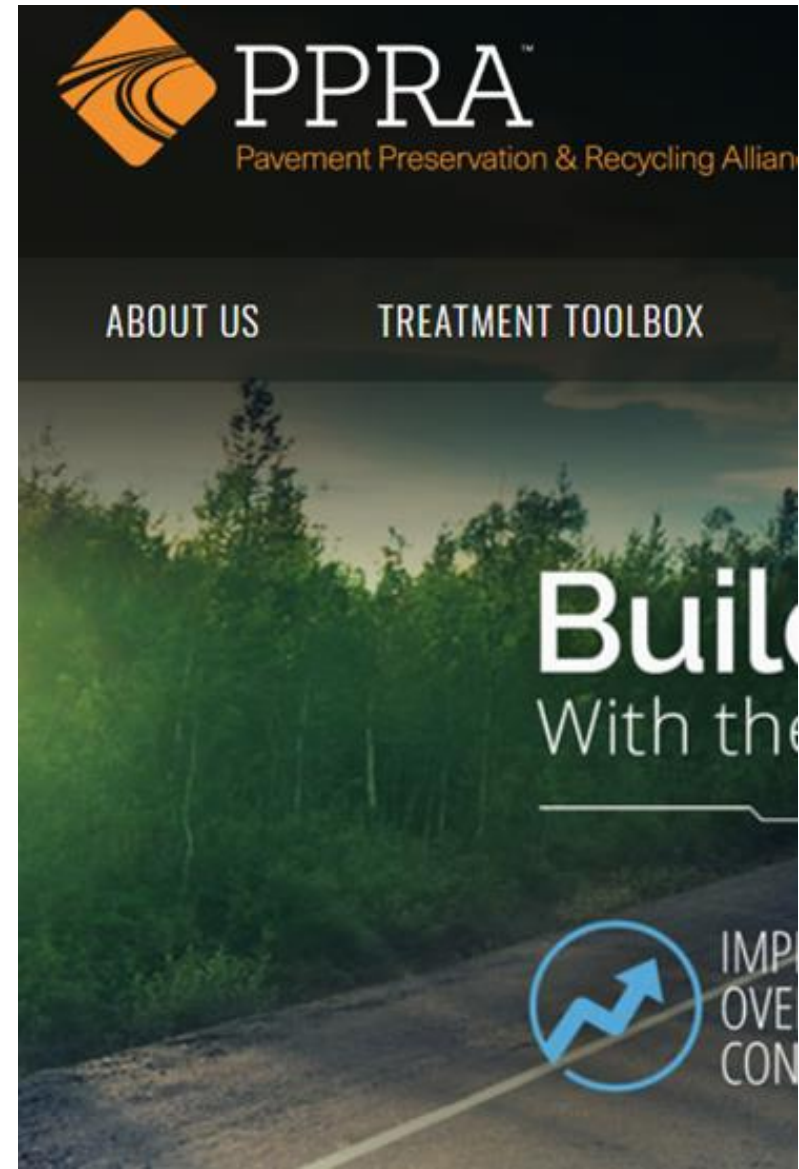
**POSSIBLE SOLUTIONS:**  
Consider treatments that address this pavement's primary distress:

**FULL DEPTH RECLAMATION**



# Treatment Toolbox

- ▶ Which Treatment is Best for my Road?
  - Explore by Pavement Criteria
  - Explore by Pavement Photos
- ▶ **Treatment Resource Center**
- ▶ Find a Contractor/Supplier





# Treatment Resource Center

The PPRA Treatment Resource Center is an index of common treatments under various progressive pavement management disciplines. For specific questions contact a [contractor or supplier](#) in your region.

## SURFACE TREATMENTS

Fog Seal

Rejuvenating Fog Seal

Slurry Seal

Micro Surfacing

Ultra Thin Lift HMA

Cape Seal

Chip Seal

Crack Seal

Scrub Seal

## PRE-TREATMENTS

Tack Coat

Prime Coat

## RECYCLING & RECLAMATION

Cold Planing & Micro Milling

Hot In-Place Recycling

Cold In-Place Recycling

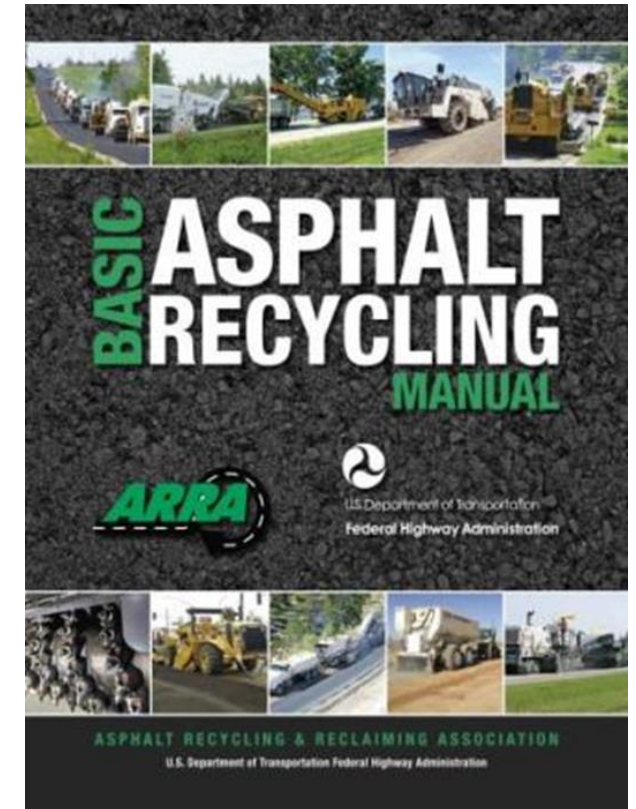
Cold Central Plant Recycling

Full Depth Reclamation

## BASE TREATMENTS

Base Stabilization

Soil Stabilization & Soil  
Modification



# Web Pages for Each Treatment on:

## ▶ OVERVIEW

- About
- Process & Variations
- Expectations
- Cost
- History
- Best Practices

## ▶ PRE-CONSTRUCTION

- Site Selection
- Material Selection
- Mix Design
- Specification Review

## ▶ CONSTRUCTION

- Preparation
- Weather Requirements
- Equipment
- Calibration
- Traffic Control
- Application

## ▶ QUALITY ASSURANCE

- Inspection
- Testing Protocol
- Troubleshooting
- Acceptance

RESEARCH & PERFORMANCE  
SUCCESS STORIES

PHOTO GALLERY

# Transportation Curriculum Coordination Council (TC3)

- ▶ Web Based Inspector Training Courses on:
  - HIR – No. 2590
  - CIR – No. 2509
  - FDR – No. 2539
- ▶ Free at Checkout (for now)
- ▶ Consist of Modules Covering
  - Introduction
  - Pre-Production Activities
  - Full Production
  - Post Construction Activities

<https://store.transportation.org/Item/TrainingDetails?ID=2509>



The screenshot shows a webpage for a training course. At the top left is the logo for the Transportation Curriculum Coordination Council (TC3) under the AASHTO banner. The main title is 'Inspection Training for Cold In-Place Recycling'. Below the title is the word 'Introduction'. On the right side, there are two images: the top one shows a yellow machine on a road, and the bottom one shows a green machine. At the bottom of the page, there is a dark blue footer with white text that reads: 'Training support files are available as attachments from the paperclip icon in the bottom right-hand part of the screen.' In the bottom right corner of the footer, there is a 'Continue' button with an orange arrow pointing right.



# www.ARRA.org

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## RESOURCES & TRAINING

Check out these industry resources

[LEARN MORE](#)



*Responsible Renewal. Reliable Results.*

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## RESOURCES



# Additional Presentations on In-Place Recycling

- ▶ Tuesday in JW 2 from 3:30 – 5:15 pm
  - Ben Bowers on *NCHRP 14-43 Guide Spec for CIR & CCPR*
  - Brian Diefenderfer on *NCHRP 9-62 Rapid Test and Specification for Construction of Bituminous Cold Recycled Pavements*
  - Dave Jones on *Optimizing Design Decisions and Construction Procedures for Full Depth Reclamation*
  - Megan Yount on *Characterizing Cold Recycled Pavements from Field-Sampled Cores*

For More Information join us at:



 **ARRA**  
Asphalt Recycling & Reclaiming Association

# 2023 PAVEMENT RECYCLING SUMMIT

INDIANAPOLIS, IN | OCTOBER 2-5

Stephen A (Steve) Cross, PhD, PE  
S Cross & Associates, LLC  
Technical Director  
Asphalt Recycling & Reclaiming Association  
[steve.cross@okstate.edu](mailto:steve.cross@okstate.edu)