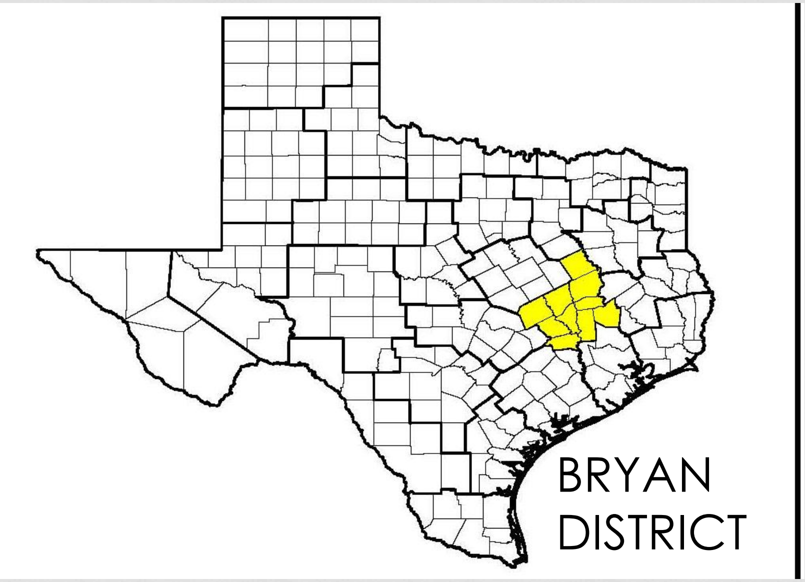


BEST PRACTICES FOR EDGE CRACKING

DARLENE C. GOEHL, P.E.
TXDOT – BRYAN DISTRICT – MAY 31, 2013

OUTLINE

- Problems – Flexible and Rigid Pavement
  - Edge Cracking
  - Environmental Cracking
  - Contributing Factors
- Testing and Design
  - Flexible Pavement
    - Design Techniques
  - Rigid Pavement
    - JCP with reinforced repair
- Maintenance

FLEXIBLE PAVEMENT LONGITUDINAL CRACKING PROBLEMS

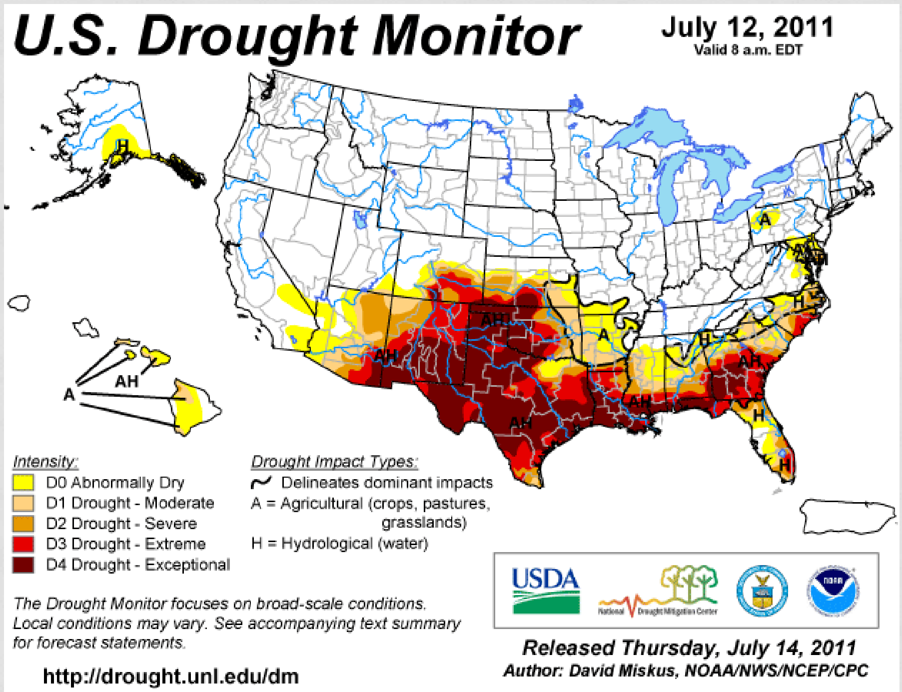
FLEXIBLE PAVEMENT LONGITUDINAL CRACKING PROBLEMS

FLEXIBLE PAVEMENT LONGITUDINAL CRACKING PROBLEMS

CRACKING IN JOINTED CONCRETE PAVEMENT

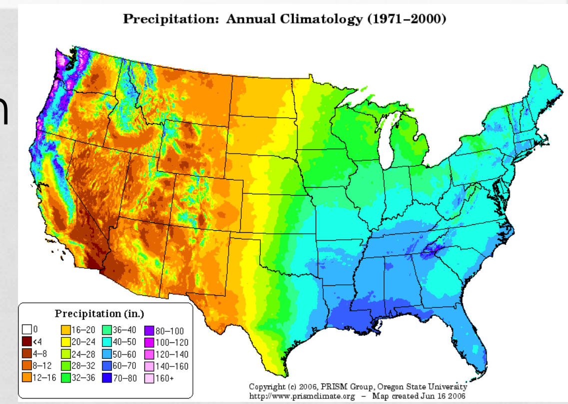
- Random Longitudinal Cracks

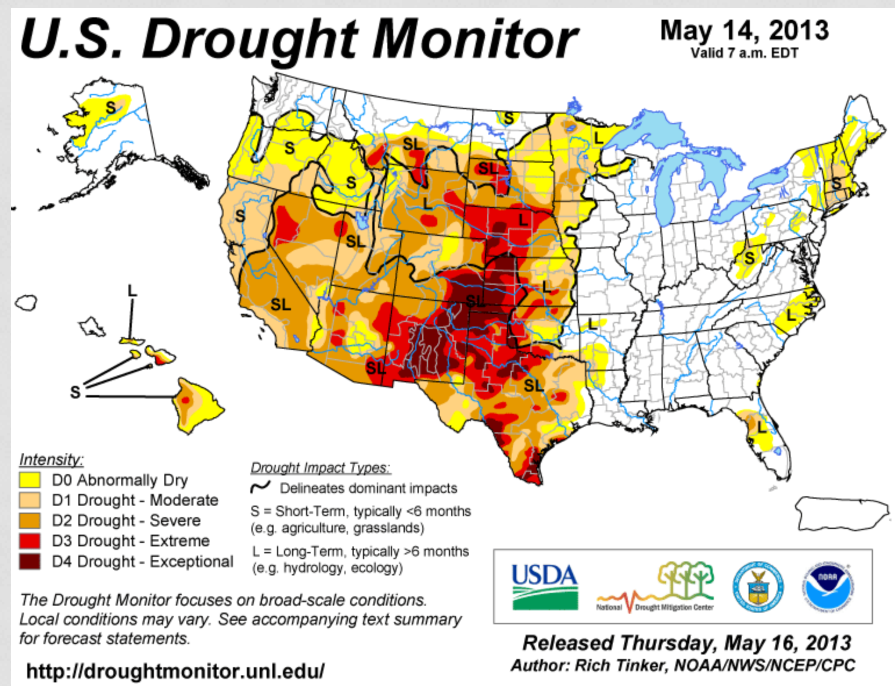
WEATHER - DROUGHT



2011

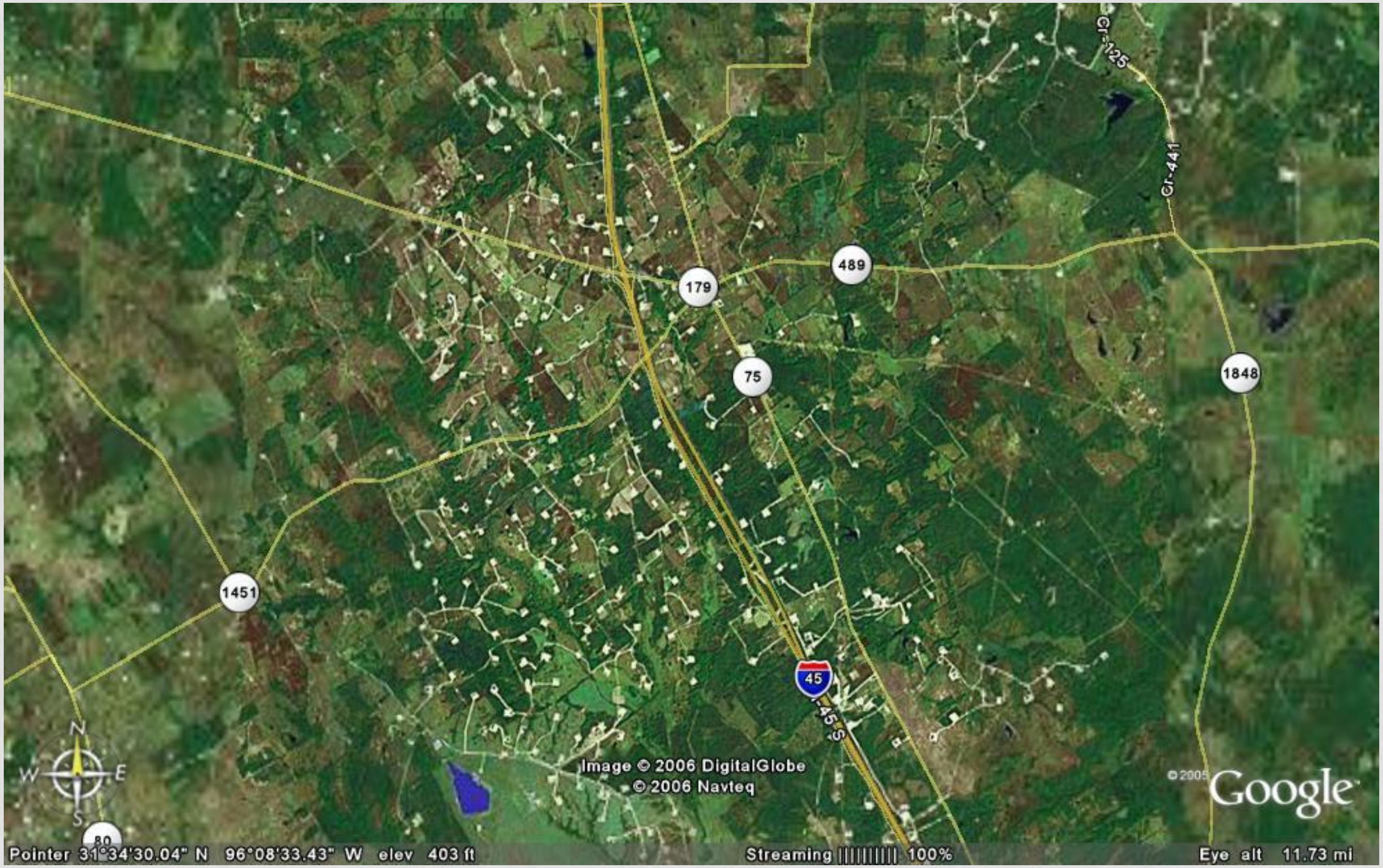
Annual Precipitation





2013

ENERGY SECTOR ISSUES



SUPERHEAVY LOADS

PROJECT SPECIFIC ISSUES

- Edge Support
- Steep Front Slopes
- Soils
  - Typically PI>35
- Vegetation
  - Oak Trees

SOME CAUSES OF LONGITUDINAL CRACKING

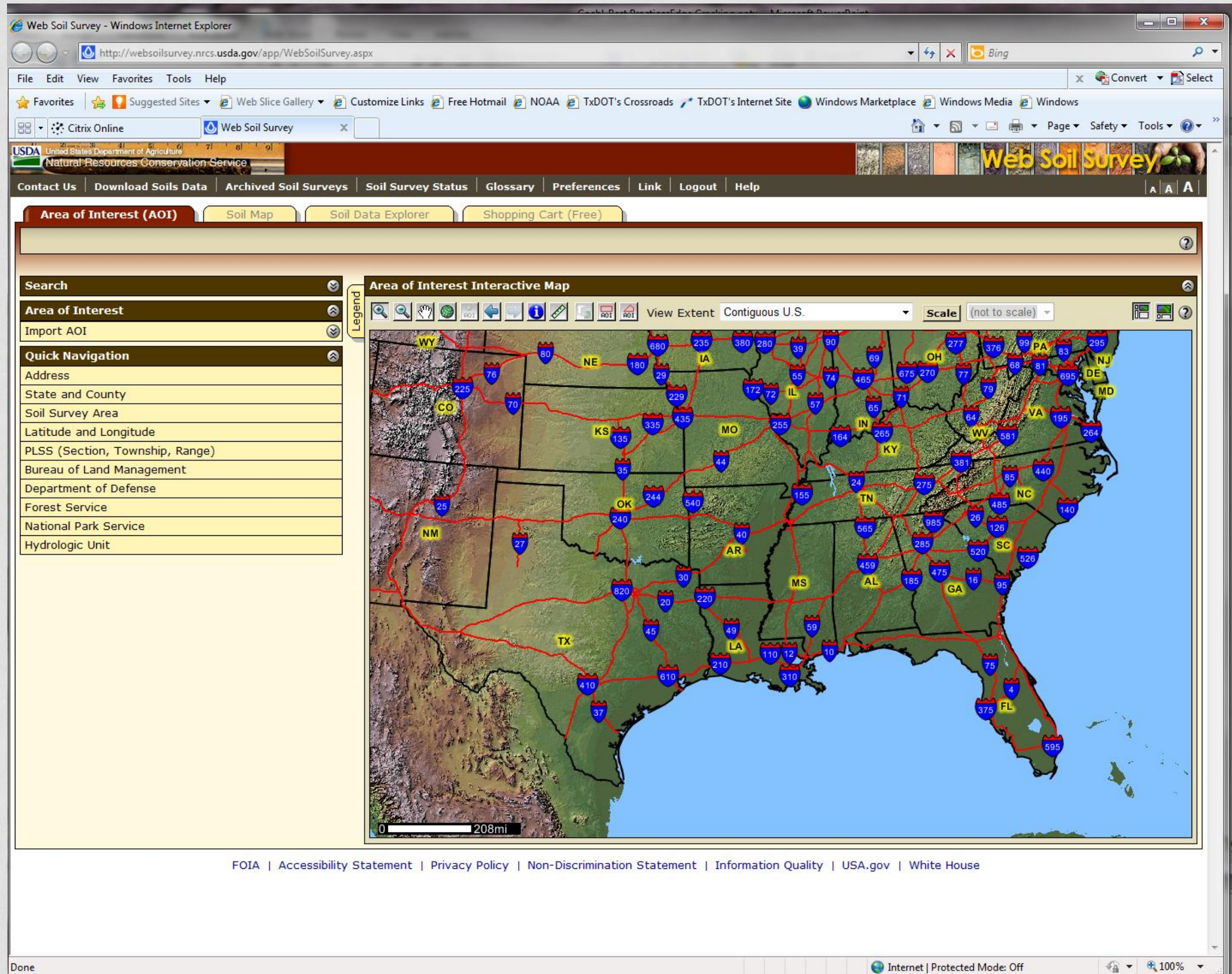
- Subgrade Shrinkage associated with:
  - PI > 35
  - Trees near edge
  - Summer droughts
  - Stiff bases

IDENTIFY THE CAUSE OF CRACKING

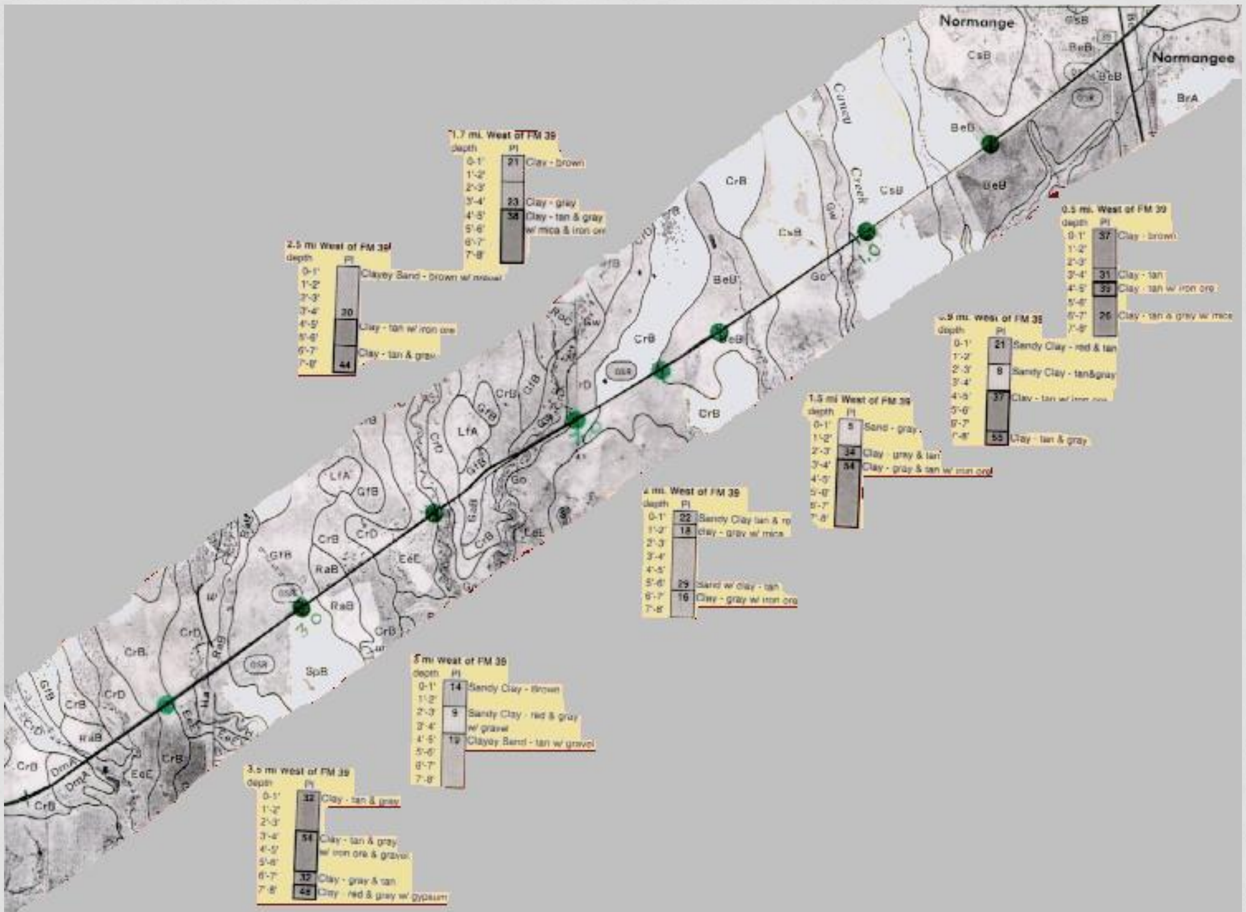
- Assemble Background Information
- Nondestructive testing (NDT) Evaluation and Section Breakdown
  - Ground Penetrating Radar (GPR)
  - Falling Weight Deflectometer (FWD)
- Verifying Pavement Structure and Sampling
  - Auger samples of pavement
  - Verification of problem location
  - Dynamic Cone Penetrometer (DCP) on shoulder/front slope for widening
  - Subgrade properties

ONLINE SOIL DATA

- http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx



TYPICAL SOIL MAP FOR BRYAN DISTRICT



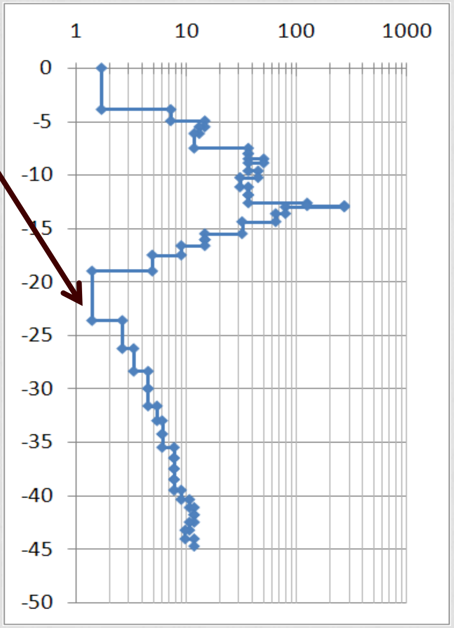
SH OSR – (FM39 to 4 miles West)
PI ranges 5 to 55 over length of project and within the same boring.

PAVEMENT EVALUATION TOOLS

- GPR - thickness variability; identify major problem areas; sampling locations
- DCP - in-site strengths of lower layers
- FWD - Strength variability; subgrade stiffness entire project

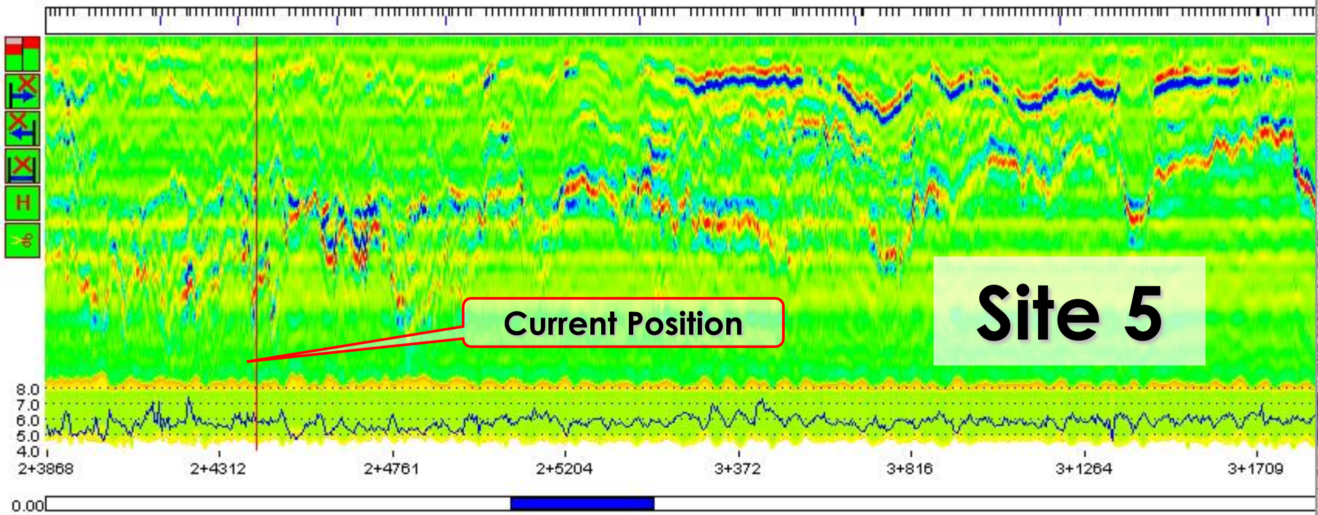
DCP

- Determine underlying pavement support
- Determine depth of failure shear plane for edge failures

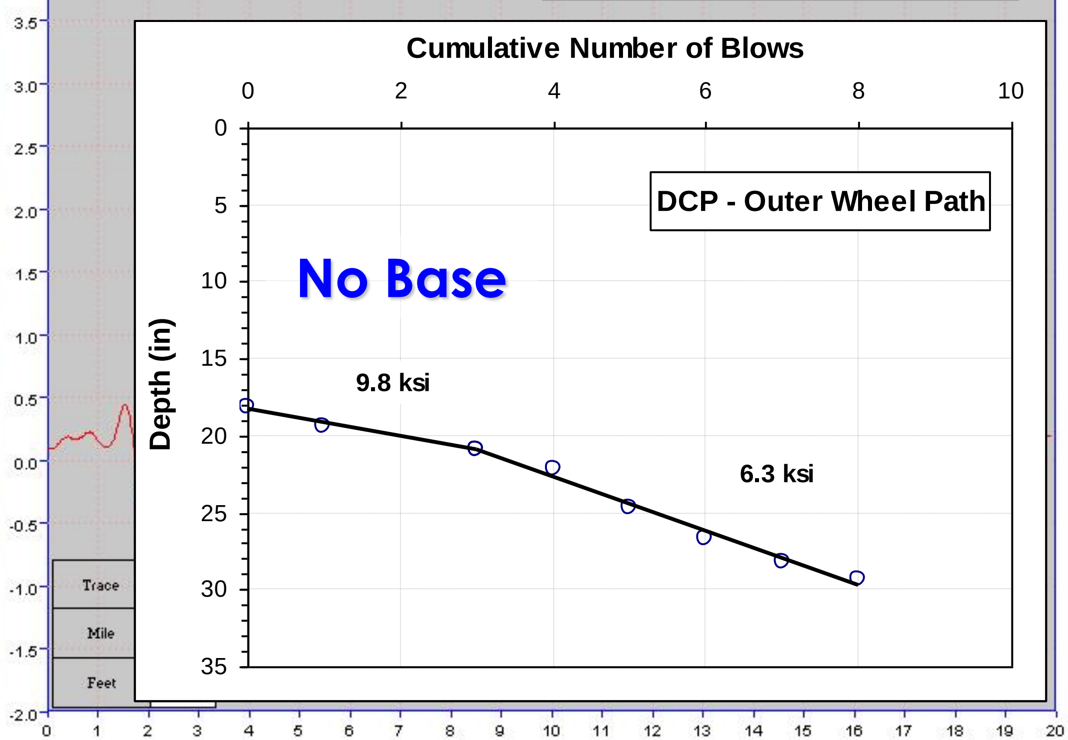


PAVEMENT EVALUATION TOOLS

Soil and Pavement sampling


Site 5
Current Position
8.0
7.0
6.0
5.0
4.0
2+3868
2+4312
2+4761
2+5204
3+372
3+816
3+1264
3+1709
0.00


2 mi 4407 ft


Cumulative Number of Blows
DCP - Outer Wheel Path
No Base
Depth (in)
9.8 ksi
6.3 ksi
0
2
4
6
8
10
0
5
10
15
20
25
30
35
Trace
Mile
Feet

PAVEMENT TESTING VS. PROJECT COST

Testing is typically less than 1.5% of project cost.

Scope of Work	Project	Project (28' rdwy)	GPR	FWD	Pave Cores	Soil Cores	Total Testing	Test % of total Project Cost
	$/sy	$/mile	$/mile	$/mile	$/mile	$/mile	$/mile	$/mile
Overlay w/ underseal	$15.22	$250,000	$155	$100	$110		$365	0.15%
Rework + 6" FB + 2cst	$16.44	$270,000	$155	$100	$110	$3,500	$3,865	1.43%
Cement Treat exist + FB+2cst	$18.26	$330,000	$155	$100	$110	$3,500	$3,865	1.17%
Spot Repair (est 15% repairs 8" thick)+SC	$7.00	$115,000	$155	$100	$110		$365	0.32%
Spot Repair (est 25% repairs 8" thick)+SC	$10.00	$165,000	$155	$100	$110		$365	0.22%

Note: Pavement is approximately 70% of the total project cost. Preliminary Engineering, including testing, is approximately 4% of the total project cost.

FLEXIBLE PAVEMENT DESIGN APPROACH

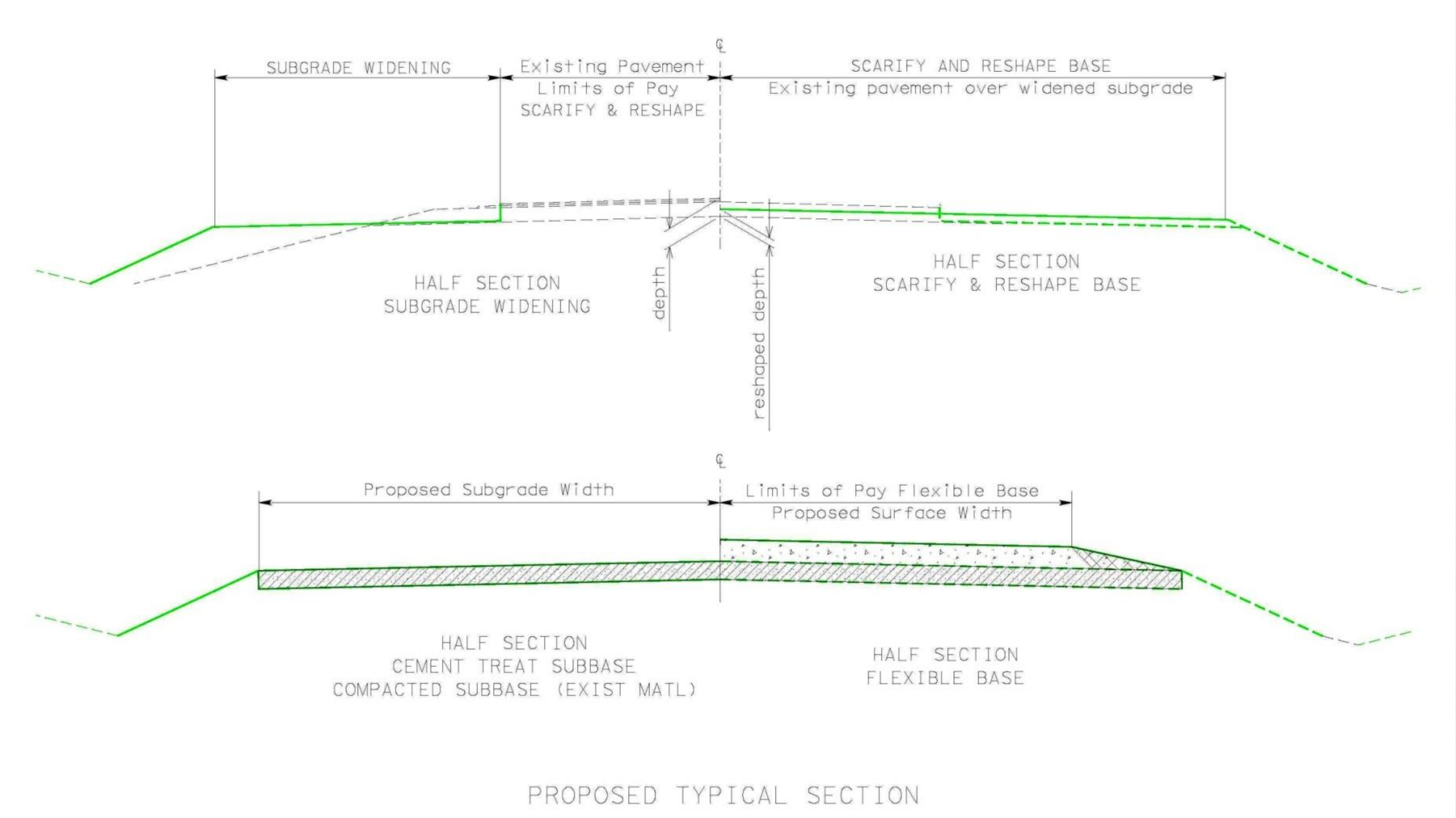
DESIGN TECHNIQUES

TYPICAL LOW VOLUME ROADWAY – PAVEMENT REPAIR

Goal –

Uniform Pavement Structure

Widen to improve edge support.



VARIABLE PAVEMENT STRUCTURE

Variable depths HMA up to 9 inches,

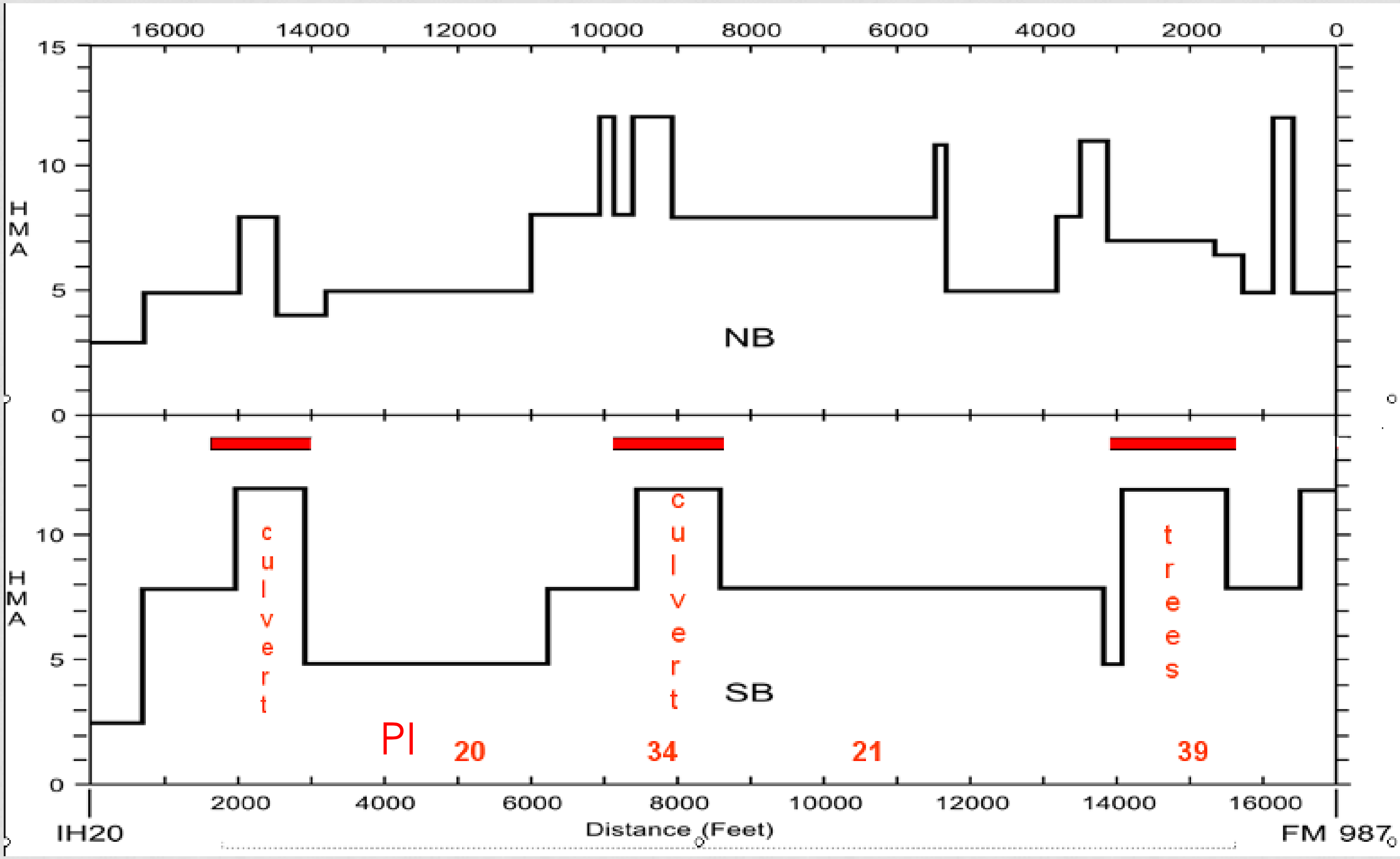
3 inches of base, PI 60 soils

Lots of maintenance;

No shoulders

Traffic handling issues

FM - HMA THICKNESS

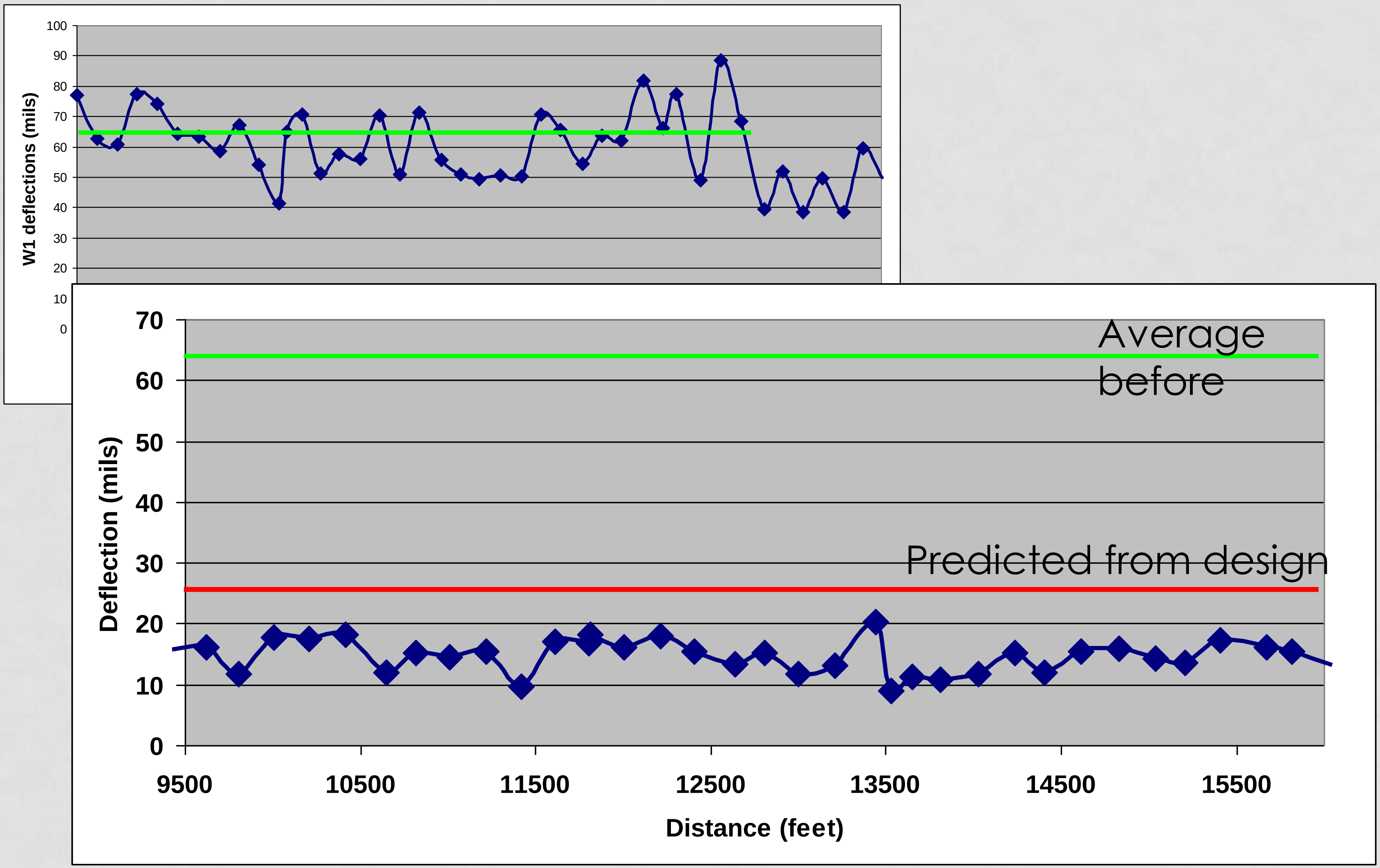


UNIFORM PAVEMENT STRUCTURE

CHANGE DESIGN STRATEGY THROUGHOUT THE LIMITS OF THE PROJECT

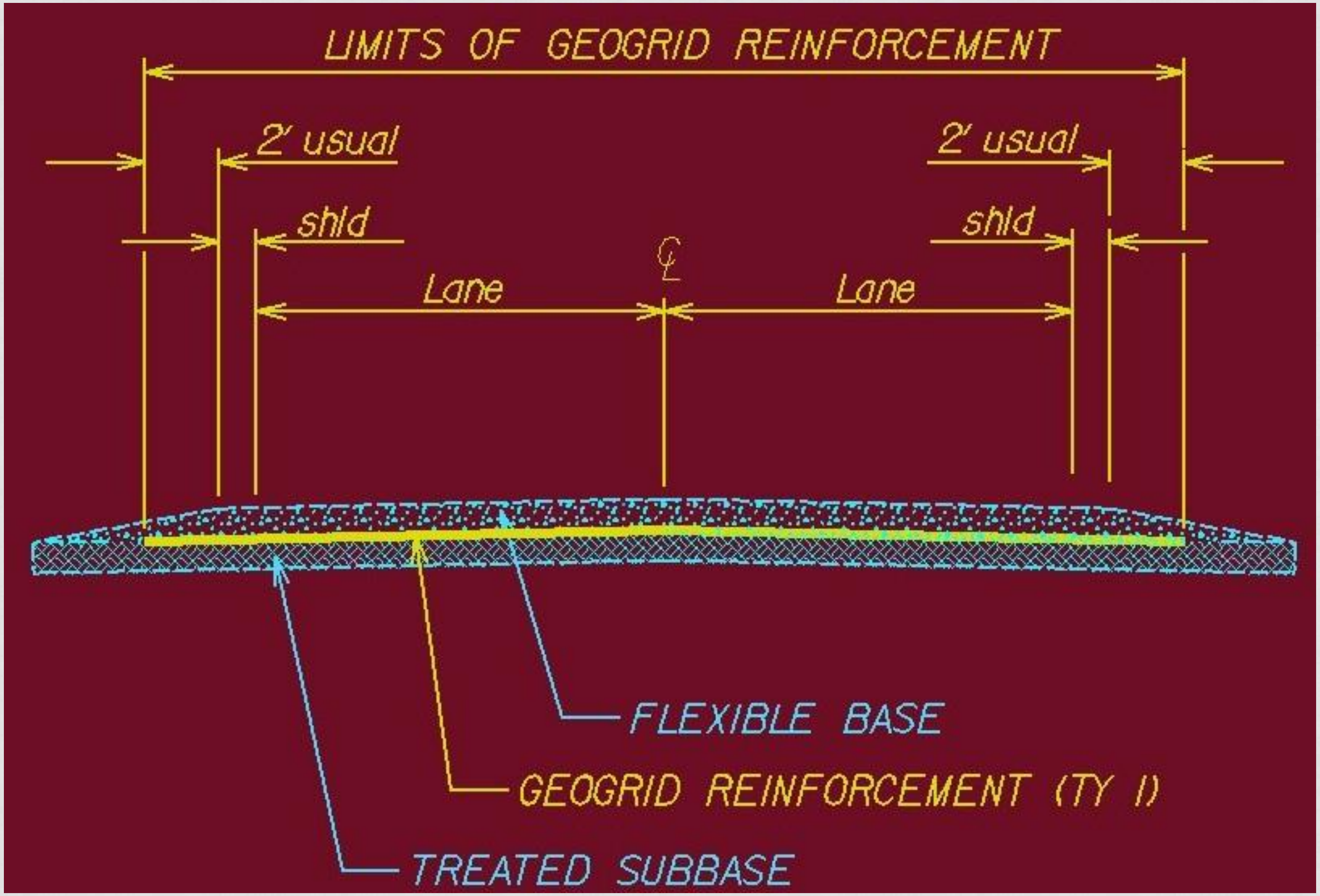
From - To (feet)	Treatment
0 - 700	2 inch overlay only (new construction)
700 - 1800	Mill 4 inches of HMA the FDR 8 ins + base overlay
1800 - 3000	Mill 6" HMA add 4" new base; FDR 8" + Geogrid + base overlay
3000 - 6000	FDR 8" + base overlay
6300 - 7200	Mill 4 inches of HMA the FDR 8 ins + base overlay
7200 - 8900	Mill 6" HMA add 4" new base; FDR 8" + Geogrid + base overlay
8900 - 14000	Mill 4 inches of HMA the FDR 8 ins + base overlay
14000 - 15600	Mill 6" HMA add 4" new base; FDR 8" + Geogrid + base overlay
15600 - 16700	Mill 4 inches of HMA the FDR 8 ins + base overlay
16700 - end	2 inch HMA over only (intersection new construction)

FWD DATA - EXAMPLE
FWD 9000 LB MAXIMUM DEFLECTION

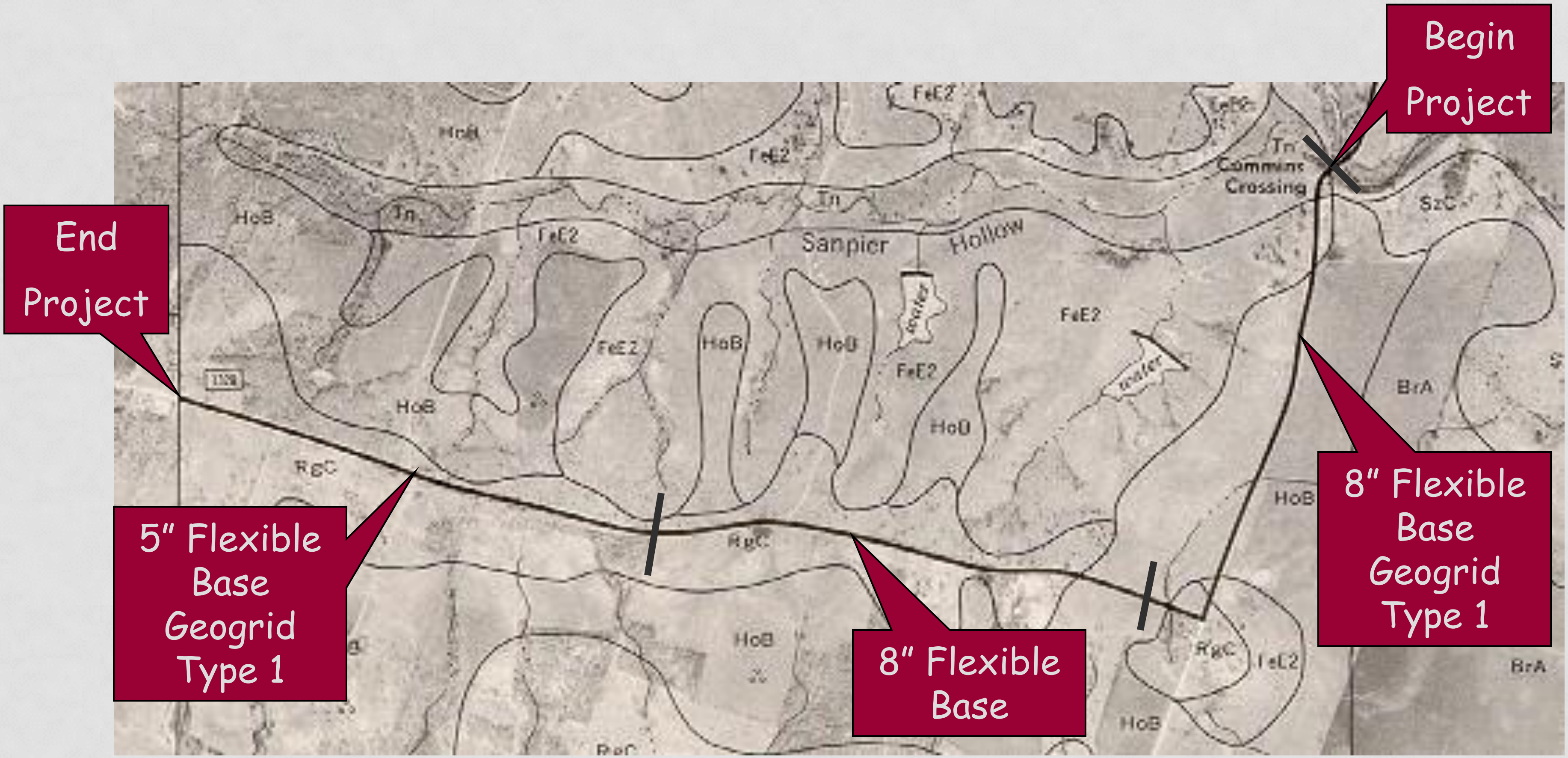


PAVEMENT REPAIR OVER HIGH PI SOILS

Use Geogrid Reinforcement to control reflective cracking from the subgrade.



FM 1915 – RECONSTRUCTED IN 1997
US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE SOIL SURVEY



All sections have 10” lime treated subbase (5% lime) and a seal coat surface.

TEST SECTION SUMMARY

Section 1	Control Section	Section 2
Geogrid and 8" Flexible base	No Geogrid 8" Flexible Base	Geogrid and 5" Flexible base
0.65 miles west of Little River Relief Bridge	1.6 miles west of Little River Relief Bridge	2.5 miles west of Little River Relief Bridge
Subgrade 6" to 6' PI = 37 Black clay Subgrade 6' to 8', PI = 36 gray clay	Subgrade 0' to 1', PI = 26 Brown clay Subgrade 1' to 2', PI = 19 Tan silty clay Subgrade 2' to 6', PI = 37 Black clay Subgrade 6' to 8', PI = 31 Gray clay	Subgrade 0' to 8' PI = 49 Black clay
No Cracking at yr 5	Cracking at yr 5	No Cracking at yr 5

FM1915 – 5 & 16 YEARS AFTER RECONSTRUCTION

DISTANCES MEASURED FROM LITTLE RIVER RELIEF BRIDGE

GEOGRID SECTION 1
0.65 MILES

2001

2013

GEOGRID SECTION 2,
2.2 miles

2001

2013

FM1915 – 5 & 16 YEARS AFTER RECONSTRUCTION

DISTANCES MEASURED FROM LITTLE RIVER RELIEF BRIDGE

CONTROL SECTION,
1.3 miles

2001

2013

CONTROL SECTION,
0.83 MILES

2001

2013

DESIGN APPROACH

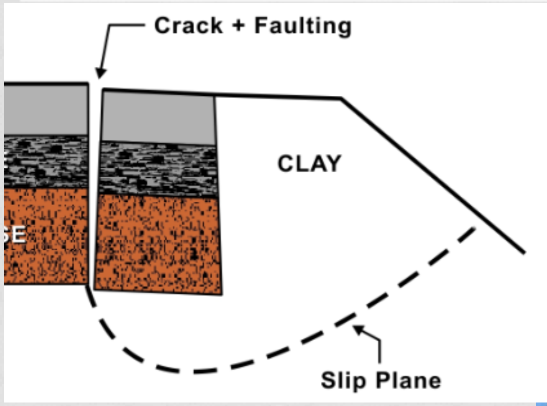
- Utilize the U.S. Department of Agriculture Soil Conservation Service maps to identify possible problem soils. Define testing locations based on this information.
  - This is in addition to the Districts standard one mile testing frequency.
- Perform soils tests to a depth of seven feet below the pavement.
  - This depth is based on the moisture fluctuation within the district.
- Define the limits of potential problem areas based on the soil testing.
- Analyze the FWD data, looking for areas of weak subgrade.
- Drive the project and look for existing problems and areas maintenance has already repaired.
- Combine all the information to define the limits of Geogrid reinforcement.

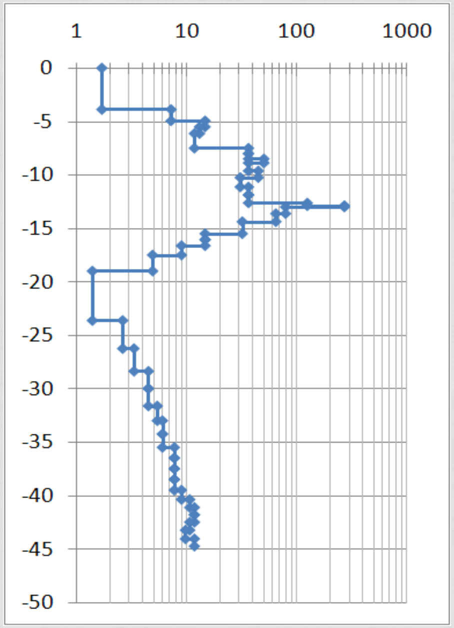
GEOGRID COST INFORMATION

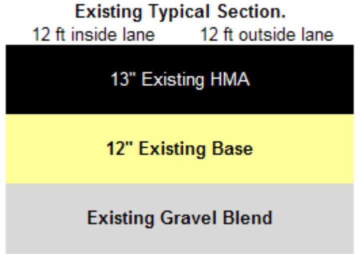
Description	Geogrid Cost	FY 01 & FY 02 Maintenance Cost
SH OSR 0475-03-048	n/a	$38,900
SH OSR 0475-03-053	$55,734	n/a
FY 00 average Geogrid Cost = $1.89/sy FY 01 average Geogrid Cost = $1.60/sy		

- These projects are adjacent between the Navasota River and FM39 in Madison County.
- **The benefit is in extending the service life of pavements under environmental loads, and consequently, reducing the maintenance costs associated with these roads**
- Note: Reference TxDOT research project 5-4829 for additional information.

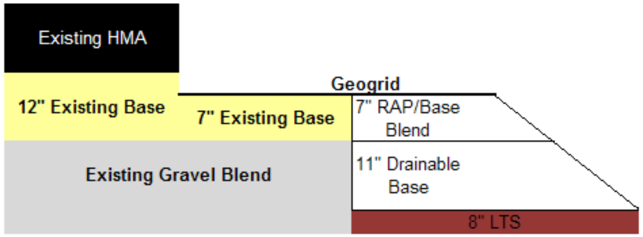
NEW APPROACHES TO SHOULDER WIDENING



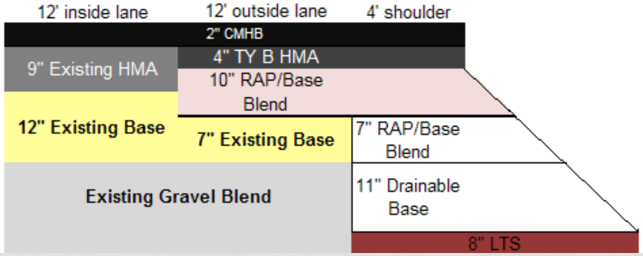




Mill 8" in outside lane.
FDR 10" and remove offsite for pugmill mixing.
Construct shoulder and place geogrid.



Place 10" RAP/Base Blend.
Place 6" new HMA.
Mill 4" in inside lane and place 2" CMHB.



SH 21 EAST OF US 290

CONTROL TRANSVERSE CRACKS IN STABILIZED BASE
MICRO-CRACK CEMENT TREATED BASE

Not Microcracked

Microcracked

MICRO-CRACKING

- Determine optimum stabilizer content based on unconfined compressive strength and moisture susceptibility.
- 12 ton vibratory roller
- 1 –2 days after placement
- 2-3 mph, High amplitude
- 2 – 4 passes
- Test after 2 passes

- TxDOT research project 4502

RIGID PAVEMENT CASE STUDY

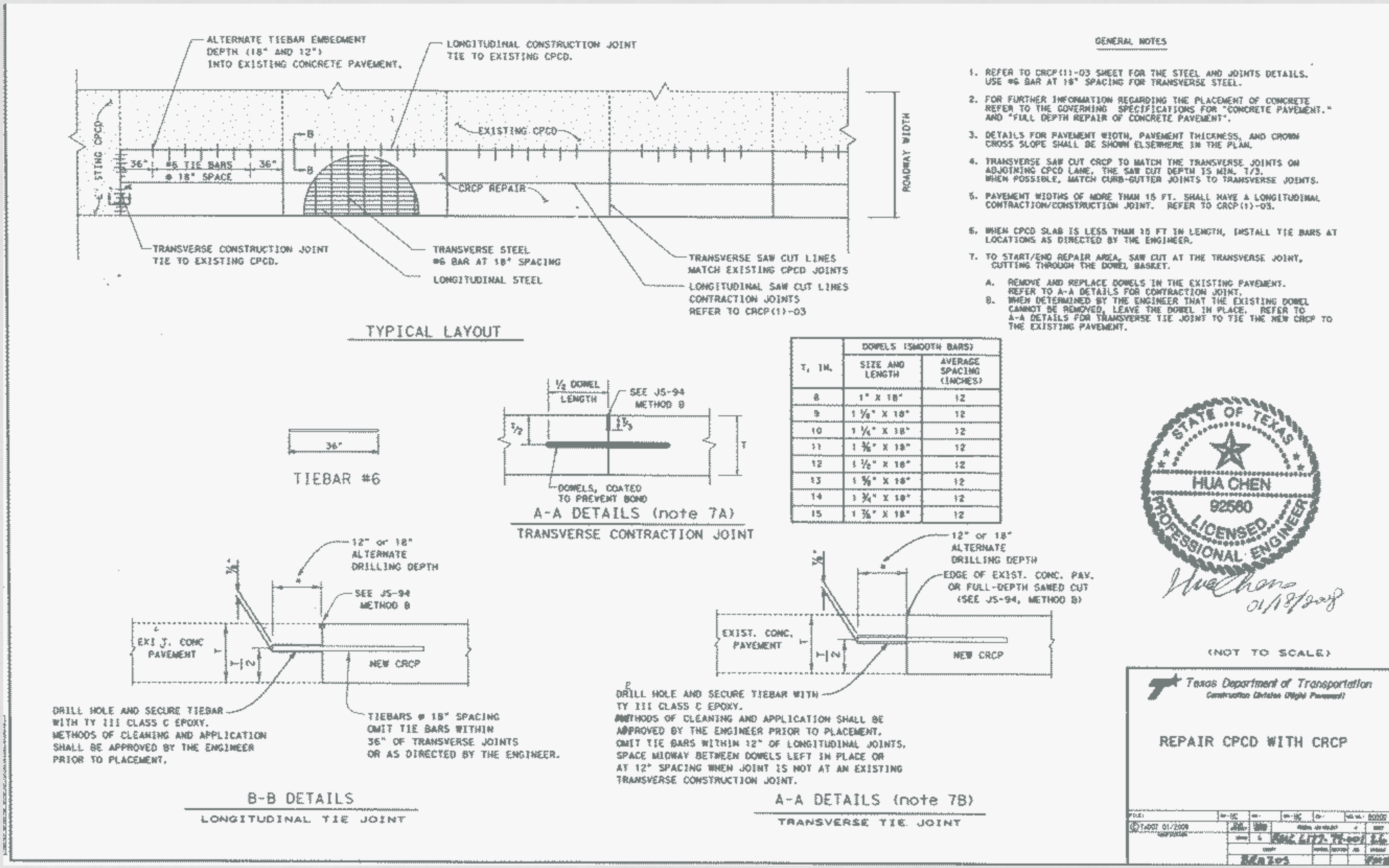
FM 2347
FROM FM 2154 TO FM 2818, BRAZOS COUNTY TEXAS

JOINTED CONCRETE PAVEMENT

- Random Longitudinal Cracks

9" CPCD
4" HMA
10" Lime Treated Subgrade
Subgrade PI ranges from 14 to 49

REPAIR DETAIL – REINFORCED PATCH OF JOINTED CONCRETE PAVEMENT



GENERAL NOTES

1. REFER TO CRCP(1)-03 SHEET FOR THE STEEL AND JOINTS DETAILS. USE #6 BAR AT 18" SPACING FOR TRANSVERSE STEEL.
2. FOR FURTHER INFORMATION REGARDING THE PLACEMENT OF CONCRETE REFER TO THE GOVERNING SPECIFICATIONS FOR "CONCRETE PAVEMENT." AND "FULL DEPTH REPAIR OF CONCRETE PAVEMENT".
3. DETAILS FOR PAVEMENT WIDTH, PAVEMENT THICKNESS, AND CROWN CROSS SLOPE SHALL BE SHOWN ELSEWHERE IN THE PLAN.
4. TRANSVERSE SAW CUT CRCP TO MATCH THE TRANSVERSE JOINTS ON ADJOINING CPCD LANE. THE SAW CUT DEPTH IS MIN. T/3. WHEN POSSIBLE, MATCH CURB-GUTTER JOINTS TO TRANSVERSE JOINTS.
5. PAVEMENT WIDTHS OF MORE THAN 15 FT. SHALL HAVE A LONGITUDINAL CONTRACTION/CONSTRUCTION JOINT. REFER TO CRCP(1)-03.
6. WHEN CPCD SLAB IS LESS THAN 15 FT IN LENGTH, INSTALL TIE BARS AT LOCATIONS AS DIRECTED BY THE ENGINEER.
7. TO START/END REPAIR AREA, SAW CUT AT THE TRANSVERSE JOINT, CUTTING THROUGH THE DOWEL BASKET.
   - A. REMOVE AND REPLACE DOWELS IN THE EXISTING PAVEMENT. REFER TO A-A DETAILS FOR CONTRACTION JOINT.
   - B. WHEN DETERMINED BY THE ENGINEER THAT THE EXISTING DOWEL CANNOT BE REMOVED, LEAVE THE DOWEL IN PLACE. REFER TO A-A DETAILS FOR TRANSVERSE TIE JOINT TO TIE THE NEW CRCP TO THE EXISTING PAVEMENT.

T, IN.	DOWELS (SMOOTH BARS)	
	SIZE AND LENGTH	AVERAGE SPACING (INCHES)
8	1" X 18"	12
9	1 1/8" X 18"	12
10	1 1/4" X 18"	12
11	1 3/8" X 18"	12
12	1 1/2" X 18"	12
13	1 5/8" X 18"	12
14	1 3/4" X 18"	12
15	1 7/8" X 18"	12

FM 2347 CONCRETE REPAIR

2006 – Before Repairs

2013 – 7 years after repairs

FM 2347 CONCRETE REPAIR

Reinforced Patch

Crack is Controlled

MAINTENANCE

- Widen Edge for Support
- Herbicide
- Blade back soil buildup
- Fix dropoffs

CONCLUSION

- Determine the cause of the cracking
  - Research History
  - Perform Field Testing
- Design a cost effective solution
  - Improve edge support
  - Consider Geogrid Reinforcement
  - Microcrack stabilized bases
  - Reinforce patches in Jointed Concrete
- Perform Routine Maintenance
  - Herbicide
  - Blade edges

QUESTIONS

Heather Goehl
Fightin' Texas Aggie
Class of 2013