



Western States In-place  
Recycling Conference  
September 11-13, 2012  
Ontario, CA

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Full-Depth Reclamation (FDR)  
Marco A. Estrada  
Pavement Recycling Systems

# Factors Driving the Need to Recycle

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- Shrinking budgets
  - Demand for good and safe road conditions
  - Scarcity and reduced quality of aggregate resources
  - Mandate to reduce greenhouse gas emissions
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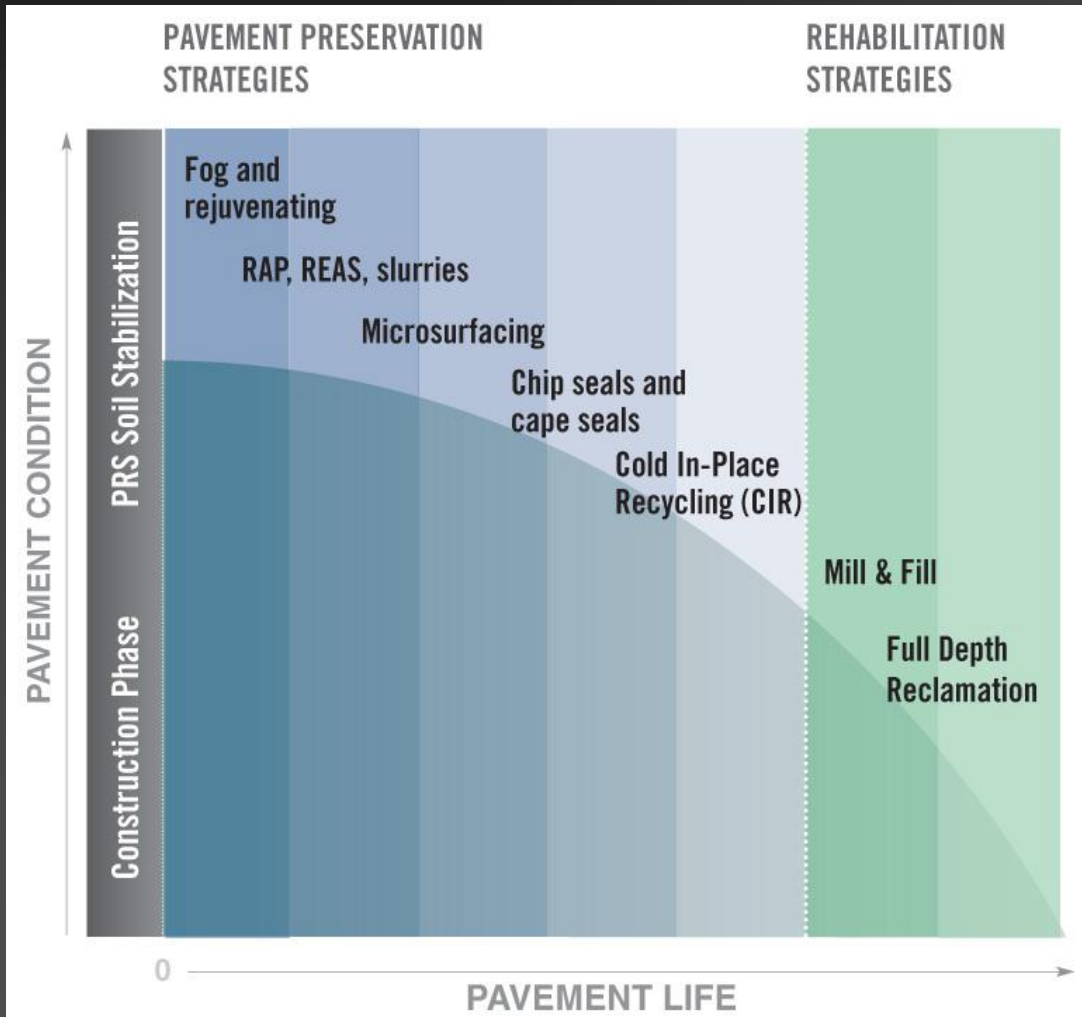
# In-Place Recycling: Preservation of infrastructure investment

- Maximize “return-on-infrastructure” by re-using in-place materials
- Stretch budgets: two or three roads for the price of one
- Structural qualities reduce maintenance costs
- Solutions for every stage of lifecycle
- From public roadways to airport runways



# Environmentally Sound Solutions for Every Phase of the Pavement Life Curve.

## Use Full Depth Reclamation for Rehabilitation.



- Preservation
- Rehabilitation

More value, at lower cost to you and the environment

# Full-Depth Reclamation

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An engineered pavement recycling process in which existing pavement materials are incorporated into a structural pavement section through the pulverization and/or stabilization processes. These processes include:

- Mechanical Stabilization
  - Bituminous Stabilization
  - Chemical Stabilization
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# Full-Depth Reclamation: Design & Construction Applications

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- Base/Subgrade distress including subgrade instability...pumping or yielding foundation
  - Subgrade instability generally controls depth of FDR
  - Increase load-bearing....structural improvements
    - Increased R-value, strength, CBR, Gravel Factor, etc.
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# FDR Additives & Reagents



## Chemical Stabilization

- Portland Cement
- Lime
- Pozzolans (Fly Ash)



## Mechanical Stabilization

- RAP
- Gravel
- Aggregate Base



## Bituminous Stabilization

- Foamed Asphalt
- Asphalt Emulsion



# Full-Depth Reclamation (FDR): Use Your Old Road to Build a Better One

When total reconstruction seems to be the only option.



1

§ Field observation and testing to identify problems and engineer solution; mix and structural design



2

§ Pulverize and blend full AC and predetermined portion of base/subgrade, cutting to required depth

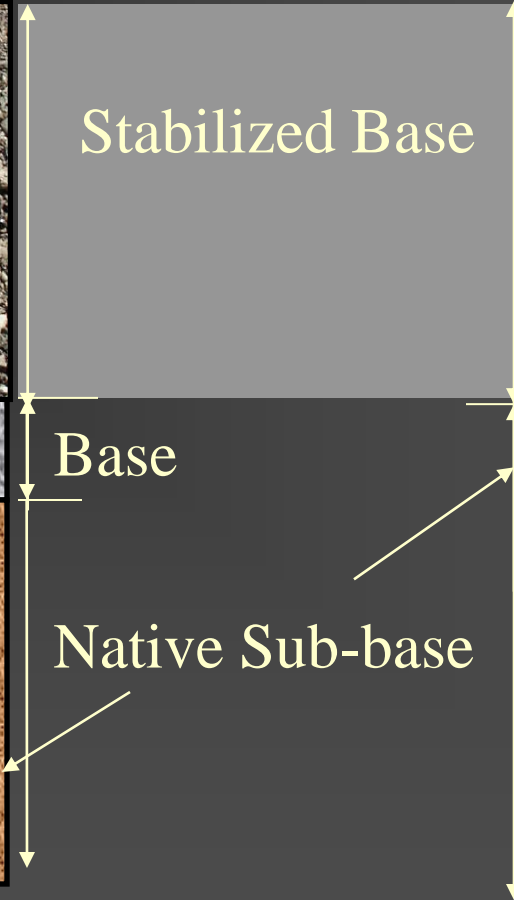


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§ Blend with the right stabilizing agent. Quality Control testing and inspection

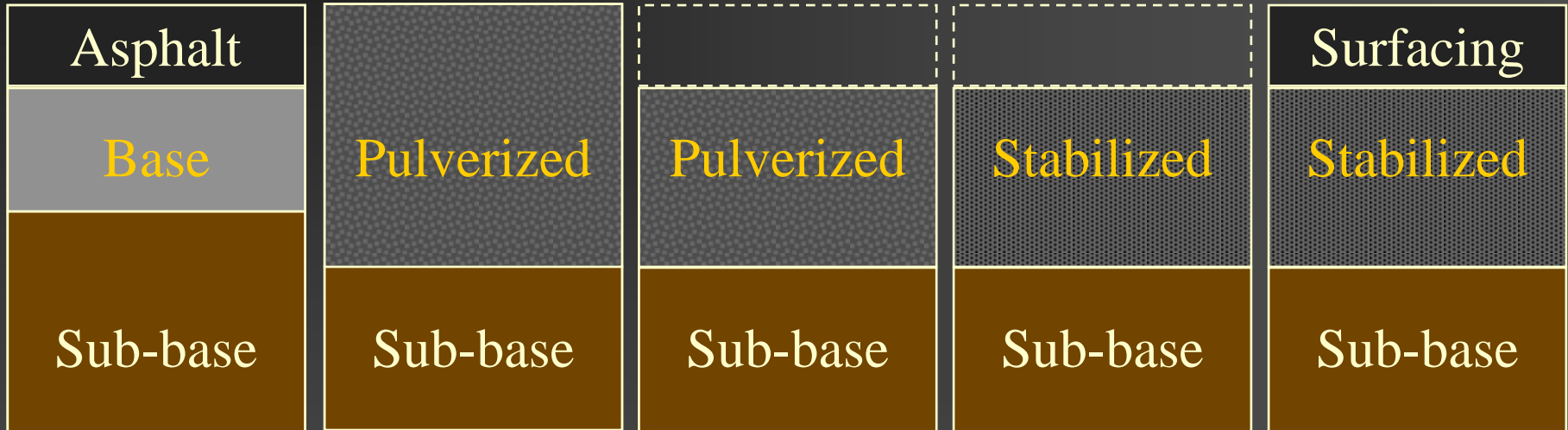


# Full Depth Reclamation (FDR)



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

# Full Depth Reclamation (FDR) Construction Sequence



**Existing road**

**Pulverization  
to design depth**

**Removal of  
excess material  
(if necessary)  
and shaping**

**Addition of  
reagents, mixing  
& compacting**

**Final surface  
treatment**



# Mechanical Stabilization



AC and underlying materials are pulverized and mixed to provide a homogenous base material. Additional aggregate may be incorporated to adjust gradation.



# Stabilized Base

## Chemical Stabilization

- Portland Cement
- Lime



## Bituminous Stabilization

- Asphalt Emulsion
- Foamed Asphalt



# Bituminous Stabilization

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## Asphalt Emulsion or Foamed Asphalt

Generally for stabilization of blended material with 8 to 20 percent fines.

Increases long term strength and pavement support characteristics, while remaining flexible and wear resistant. (Typical Gravel Factor = 1.5 to 1.7)

Does not crack within itself (shrinkage cracking). Immediate traffic.

Can add RAP, Aggregate Base, Cement or Lime to enhance gradations or change underlying soil plasticity characteristics.

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# Delano, CA – FDR with Asphalt Emulsion

## Traffic Index - 9



# Pulverizing

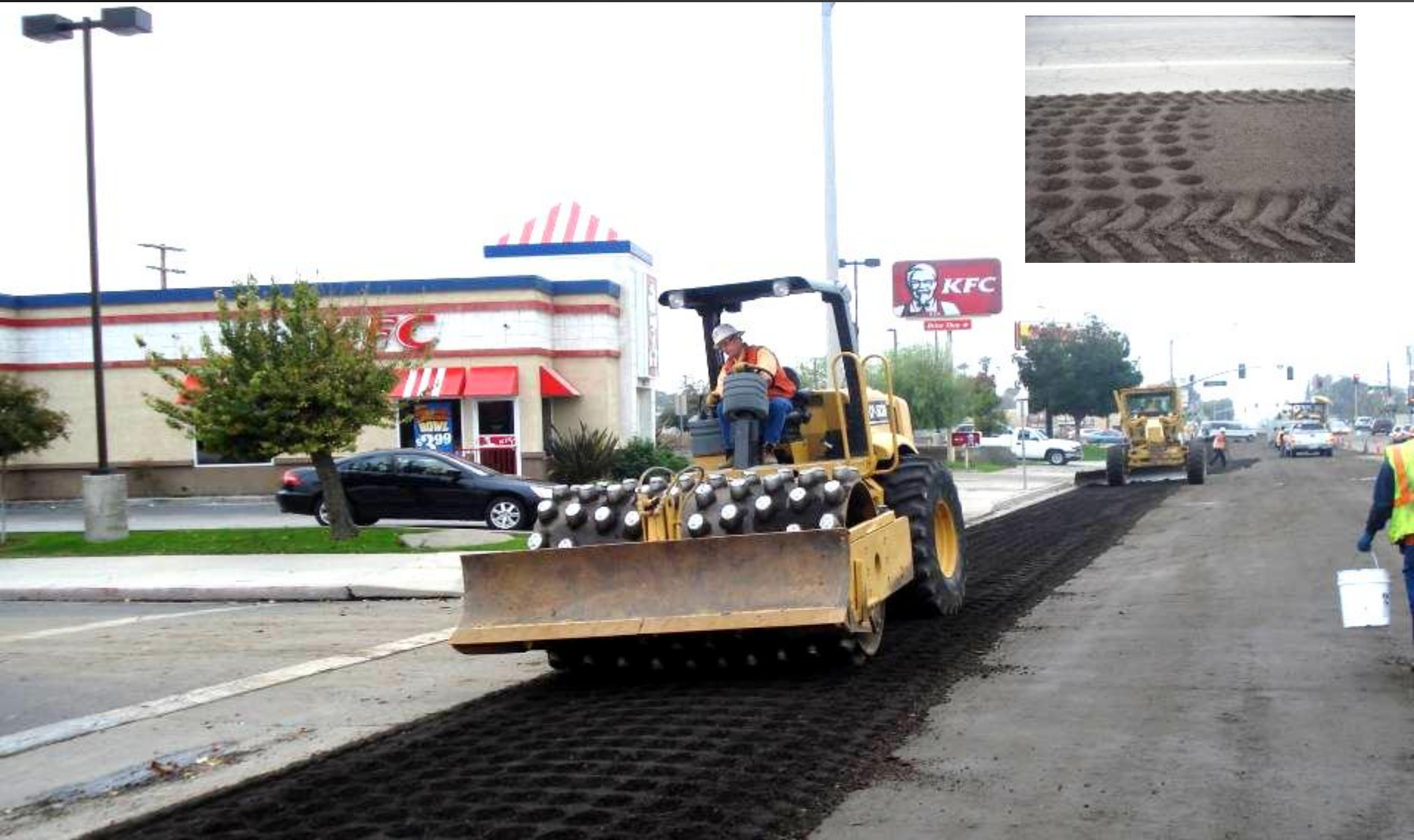




# Reclaimer adding 4% Emulsion



# Compaction and Grading





Project scheduled for 33 days. Reconstructed in just 11 days utilizing Full Depth Reclamation.

Before



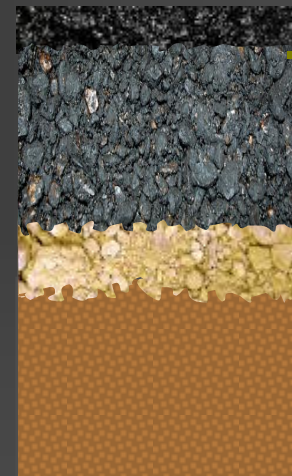
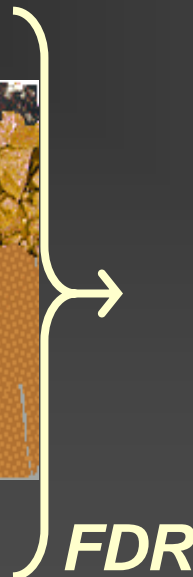
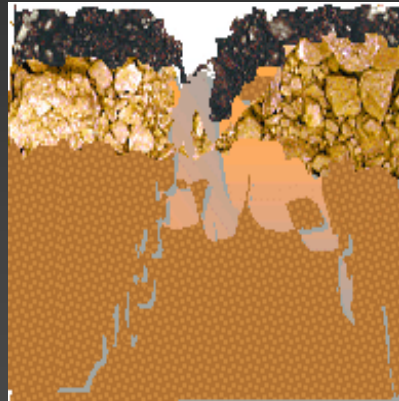
After



# Cecil Avenue Before

# FDR Solution After

Bituminous pavement  
needing repair



- 2" Overlay
- 6.5 inch  
stabilized  
material
- Granular base
- Soil

# Chemical Stabilization

## Portland Cement or Quicklime (CaO)

Cement is the most economical way to gain substantial increases in strength and wear resistance, but more rigid behavior. Design for lower strength and increased depth (Typical Gravel Factor = 1.2 to 1.6)

Lime is used to increase the performance when soils have plastic and expansive properties. (Typical Gravel Factor = 1.2 to 1.3)

Curing period typically 3 to 5 days; requirement can be waived under firm and unyielding conditions.

May require a stress relief course to prevent new reflective cracking or utilize micro-cracking.





# City of Oxnard FDR Strategy Using Type II Portland Cement

# Pavement Pulverized







Pulverization disrupts cracking pattern





Sub grade Conditions



# Spreading Portland Cement





# Initial Mixing





# Secondary Mixing (adding water)







**Access to the local Residents**





# Grading & Compaction





**Cement Stabilized Base**



# Quality Control







Paving

# Why FDR?

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- Uses Value of the Existing Pavement
  - Eliminates Existing Cracking Patterns
  - Cost Effective: Savings of 30 to 50 percent
  - Reduces Carbon Footprint – Trucking 40:1
  - Adding Asphalt Foam, Emulsion, Cement and/or Lime Increases Base Effective Depth Without Excavation
    - Significant Increases in R Value and Strength
    - Gravel Factors = 1.2 to 1.7
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# Summary - Benefits of Recycling and Reclamation

- Shorter Construction Periods with Reduction in User Delays
- Improved Pavement and Structural Section Properties
- 20 Plus Years Performance Expectations
- Cost Savings Over Traditional Rehabilitation Methods
  - Preserves the Investment Already Made in Pavements
- Sustainable Development “.... Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”
  - Optimize the use of natural resources
  - Reduce energy consumption
  - Reduces Truck Traffic
  - Reduce greenhouse gas emissions, limiting pollution



# There Are **Economic And Environmental Benefits** In Re-Using Existing Materials/Assets Already In-Place And Paid For

- \* The aggregate in old asphalt has value
- The existing pavement sections/subgrades below the asphalt/building pads can be strengthened in-place instead of being removed and replaced
- \* **Key is to recycle and re-use existing assets/materials** instead of paying to have them removed and paying to have new material imported.



# FDR Today

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- Local Contractor expertise and higher capacity equipment.....FDR sections of 18” in one lift
  - Increased partnership efforts between Agency & Contractors
    - Industry & Caltrans task groups working on FDR specifications
    - GreenBook Committees working on specifications
  - Guidelines & Specifications available
    - ARRA
    - Local agencies (over 50 local agencies specify FDR)
    - Pavement & Geotechnical Engineers
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# Cities Specifying FDR

- \* City of Azusa
- \* City of Bakersfield
- \* City of Barstow
- \* City of Beaumont
- \* City of Buena Park
- \* City of Burbank
- \* City of Carson
- \* City of Chula Vista
- \* City of Costa Mesa
- \* City of Delano
- \* City of Downey
- \* City of El Centro
- \* City of Fontana
- \* City of Hanford
- \* City of Hawthorne
- \* City of Huntington Beach
- \* City of La Habra
- \* City of Lakewood
- \* City of LaVerne
- \* City of Long Beach
- \* City of La Quinta
- \* City of Los Angeles
- \* City of Moreno Valley
- \* City of Oxnard
- \* City of Pomona
- \* City of Porterville
- \* City of San Clemente
- \* City of San Dimas
- \* City of San Gabriel
- \* City of Santa Ana
- \* City of Seal Beach

# Public Agencies Specifying FDR

- \* City of Thousand Oaks
- \* City of Temecula
- \* City of Torrance
- \* City of Tulare
- \* City of Ventura
- \* City of Vista
- \* City of Walnut
- \* City of Westminster
- \* City of Westmorland
- \* County of Imperial
- \* County of Los Angeles
- \* County of Orange
- \* County of Riverside
- \* County of San Bernardino
- \* County of Ventura
- \* County of Santa Clara
- \* Los Angeles Airports
- \* Port of Long Beach
- \* Port of San Diego





Thank you!! Questions?