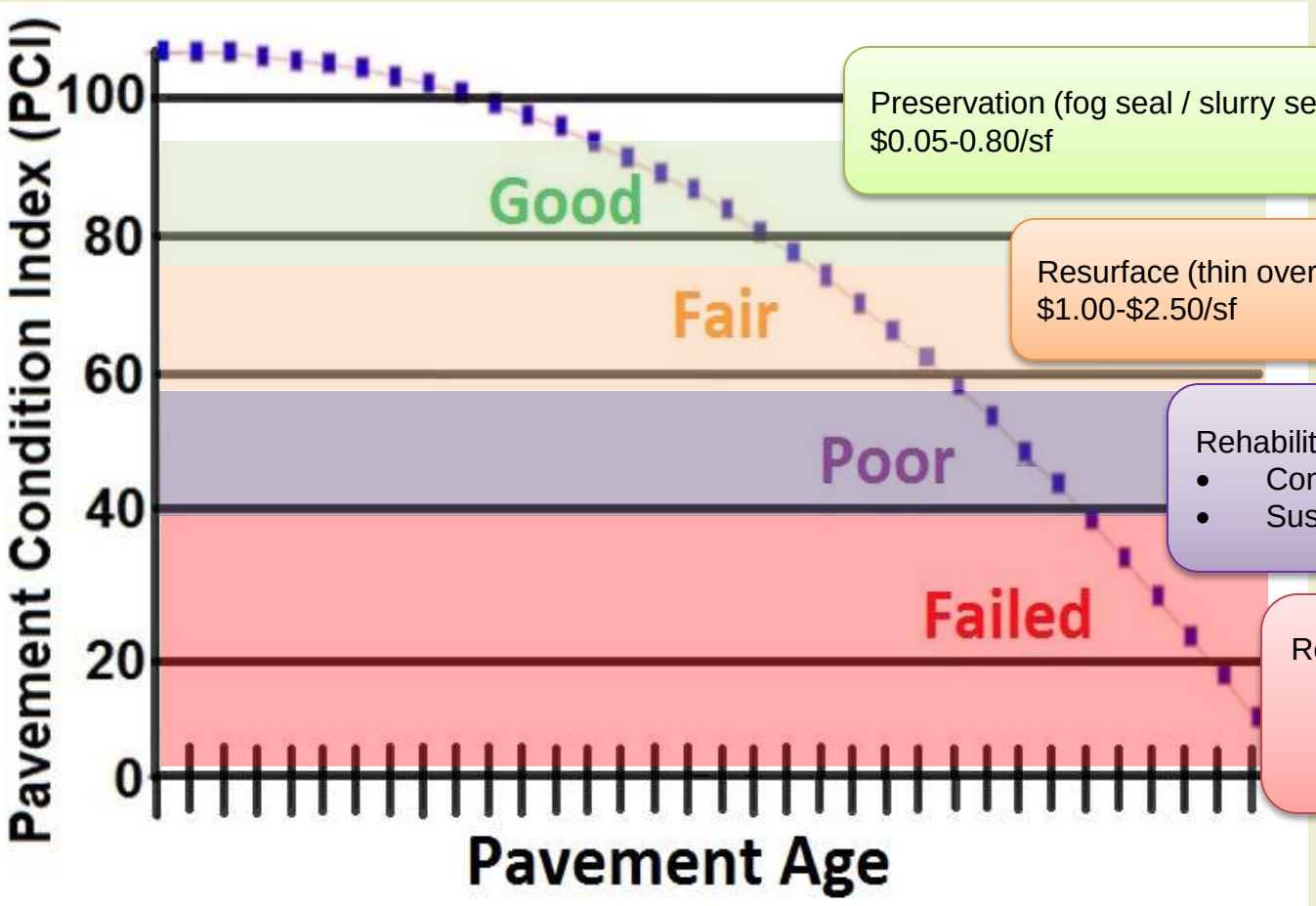
2016 ARIZONA PAVEMENTS/MATERIALS CONFERENCE
NOVEMBER 16-17, 2016
PHOENIX, ARIZONA

Soil Stabilization & Full Depth Reclamation Sustainable Engineering Designs

Marco A. Estrada
Pavement Recycling Systems

TYPICAL PERFORMANCE CURVE



Preservation (fog seal / slurry seal / chip seal / cape seal): $0.05-0.80/sf

Resurface (thin overlay / 2 or 3-layered system): $1.00-$2.50/sf

Rehabilitation:

- Conventional (R&R): $3-$5/sf
- Sustainable (CIR/CCPR): $2-$3/sf

Reconstruction:

- Conventional: $6-$12/sf
- Sustainable (CCPR w/ Soil Stabilization): $3-$5/sf


Unstable Subgrade
Remediation

SUSTAINABLE ENGINEERING TECHNOLOGIES

- Soil Stabilization
  - Remediation of Unstable Subgrade or Base
  - New Construction Structural Design Applications
- Full-Depth Reclamation
  - Asphalt Pulverization with Cement for Base Modification
  - Thicker asphalt pavement structural sections
- Benefits of Soil Stabilization &Full-Depth Reclamation
  - Structural Pavement Design
  - Lower Costs
  - Reduced Environmental Impacts
  - Reduced Community & Utility Impacts

THE PROBLEM: POOR QUALITY "UNSUITABLE" SOILS & BASES

Typical Poor Quality Soil

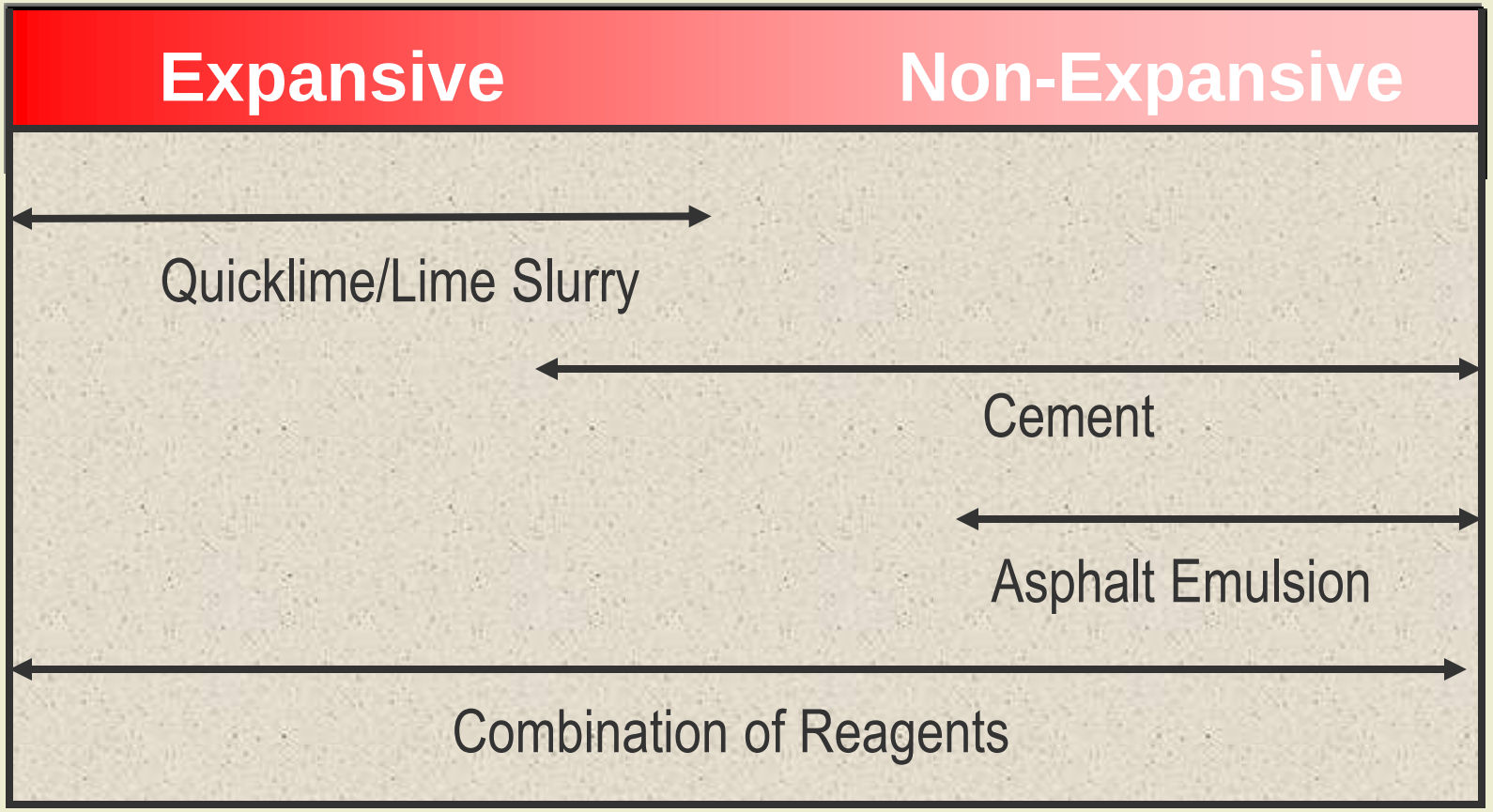
- Exhibit Poor Pavement Support
  Low R-values & Unconfined Compressive Strength
- Typically Moisture Sensitive
  Expansion Potential & Swell Pressure
- Constructability Issues
  "Pumping - *Poor Workability*
  Not Readily Compactable

GENERAL ENGINEERING PAVEMENT RECOMMENDATIONS

- Remediation of Unstable Subgrade
  - Scarify, aerate, & re-compact
  - Remove unstable, pumping soil and replace with geotextile fabrics and base
- Structural Design Applications
  - Remove low R-value soil and replace with base
  - Thicker asphalt pavement structural sections
  - Interlayer grid systems

THE SOLUTION:
SOIL STABILIZATION & FDR

Critical Element: Selection of Soil Stabilization Reagents for the Spectrum of Soil Types

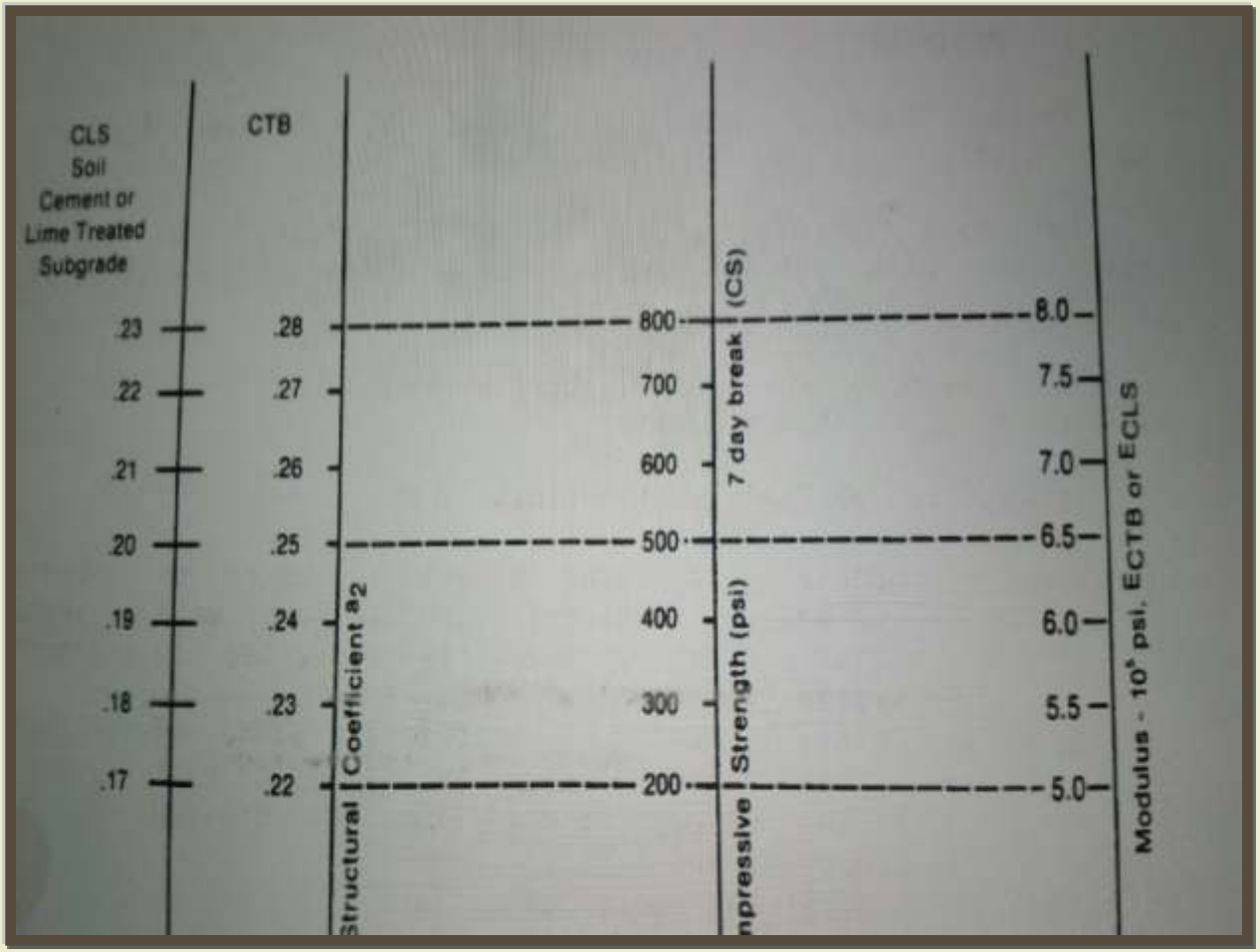


CRITICAL ELEMENTS DESIGN

- Pavement Structural Design: Increase load-bearing….structural improvements
  - Increased R-value, compressive strength, CBR, Structural Number, etc.
- Base/Subgrade distress including subgrade instability…pumping or yielding foundation
- Subgrade instability generally controls depth of design section

SUBGRADE STABILITY CAN CONTROL
DEPTH OF STABILIZED SECTION

STRUCTURAL EQUIVALENCY: PAVEMENT SECTION DESIGN



SURFACING AND BASE COEFFICIENTS

	Maximum coefficient
Asphaltic Concrete (3/4" or 1/2" Mix; Virgin or Recycled)	.44 - a_1
Cement Treated or Bituminous Treated Base	.28 - a_2
Cement or Lime Treated Subgrade	.23 - a_2
Aggregate Base	.14 - a_2
Aggregate Subbase	.11 - a_3

City of Marana

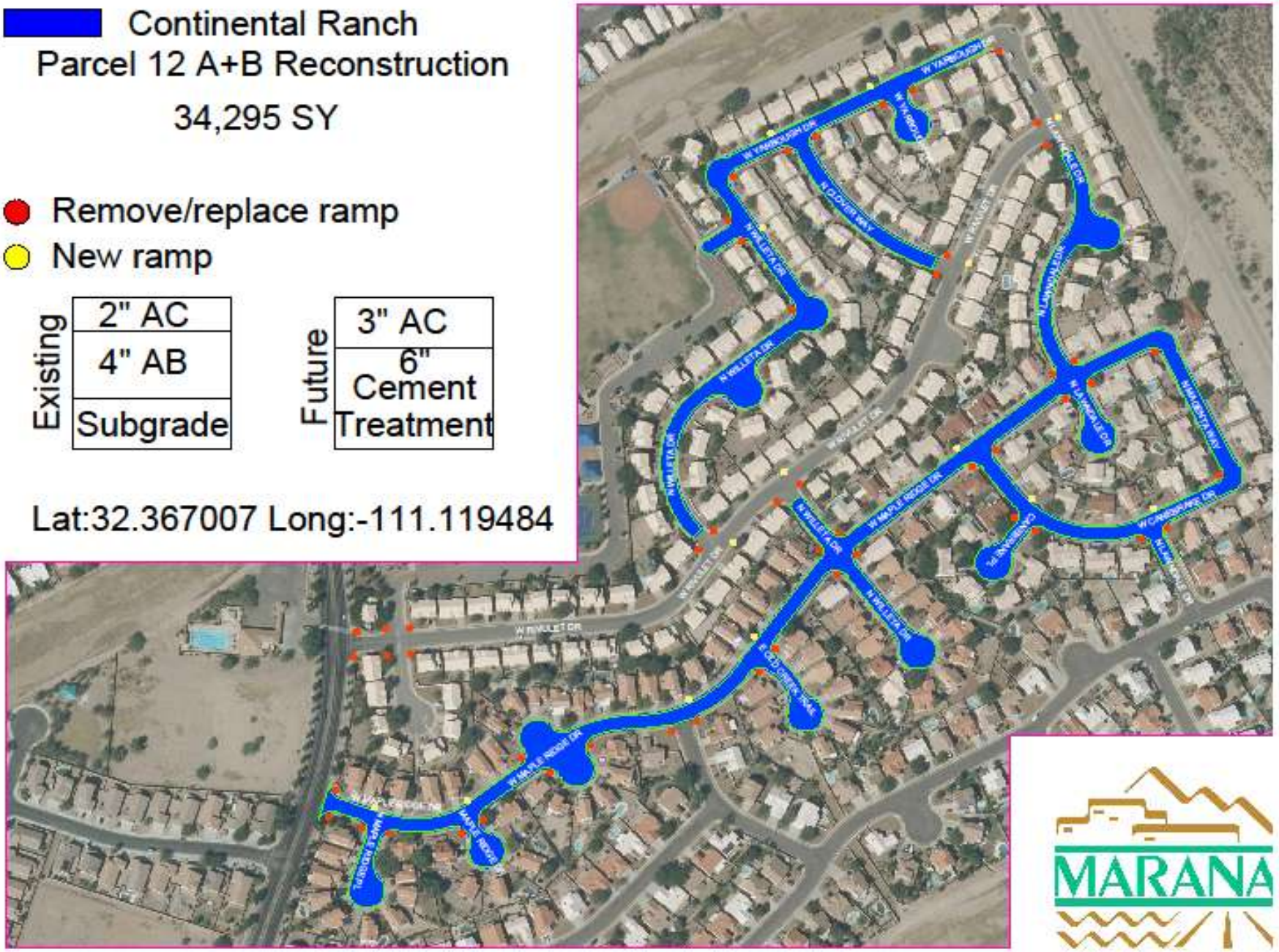
Continental Ranch
Parcel 12 A+B Reconstruction
34,295 SY

- Remove/replace ramp
- New ramp

Existing
2" AC
4" AB
Subgrade

Future
3" AC
6" Cement Treatment

Lat:32.367007 Long:-111.119484



CITY OF TUCSON
2016 ROAD REHABILITATION PROJECT

- **Distressed Pavement Existing Section**
  Typical 2” to 3” Asphalt over 8” Aggregate Base Course

- **Full Depth Reclamation**
  Pulverize and Blend existing pavement materials to 12”

- **Sustainable Engineering Design**
  Cement Stabilization 5% cement at 7” depth

Arterial Street FDR: Traffic Control

Project Phasing

Arterial Street FDR: Community Access


LANE CLOSED
OPEN TRENCH

Residential Street: Traffic Control

Residential Street: Community Access

Access to the local residents


Same day Residential Street:
Cement stable, access to
local traffic
WM
263049
CAUTION

COMMUNITY & ENVIRONMENTAL BENEFITS

Minimizes export of construction materials

Reduces import of virgin aggregate base

1 TRUCK LOAD OF CEMENT ELIMINATES 40 TRUCK LOADS OF EXPORT & IMPORT

CITY-WIDE RESIDENTIAL STREETS REPAIR 2 MILLION SQUARE FEET CEMENT TREAT ENERGY & TIME SAVINGS COMPARISON

- Excavate & Export (8”).....49,630 cy or 4,727 trucks
- Import (8”).....90,450 tons of base or 5,025 trucks
- Cement Treatment (8” 5% Cement).....4,355 tons of cement or 168 trucks
- **Eliminated over 9,500 trucks from the job (58:1 ratio)**
- Equipment days to complete R & R.....100
- Equipment days to complete treatment.....70
- Reduced construction time by 30%.

GREENHOUSE GAS & ENERGY REDUCTION

SUSTAINABLE TREATMENTS - BENEFITS

ENERGY USAGE, GREENHOUSE GAS EMISSIONS, LANDFILL REDUCTION, AND COST SAVINGS FOR SUSTAINABLE PAVEMENT TREATMENTS [1]					
SINCE 2009	COLD IN-PLACE RECYCLING	COLD CENTRAL PLANT RECYCLING	SUBGRADE STABILIZATION	PAVEMENT PRESERVATION	TOTAL
NUMBER OF PROJECTS COMPLETED	9 Projects	6 Projects	11 Projects	25 Projects	51 Projects
REDUCTION IN ENERGY CONSUMPTION (% or kWh) [2]	77%	77%	97%	80%	81%
REDUCTION IN GHG EMISSIONS (% or metric tons) [2]	79%	79%	97%	86%	85%
LANDFILL REDUCTION (CY)	28,000	16,000	96,000	121,000	261,000
COST SAVINGS (%)	45%	21%	74%	43%	47%
COST SAVINGS ($)	$4,804,000	$1,018,000	$9,165,000	$16,736,000	$31,723,000
690,000 TIRES WERE ELIMINATED FROM LANDFILLS BY INCORPORATES TIRE PARTICLES INTO THE ASPHALT HOT MIX (APPROX. 1,000 TIRES / 1 LANE-MILE / 1-INCH ARHM OVERLAY)					

[1] Chehovits, J. & Galehouse, L. (2010). Energy Usage and Greenhouse Gas Emissions of Pavement Preservation Processes for Asphalt Concrete Pavements. National Center for Pavement Preservation, Okemos, Michigan, United States (2010) https://www.pavementpreservation.org/icpp/paper/65_2010.pdf

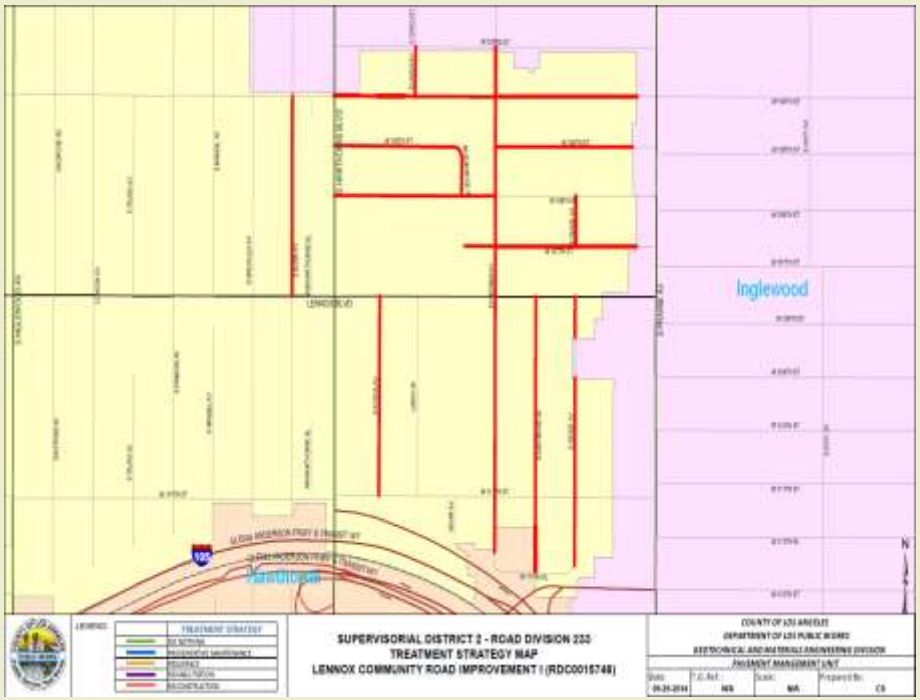
[1] Chappat, M. & Bilal, J. (2003). The Environmental Road of the Future: Life Cycle Analysis, Energy Consumption and Greenhouse Gas Emissions. Colas Group. 2003. http://www.colas.com/sites/default/files/publications/route-future-english_1.pdf

18,000 metric tons of CO_2E reduced = 3,800 passenger vehicles removed from roads*

** Based on latest updated of the average fuel economy and the emissions factor for the combustion of gasoline as of August 25, 2015. The emissions factor for passenger vehicles is 5.2 tons/vehicle/year. (www.epa.gov)*

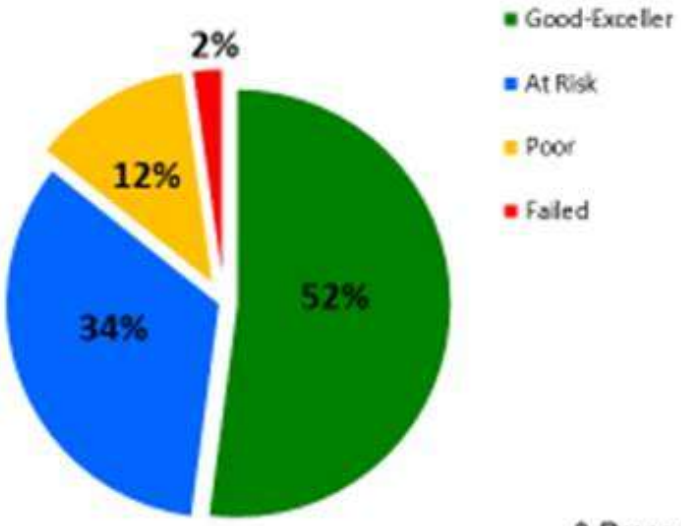
Lennox Community Road Improvement Project
Cold Central Plant Recycling (CCPR) with Soil Stabilization

- **Urban Residential Streets:**
  Project is located City of Inglewood
- **Length:** 7 lane miles
- **Area:** 471,600 sf
- **Pavement Condition Index :**
  - 56 (Poor)
- **Treatment Strategies:**
  Reconstruction
  - 1½" of ARHM
  - 3" of CCPRACP
  - 6" of Soil Stabilization
- **Cost Savings:** ***($1.1M Cost Saving)***
  - Conventional Reconstruction: $2.05M ($4.34/sf)
  - Sustainable Reconstruction : $971K ($2.06/sf)

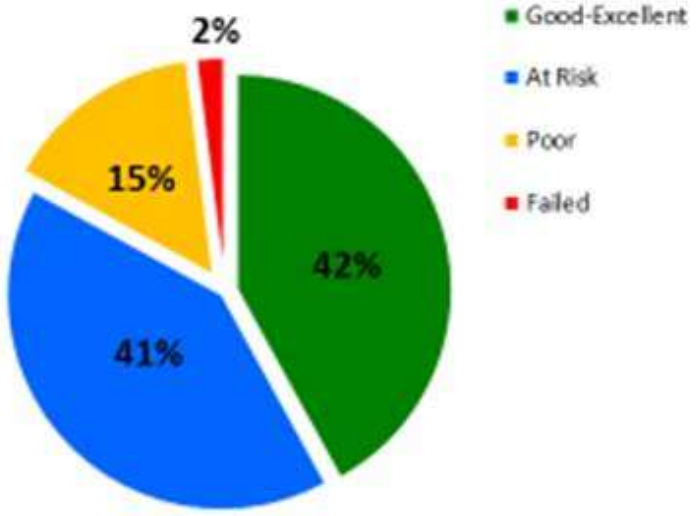


PCI Comparison
Sustainable Approach vs. Worst First

COUNTY'S THREE-PRONGED SUSTAINABLE APPROACH



WORST FIRST APPROACH (PROJECTED)



		3-Pronged Sustainable Approach	Worst First Approach (Projected)	Δ
Square footage to be treated	=	145MSF	45MSF	100MSF
Roads rated Good-Excellent	=	52%	42%	Almost 25% increase
Roads rated Poor & Failed	=	14%	17%	Almost 20% decrease
Overall Network PCI	=	71	66	Almost 10% increase

ECONOMIC & ENVIRONMENTAL VALUE OF FDR

- Recycles Soil & Minimizes cost versus Export/Import Practices Savings of 30 to 50 percent
- Time savings of up to 50%
- Reduces Carbon Footprint – Trucking 40:1
- Minimizes Distress on Existing Roadway Infrastructure
- All weather access…..reduced schedule impacts
- Increases Structural Number Without Excavation
  - Significant Increases in R Value and Strength
  - Coefficients= 0.23 to 0.28

SOIL STABILIZATION & FDR TODAY

- Engineered Approach: Design and Training
- Local Contractor expertise and higher capacity equipment…FDR sections of 18” in one lift
- Increased partnership efforts between Agency & Contractors
  - Industry & Agency task groups working on specifications
  - Joint Committees working on specifications
- Guidelines & Specifications available
  - MAG
  - Local agencies
  - Pavement & Geotechnical Engineers

Questions?

ASPHALT BUSTERS
PULVERIZING • RECYCLING • STABILIZING
A Division of Pavement Recycling Systems, Inc.

Marco A. Estrada (951) 205-6000
marcoestrada@pavementrecycling.com

PAVEMENT RECYCLING PRS SYSTEMS