WESTERN STATES IN-PLACE RECYCLING CONFERENCE AUGUST 5-7, 2014 DENVER, CO

Critical Elements for a Successful Full-Depth Reclamation (FDR) Project

Marco A. Estrada
Pavement Recycling Systems

FULL-DEPTH RECLAMATION

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

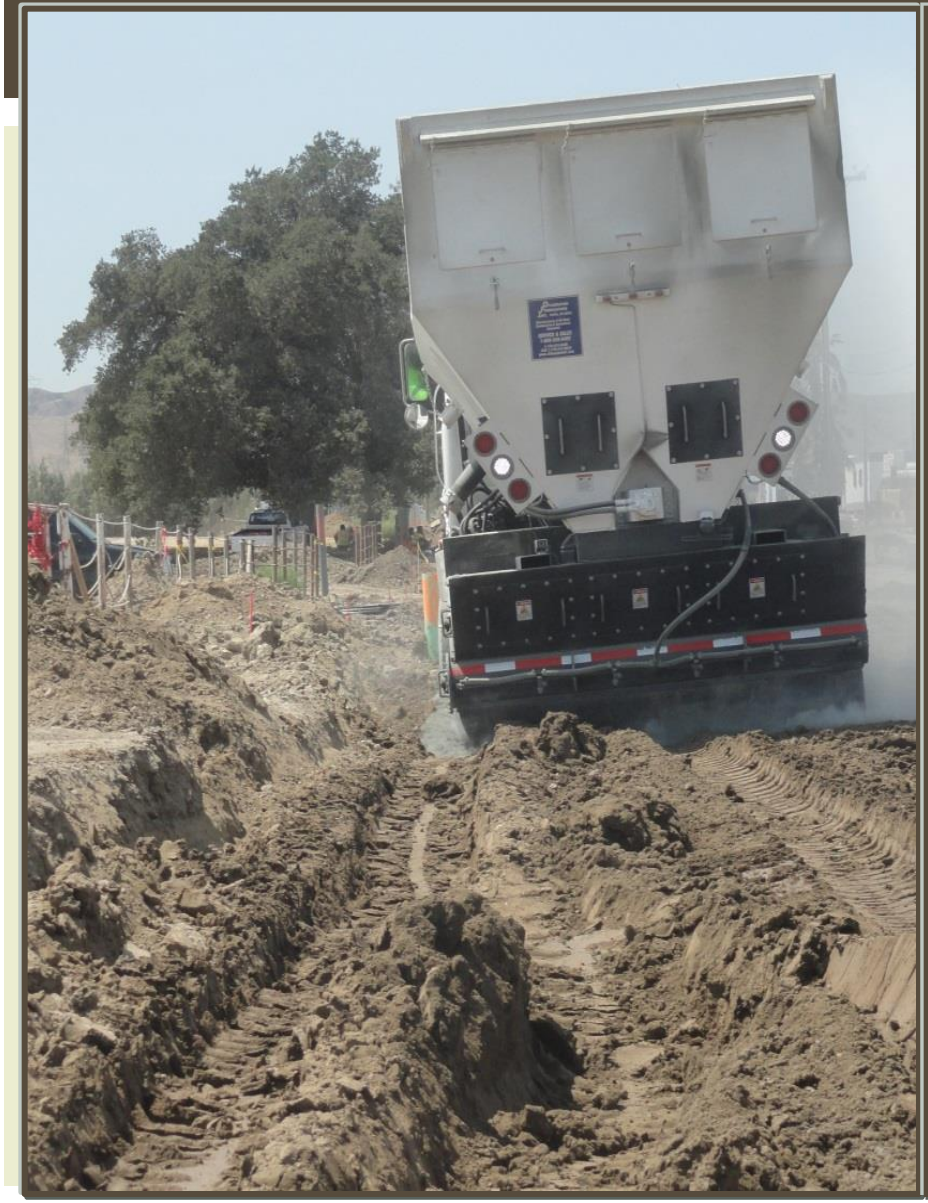
- Chemical Stabilization
- Bituminous Stabilization

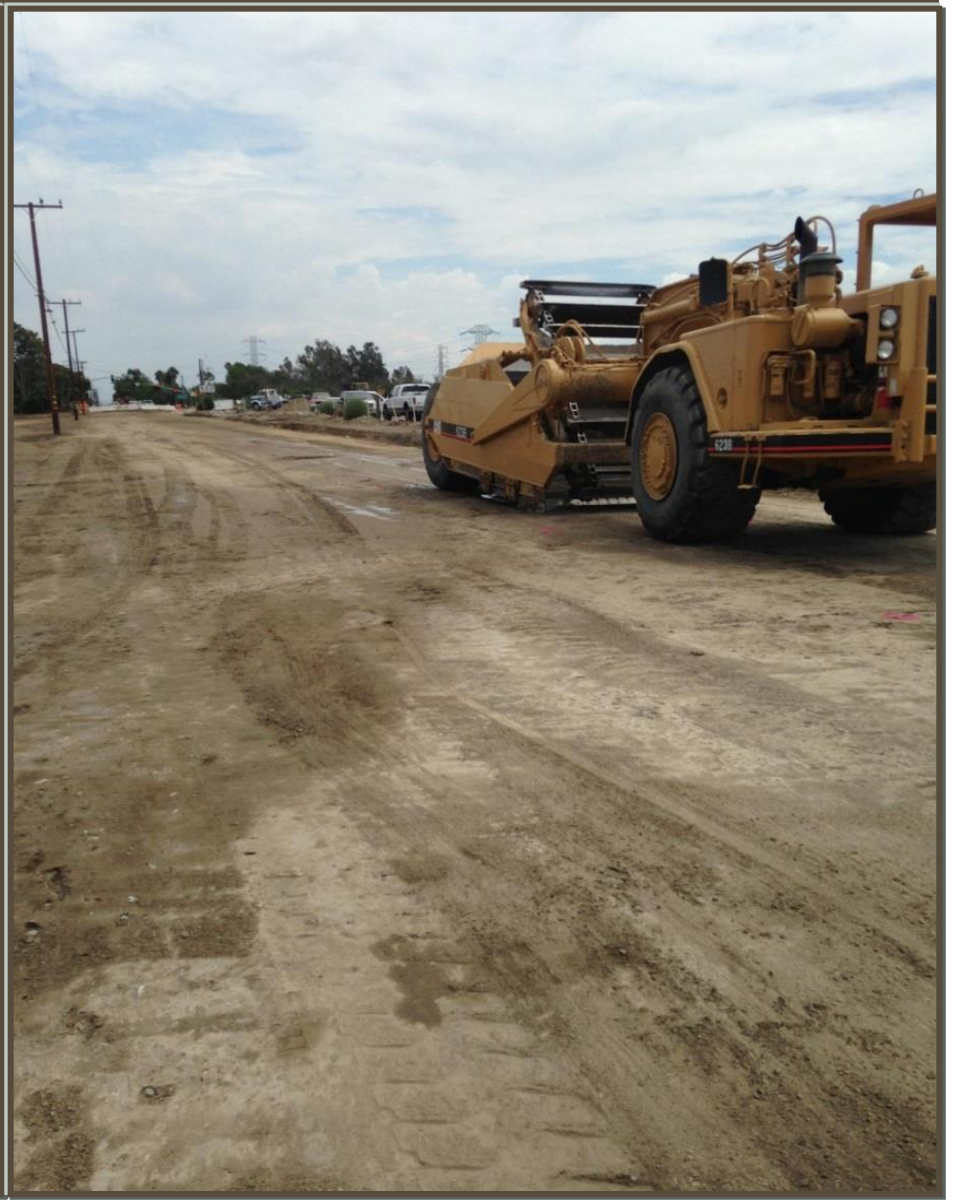
CRITICAL ELEMENTS FDR DESIGN

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

SUB GRADE CONDITIONS

UNSTABLE SUBGRADE REMEDIATION





FDR ADDITIVES & REAGENTS

Chemical Stabilization

- Portland Cement
- Lime
- Pozzolans (Fly Ash)

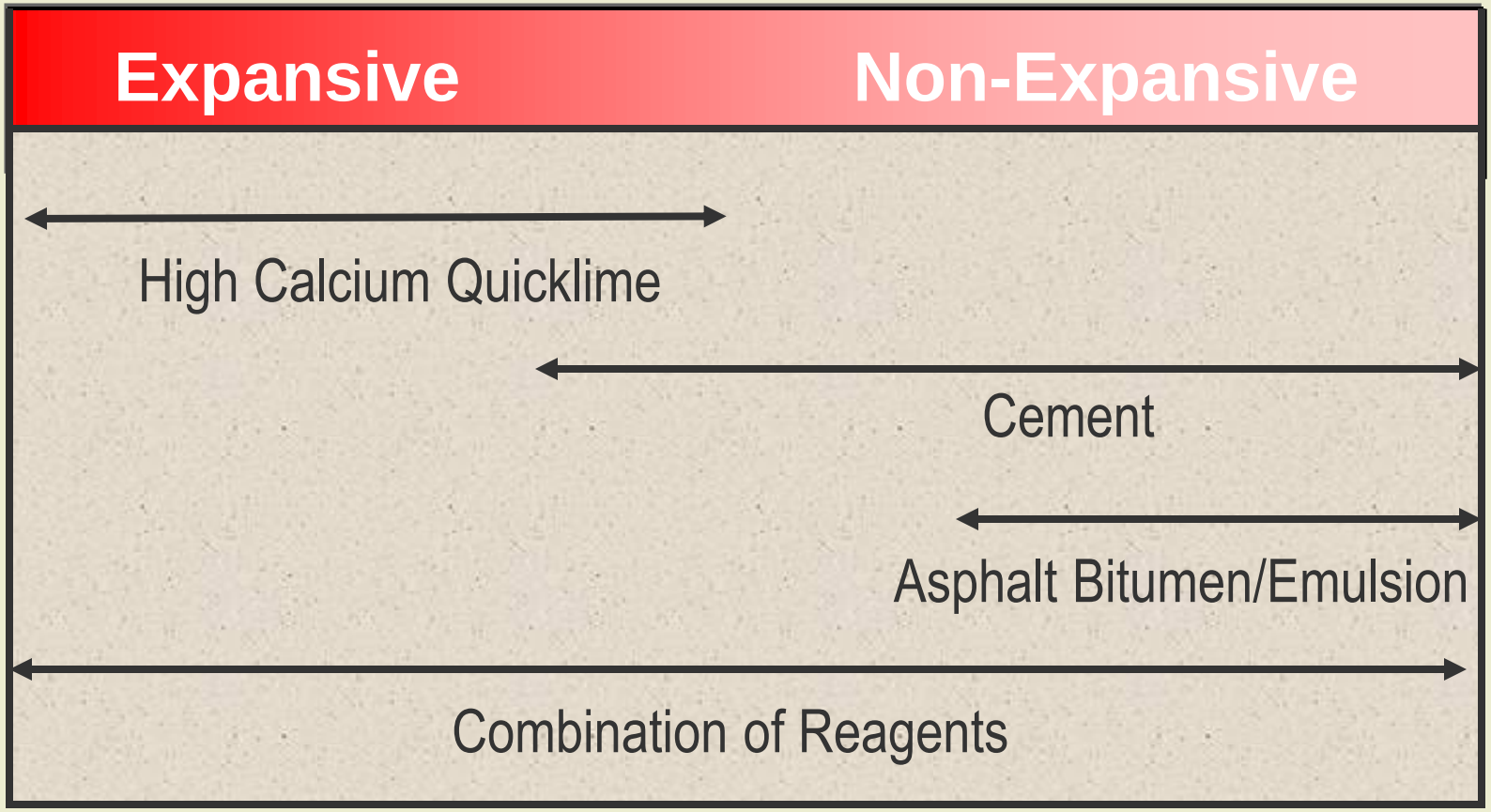
Mechanical Stabilization

- RAP
- Gravel
- Aggregate Base

Bituminous Stabilization

- Foamed Asphalt
- Asphalt Emulsion

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

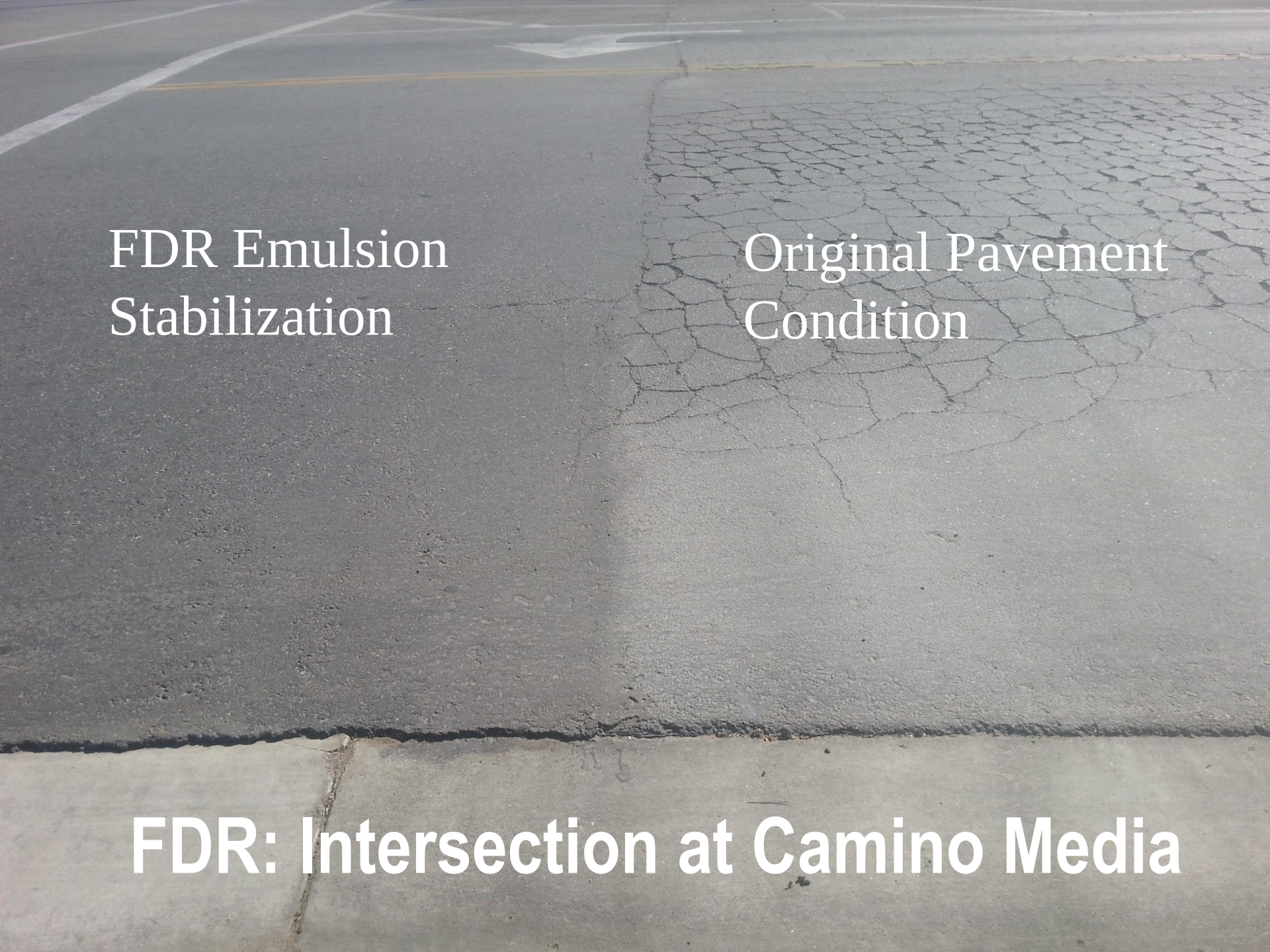


BITUMINOUSSTABILIZATION: RECLAIMER ADDING 4% EMULSION

BITUMINOUS STABILIZATION

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.
- 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.



FDR: Intersection at Camino Media

FDR Chemical Stabilization

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 UCS 300 to 500 psi)

- Lime is used to increase the performance when soils have plastic and expansive properties. (Typical UCS 200 to 400 psi)

- 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.


FDR Reconstruction: Unstable
Subgrade Remediation

CRITICAL ELEMENTS FDR PLANNING

- Underground Utility Location
  - USA and markings
  - Pot-holing
- Project Phasing
  - Facilitate construction operations
  - Minimize impact on businesses and residents
- Traffic control and Community Access
  - Resdiential
  - Arterial

USA Utility Markings

Pot-Holing & Location

Project Phasing

Access to the local Residents

Same day Residential Street: FDR Cement stable, access to local traffic

Residential Street FDR: Traffic Control

Residential Street FDR: Community Access

Arterial Street FDR: Community Access


Arterial Street FDR:
Traffic Control

PLANNING: QC TESTING FOR SOIL STABILIZATION AND FDR PROJECTS

- Sample asphalt/base/soil in section to be treated with reagent
- Conduct laboratory mixed moisture-density curves
- Document variations in FDR asphalt/base/soil and site conditions
- Pre-Construction meeting

FIELD QUALITY CONTROL TESTING & INSPECTION

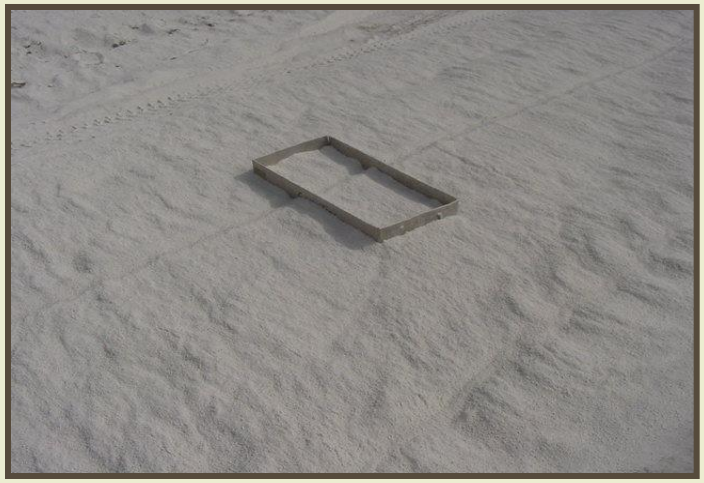
- Reagent spread rate application
- Depth of mixing
- Moisture content
- Mellowing period (lime only)
- Uniformity of mixing and particle sizing
- Compaction testing
- Post compaction curing

SPREADING

- Mechanical vane feed spreader allows for uniform distribution on the grade

- On board controls provide for a metered material application

SPREAD RATE INSPECTION



- Check Point Inspection
- - Pan Method: Using a pan of a known area, determine the spread rate in lb/sf.

- Mathematical Inspection
- - Confirm the area of coverage for each spreader truck load using the certified weights & theoretical spread rate.

INITIAL MIXING

- High capacity rotary mixers provide for increased uniformity of soil, reagent, and water mixture

- Water system allows for introduction of water into mixing chamber for reagent hydration throughout the depth of stabilization

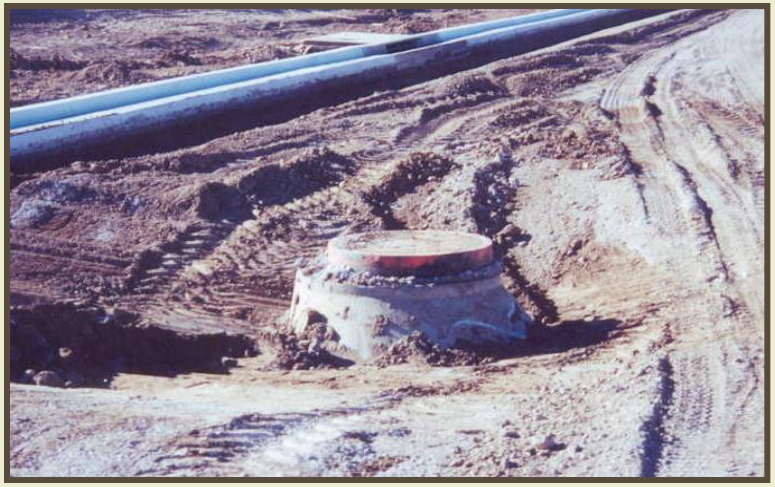
DEPTH OF TREATMENT INSPECTION

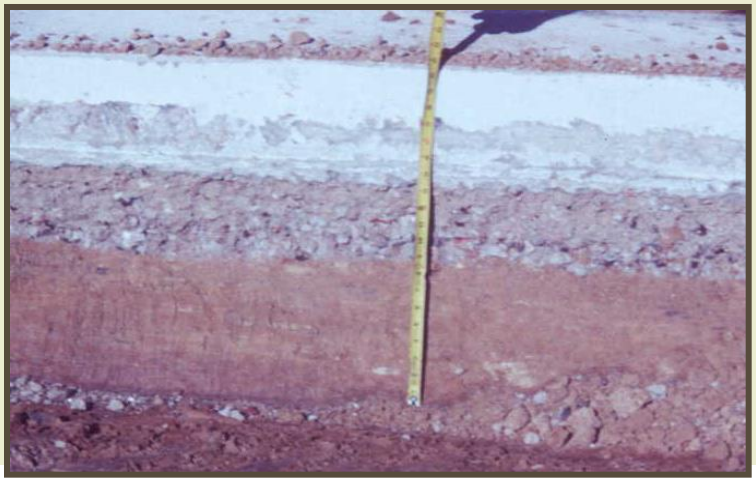
- Excavate test pit in treated section either loose or compacted
- Phenolthalein pH indicator solution. Color change at pH 10-10.5
- Spray solution along face of test pit to determine treatment bottom
- Check Depth using grade stake elevations or measure compacted depth

“MELLOWING” OR LOOSE CURING PERIOD LIME ONLY

- Moisture condition to +3 over OMC & allow to cure or mellow in loose state for minimum of 16 hours.
- Allows for cationic transfer and initial pozzolan formation
- “Breaks down” clay particles.

HEALING OUT STRUCTURES & EDGES





- Soil around structures such as manholes, utility risers, and cross gutters is “healed or pulled out” into area accessible to mixer

- Edges adjacent to curb and gutter are “healed or pulled out” into areas accessible to mixer

FINAL MIXING

- Remix soil-lime/cement mixture to achieve gradation:

- 100% passing 1.5”

- 60% passing No. 4

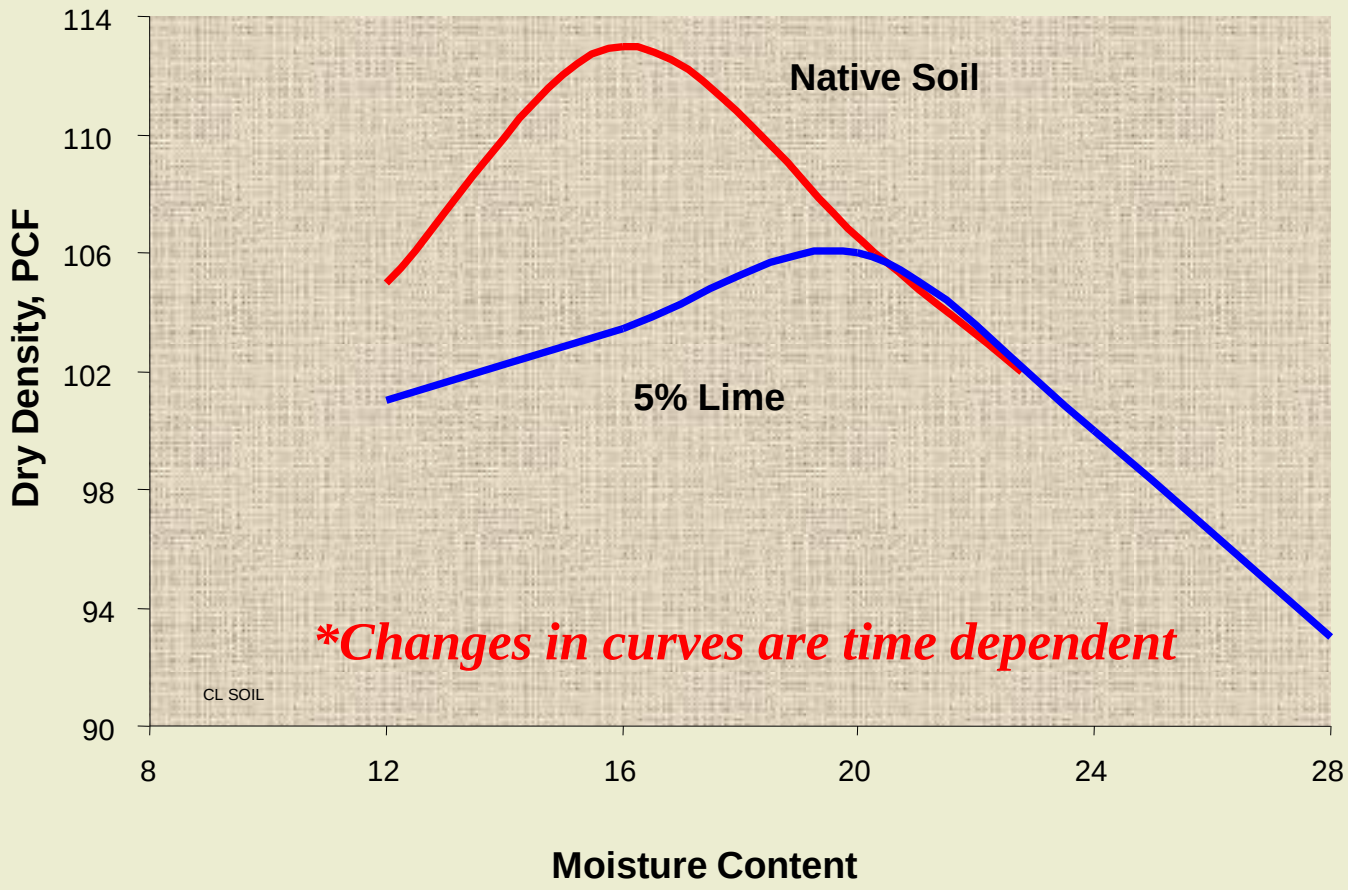
- Moisture condition to a minimum +2 above OMC prior to initial compaction

- Use phenolthalein to check for uniformity

INITIAL COMPACTION & FINE GRADING

- Initial compaction using a steel segmented compactor
- Typically 95% of MDD
- Moisture 0% to +3% of OMC
- Fine grading after initial

MOISTURE/DENSITY RELATIONSHIPS



COMPACTION TESTING

- Use conventional testing methods such as nuclear gauge and sandcone methods
- MDD & OMC determined on lime stabilized soil. Curve reflects decrease in MDD and increase in OMC
- Utilize wet-density methods to determine relative compaction


LANE CLOSED
OPEN TRENCH

MICRO-CRACKING

- Measure initial stiffness after 24 hours of curing
- Within 48 to 72 hours initiate micro-cracking
- Micro-crack using vibratory steel drum roller
- Typically 3 to 4 passes
- Caution not to over-roll

COMMON QUALITY CONTROL ISSUES

- Asphalt Pulverization Gradation: typical 2” minus gradation specification
- Stabilized Soil Gradation: material changes requiring more reagent or more mellowing time
- Pumping Soil/Failing Compaction: compact to “maximum achievable field density”
- Areas of more severe subgrade distress

COMMON QUALITY CONTROL ISSUES

- "Healing of material" adjacent to structures
- Grading operations result in "sliver fills"
- Inadequate curing of stabilized surface
- Initial and Final Stiffness Readings are not achieved during Micro-cracking

FDR TODAY

- 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 FDR specifications
  - Joint Committees working on specifications
- Guidelines & Specifications available
  - ARRA
  - Local agencies
  - Pavement & Geotechnical Engineers

THANK YOU!!

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