NAPTF F/HWD Round-Up

October 2010

National Airport Pavement Test Facility

Building 296 (Research and Development)

Atlantic City Int'l Airport

Introduction

The purpose of this document is to provide documentation of the HWD Round-Up construction. Specifically, the pavement structure, characterization testing of pavement structure, and instrumentation of the pavement structure. This data will provide a basis for understanding the project and the data that will be collected during the F/HWD testing.

Currently, several variations of F/HWD equipment exist on the market. While the purpose of the equipment is the same, some subtle differences are evident between each manufactured F/HWD. The NAPTF Round-Up provides the opportunity to examine the different market available F/HWD equipment. Each model will perform the same testing on a known pavement structure in order to compare testing procedures, data acquisition, and data output. This data will be coupled with data collected from instrumentation constructed into the pavement structure. Finally, F/HWD data from each model will be utilized in backcalculation software to determine modulus values of the layers of the pavement structure.

Report Sections

- Plans

  Provides a drop plan for documentation of F/HWD drop locations and orientation of vehicles, an instrumentation plan, and a facility layout plan. Cross-sections of the pavement structure are included in these drawings.

- Mix Designs

  Provides mix data for the P-501, P-401, and P-403 sections of pavement utilized in this project pavement structure.

- Break Data

  Provides cylinder and flexural beam break data for the P-501 and P-306 sections of pavement utilized in this project pavement structure.

- PSPA Data

  Provides PSPA data collected on the top of each pavement layer except the P-501 and P-401.

- P-154 Density Data

  Provides sand cone and nuclear density gauge data collected for the P-154 pavement layer.

- Dupont Clay Plate Load Data

  Provides test results for a plate load test performed on the Dupont clay pavement layer.

- Dupont Clay CBR and Density Data

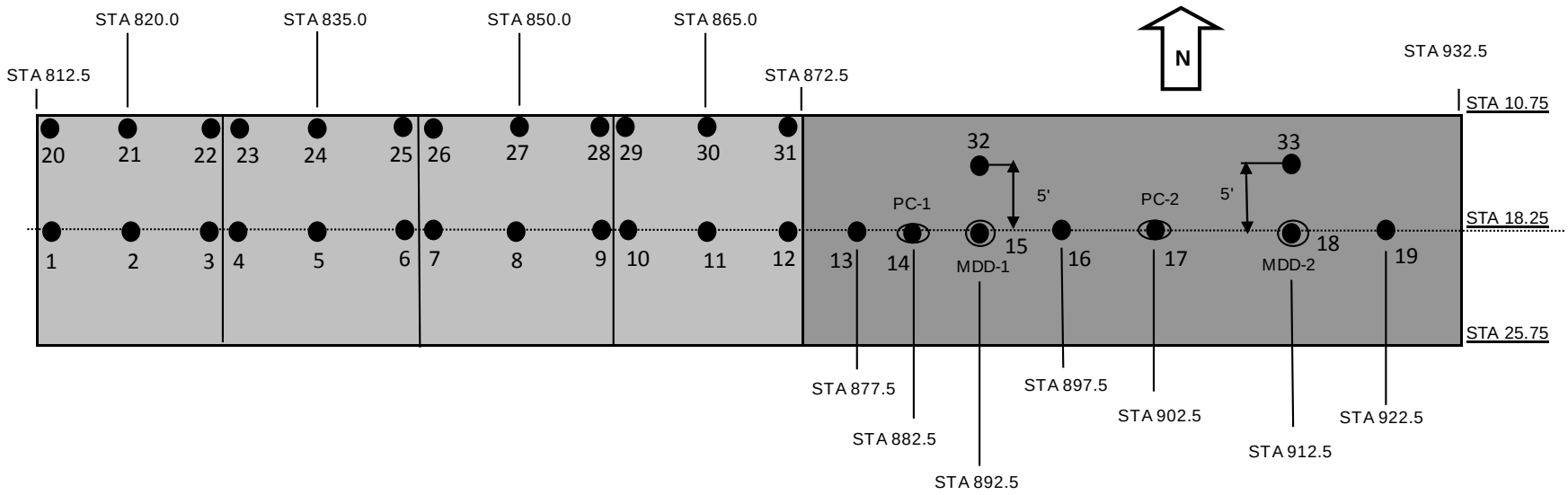
  Provides CBR and drive cylinder testing results performed on the Dupont clay pavement layer.

- Dupont Clay Vane Shear Data

  Provides vane shear testing results performed on the Dupont clay pavement layer.

PLANS

DROP PLAN



RIGID PAVEMENT **FLEXIBLE PAVEMENT**

● **Drop Location**

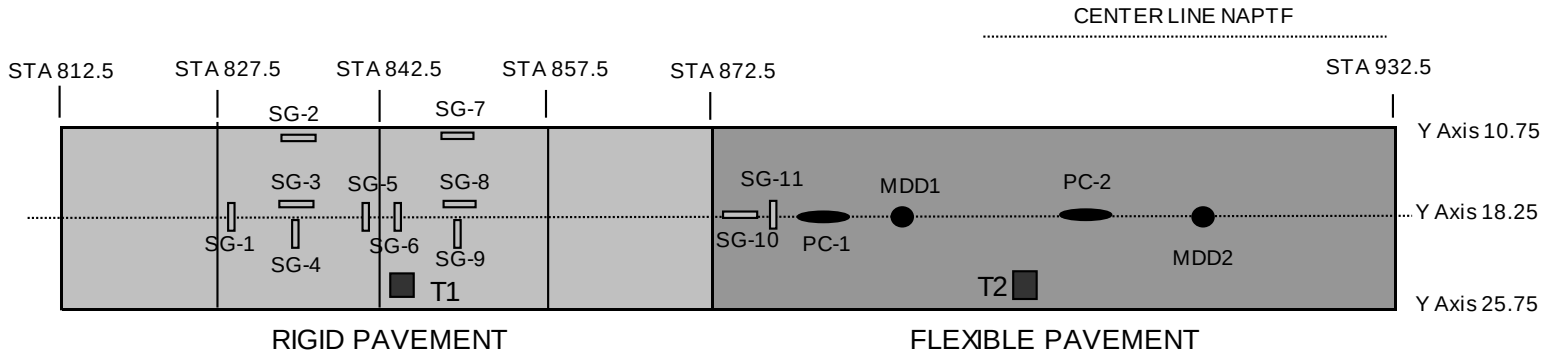
Drop Plan

Cycle 1: Traveling west to east: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
Traveling east to west: 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1
Traveling west to east: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33
Traveling east to west: 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20
Cycle 2: Traveling west to east: 5, 6, 7, 8, 9, 10, 14, 15, 16, 17, 18
Traveling east to west: 18, 17, 16, 15, 14, 10, 9, 8, 7, 6, 5

FWD- Testing Load Levels	HWD- Testing Load Levels
9,000 lbs	**12,000 lbs**
12,000 lbs	**24,000 lbs**
16,000 lbs	**36,000 lbs**

Drop Locations and Pavement Sensor Locations								
NOTE 1: The coordinates below are based on the NAPTF longitudinal & transverse system.								
NOTE 2: The coordinates are located at the approximate center of the 12" drop locations.								
Drop			**Note: Centerline (CL) to CL of Round up Pavement only**					
Location	**X (ft.)**	**Y (ft.)**						
Rigid Pavement			**Drop Location Comments**					
1	813	18.25	West end of pavement on slab 1, on the centerline					
2	820	18.25	Center of slab I on the centerline					
3	827	18.25	East end of slab 1 on centerline					
4	828	18.25	West side of slab 2 on centerline above SG-1					
5	835	18.25	Center of slab 2 on centerline above SG - 3 & 4					
6	842	18.25	East side of slab 2 on centerline above SG - 5					
7	843	18.25	West side of slab 3, on centerline, above SG-6					
8	850	18.25	Center of slab 3, on centerline above SG- 8					
9	857	18.25	East side of slab 3, on the centerline					
10	858	18.25	West side of slab 4, on thecenterline					
11	865	18.25	Center of slab 4, on the centereline					
12	870	18.25	East side of slab 4, on the centerline					
Flexible Pavement								
13	877.5	18.25	Centerline of flexible pavement, above SG 10 & 11					
14	882.5	18.25	Centerline of flexible pavement, above Pressure Cell-1					
15	892.5	18.54	Centerline of flexible pavement, above MDD-1					
16	897.5	18.25	Centerline of flexible pavement					
17	902.5	18.25	Centerline of flexible pavement, above Pressure Cell-2					
18	912.2	18.25	Centerline of flexible pavement, above MDD-2					
19	922.5	18.25	Centerline of flexible pavement					
Rigid Pavement								
20	813	11.25	North edge of rigid pavement					
21	820	11.25	North edge of rigid pavement					
22	827	11.25	North edge of rigid pavement					
23	828	11.25	North edge of rigid pavement					
24	835	11.25	North edge of rigid pavement, above SG-2					
25	842	11.25	North edge of rigid pavement					
26	843	11.25	North edge of rigid pavement					
27	850	11.25	North edge of rigid pavement, above SG-7					
28	857	11.25	North edge of rigid pavement					
29	858	11.25	North edge of rigid pavement					
30	865	11.25	North edge of rigid pavement					
31	870	11.25	North edge of rigid pavement					
Flexible Pavement								
32	982.5	13.25	5 feet North of MDD-1 on flexible pavement					
33	912.5	13.25	5 feet North of MDD-2 on flexible pavement					

INSTRUMENTATION PLAN



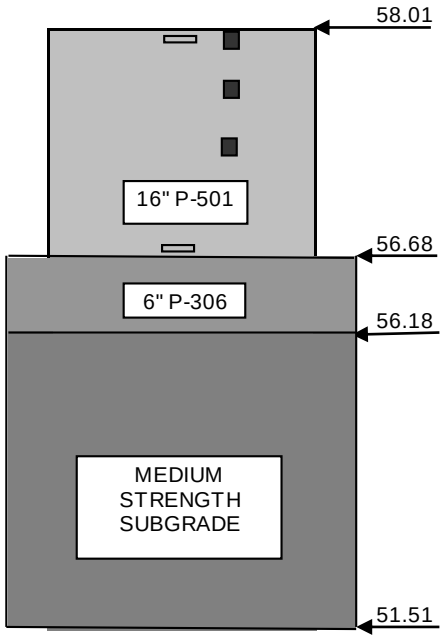
Temp. Sensor

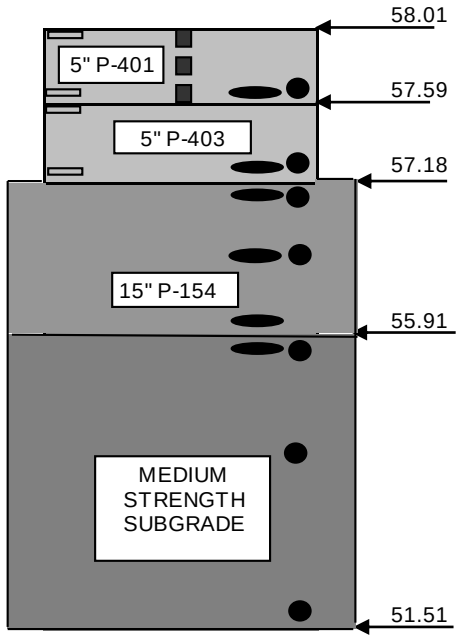
Strain Gage

MDD

Pressure Cell

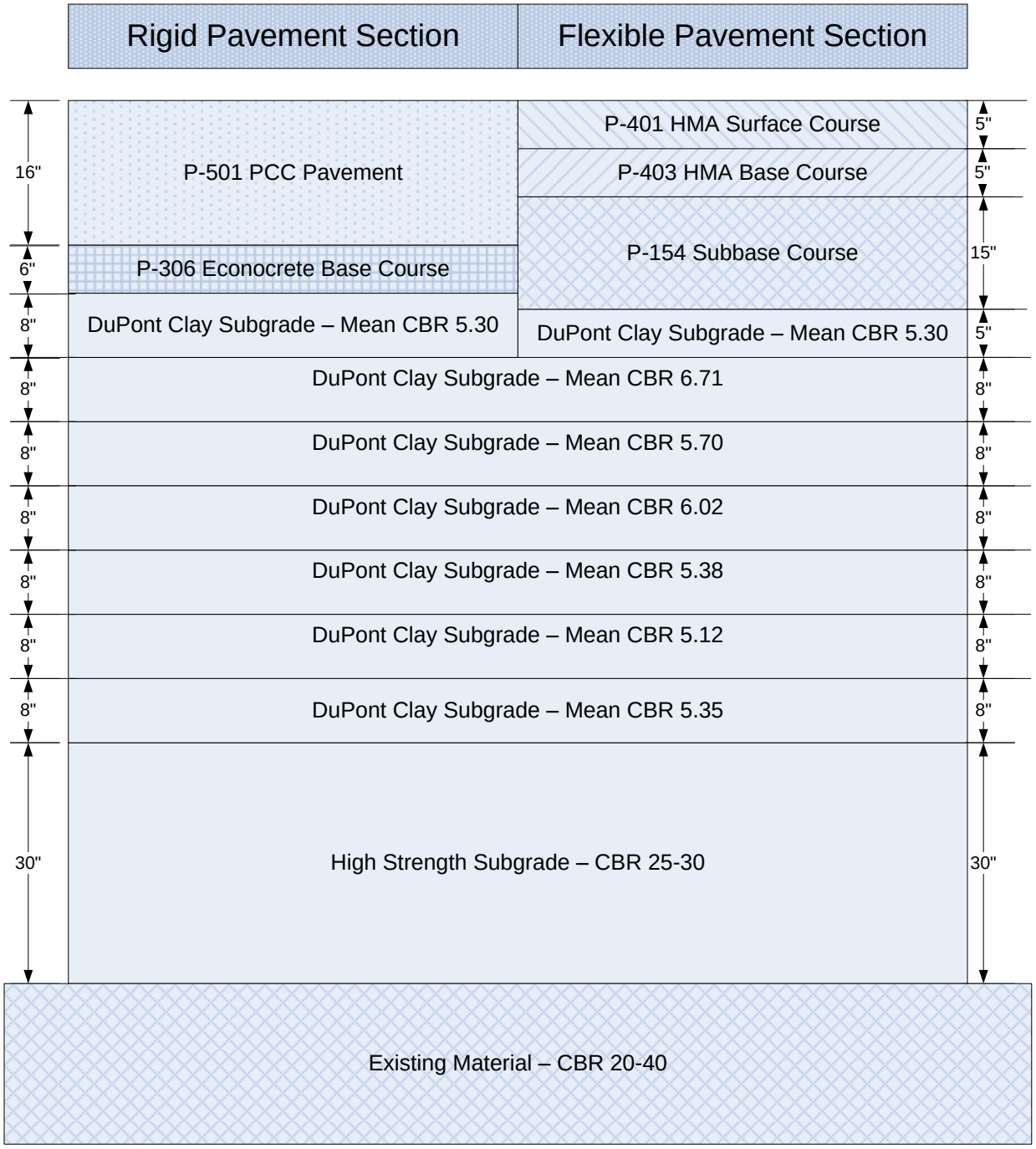
gages shown in the cross section view are shown pictorially and do not represent the 'Y' axis location



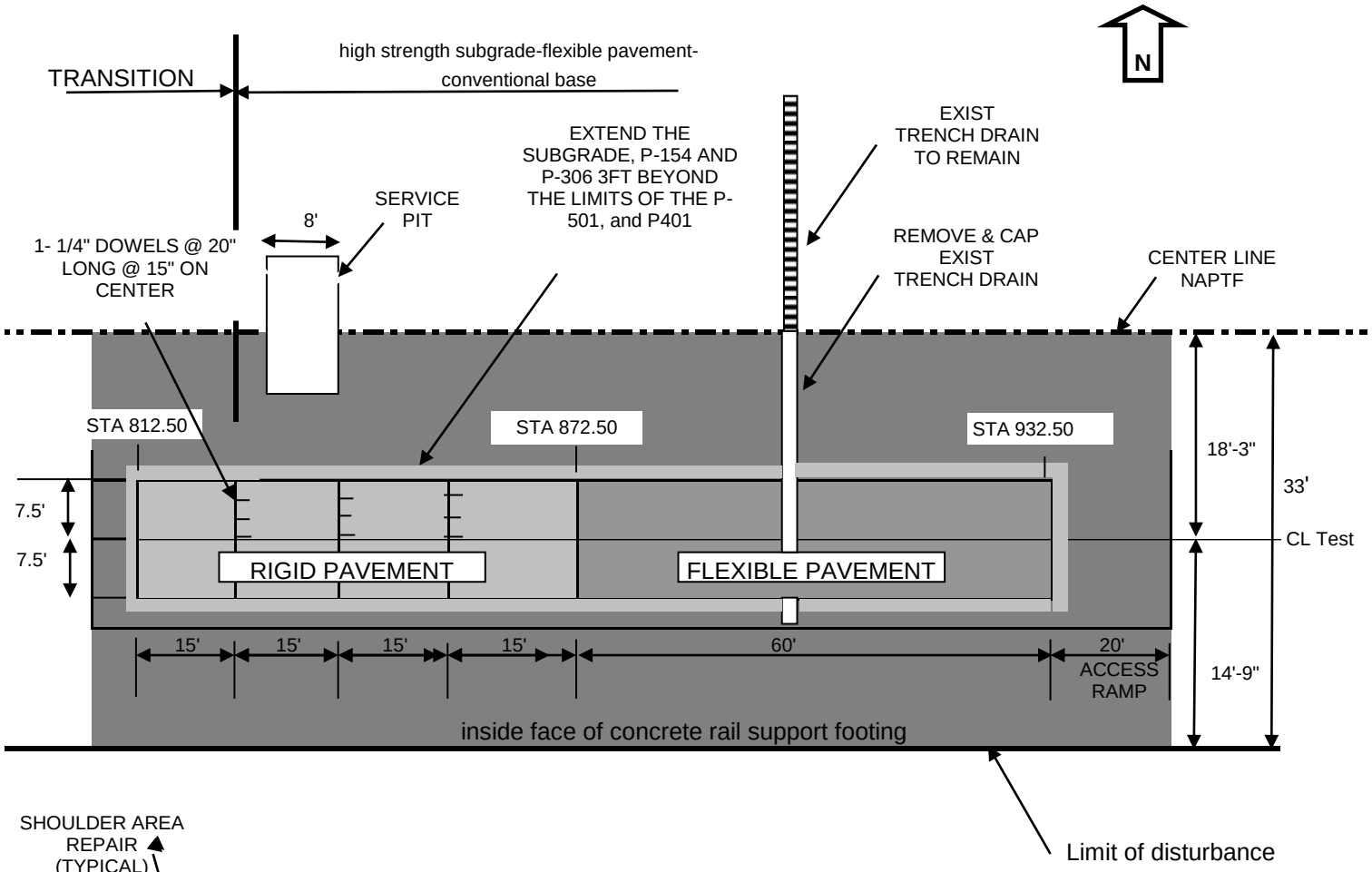


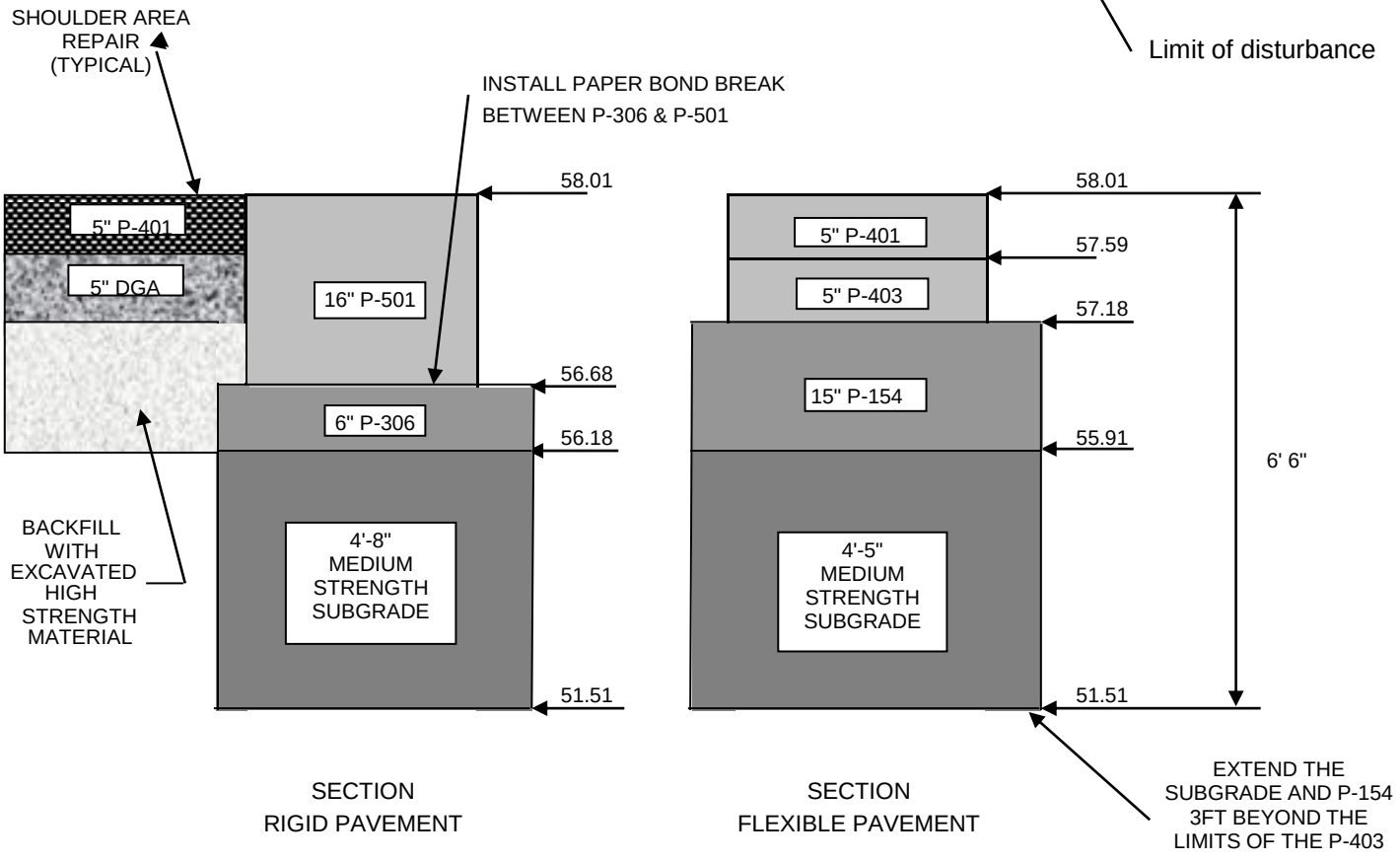
INSTRUMENTATION PLAN

RIGID PAVEMENT				FLEXIBLE PAVEMENT							
TEMP	**X, FT**	**Y, FT**	**Z, IN**	**TEMP**	**X, FT**	**Y, FT**	**Z, IN**	**Pressure**	**X, FT**	**Y, FT**	**Z, IN**
T1-A	844.5	23.75	0.5	T2-A	897.5	23.75	0.5	PC2-A	902.5	18.25	4.5
T1-B	844.5	23.75	4.5	T2-B	897.5	23.75	3	PC2-B	902.5	18.25	9.5
T1-C	844.5	23.75	8	T2-C	897.5	23.75	4.5	PC2-C	902.5	18.25	23.5
ST GAGES	**X, FT**	**Y, FT**	**Z, IN**	**MDD**	**X, FT**	**Y, FT**	**Z, IN**	**Pressure**	**X, FT**	**Y, FT**	**Z, IN**
SG1-A	828	18.25	1	MDD1-A	892.5	18.25	4.5	PC1-A	882.5	18.25	4.5
SG1-B	828	18.25	15	MDD1-B	892.5	18.25	9.5	PC1-B	882.5	18.25	9.5
SG2-A	835.0	11.25	1	MDD1-C	892.5	18.25	10.5	PC1-C	882.5	18.25	13.5
SG2-B	835.0	11.25	15	MDD1-D	892.5	18.25	16	PC1-D	882.5	18.25	17.5
SG3-A	835.0	17.75	1	MDD1-E	892.5	18.25	22.5	PC1-E	882.5	18.25	21.5
SG3-B	835.0	17.75	15	MDD1-F	892.5	18.25	50	PC1-F	882.5	18.25	25.5
SG4-A	835.0	18.75	1	MDD1G	892.5	18.25	77.5	**ST GAGES**	**X, FT**	**Y, FT**	**Z, IN**
SG4-B	835.0	18.75	15	**MDD**	**X, FT**	**Y, FT**	**Z, IN**	SG10-A	877	18.25	0.5
SG5-A	842	18.25	1	MDD2-A	912.5	18.25	4.5	SG10-B	877	18.25	4.5
SG5-B	842	18.25	15	MDD2-B	912.5	18.25	9.5	SG10-C	877	18.25	5.5
SG6-A	843.0	18.25	1	MDD2-C	912.5	18.25	10.5	SG10-D	877	18.25	9.5
SG6-B	843.0	18.25	15	MDD2-D	912.5	18.25	16	**ST GAGES**	**X, FT**	**Y, FT**	**Z, IN**
SG7-A	850.0	11.25	1	MDD2-E	912.5	18.25	22.5	SG11-A	878	18.25	0.5
SG7-B	850.0	11.25	15	MDD2-F	912.5	18.25	50	SG11-B	878	18.25	4.5
SG8-A	850.0	17.75	1	MDD2-G	912.5	18.25	77.5	SG11-C	878	18.25	5.5
SG8-B	850.0	17.75	15					SG11-D	878	18.25	9.5
SG9-A	850.0	18.75	1								
SG9-B	850.0	18.75	15								


Rigid Pavement Section
Flexible Pavement Section
16"
P-501 PCC Pavement
P-401 HMA Surface Course
5"
P-403 HMA Base Course
5"
6"
P-306 Econocrete Base Course
P-154 Subbase Course
15"
8"
DuPont Clay Subgrade – Mean CBR 5.30
DuPont Clay Subgrade – Mean CBR 5.30
5"
8"
DuPont Clay Subgrade – Mean CBR 6.71
8"
8"
DuPont Clay Subgrade – Mean CBR 5.70
8"
8"
DuPont Clay Subgrade – Mean CBR 6.02
8"
8"
DuPont Clay Subgrade – Mean CBR 5.38
8"
8"
DuPont Clay Subgrade – Mean CBR 5.12
8"
8"
DuPont Clay Subgrade – Mean CBR 5.35
8"
30"
High Strength Subgrade – CBR 25-30
30"
Existing Material – CBR 20-40

FACILITY LAYOUT





SECTION
RIGID PAVEMENT

SECTION
FLEXIBLE PAVEMENT

MIX DESIGNS

F/HWD Concrete Mix Design Data

F/HWD Placement Concrete Mix Per Cubic Yard

Material	750 P1
No. 57 Coarse Aggregate, lbs	1475
No. 8 Intermediate Coarse Aggregate, lbs	490
Cocnrete Sand, lbs	1225
Water, lbs	230
Type 1 Portland Cement, lbs	500
Air, %	7
Slump, in.	5.5
SIKAair, oz.	5
W/C Ratio	0.46

No. 57 Coarse Aggregate - Coarse Aggregate Testing

Specific Gravity	2.76
Unit Weight (dry rodded)	101 lb/Cu Ft
Percent Voids	49%
Absorption	0.4%
LA Abrasion Loss %	16.30

Gradation

Sieve	%Passing	ASTM C-33
1 1/2"	100.0	100
1"	99.1	95 - 100
3/4"	90.2	
1/2"	52.1	25 - 60
3/8"	25.0	
#4	8.8	0 - 10
#8	3.7	0 - 5

No. 8 Intermediate Coarse Aggregate - Coarse Aggregate Testing

Specific Gravity	2.76
Unit Weight (dry rodded)	100 lb/Cu Ft
Percent Voids	49%
Absorption	0.6%
LA Abrasion Loss %	N/A

Gradation

Sieve	%Passing	ASTM C-33
1/2"	100.0	100
3/8"	87.3	85 - 100
#4	19.5	10 - 30
#8	4.0	0 - 10
#16	1.8	0 - 5

Concrete Sand - Fine Aggregate Testing

Specific Gravity	2.63
Unit Weight (dry rodded)	105 lb/Cu Ft
Percent Voids	37%
Absorption	0.4%
Deleterious Materials	Nil

Gradation

Sieve	%Passing	ASTM C-33
3/8"	100.0	100
#4	96.9	95 - 100
#8	88.0	80 - 100
#16	74.9	50 - 85
#30	48.6	25 - 60
#50	20.6	10 - 30
#100	1.7	1 - 10
#200	0.4	0 - 3
Fineness Modulus	2.69	2.3 - 3.1

F/HWD Asphalt Mix Design Data

F/HWD Placement Asphalt Mix % of Final Agg. Blend: P-401 Surface PG 64-22

Material	P-401
#7 Stone, %	18
#8 Stone, %	22
#9 Stone, %	11
#10 Screenings, %	48
Bag House Dust	1

Job Mix Formula Gradation

Sieve	#7 Stone - 18%		#8 Stone - 22%		#9 Stone - 11%		#10 Screen. - 48%		Dust - 1%		JMF	Spec.
	%Pass	%Batch	%Pass	%Batch	%Pass	%Batch	%Pass	%Batch	%Pass	%Batch	Grad.	
1"		0		0		0		0		0	0	
3/4"	100.0	18.0	100.0	22.0	100.0	11.0	100.0	48.0	100.0	1.0	100.0	100
1/2"	74.5	13.4	100.0	22.0	100.0	11.0	100.0	48.0	100.0	1.0	95.4	79 - 99
3/8"	50.9	9.2	83.4	18.3	100.0	11.0	100.0	48.0	100.0	1.0	87.5	66 - 88
#4	17.4	3.1	15.5	3.4	80.2	8.8	96.9	46.5	100.0	1.0	62.9	48 - 68
#8	8.6	1.5	5.7	1.3	18.3	2.0	64.7	31.1	100.0	1.0	36.9	33 - 53
#16	6.6	1.2	4.2	0.9	7.8	0.9	38.2	18.3	100.0	1.0	22.3	20 - 40
#30	6.0	1.1	3.7	0.8	4.8	0.5	24.4	11.7	100.0	1.0	15.1	14 - 30
#50	5.8	1.0	3.4	0.7	4.2	0.5	17.8	8.5	97.8	1.0	11.8	9 - 21
#100	5.5	1.0	3.2	0.7	3.8	0.4	12.2	5.9	88.1	0.9	8.8	6 - 16
#200	4.8	0.9	2.7	0.6	2.6	0.3	6.8	3.3	76.3	0.8	5.8	3 - 6

Hot Mix Design Data: Marshall Method

AC Specific Gravity	1.028
Mixing Temp., F	325
Compaction Temp., F	285
Asphalt Contnet, %	5.0
Marshal Stability. Lbs	3287
Flow Value, .01 in.	8.3
Air Voids, %	3.4
VMA, %	15.4
Unit Weight, lbs/cu ft	158.5
Max. Theor. Specific Gravity	2.628

F/HWD Placement Asphalt Mix % of Final Agg. Blend: P-403 Base PG 64-22

Material	P-401
#67 Stone, %	23
#8 Stone, %	28
#10 Screenings, %	48
Bag House Dust	1

Job Mix Formula Gradation

Sieve	#67 Stone - 23%		#8 Stone - 28%		#10 Screen. - 48%		Dust - 1%		JMF	Spec.
	%Pass	%Batch	%Pass	%Batch	%Pass	%Batch	%Pass	%Batch	Grad.	
1"	100.0	23.0	100.0	28.0	100.0	48.0	100.0	1.0	100.0	100.0
3/4"	85.3	19.6	100.0	28.0	100.0	48.0	100.0	1.0	96.6	76 - 98
1/2"	37.3	8.6	100.0	28.0	100.0	48.0	100.0	1.0	85.6	66 - 86
3/8"	13.9	3.2	84.9	23.8	100.0	48.0	100.0	1.0	76.0	57 - 77
#4	1.4	0.3	14.7	4.1	96.9	46.5	100.0	1.0	52.0	40 - 60
#8	0.9	0.2	5.1	1.4	64.7	31.1	100.0	1.0	33.7	26 - 46
#16	0.9	0.2	3.8	1.1	38.2	18.3	100.0	1.0	20.6	17 - 37
#30	0.9	0.2	3.3	0.9	24.4	11.7	100.0	1.0	13.8	11 - 27
#50	0.9	0.2	3.1	0.9	17.8	8.5	97.8	1.0	10.6	7 - 19
#100	0.9	0.2	2.9	0.8	12.2	5.9	88.1	0.9	7.8	6 - 16
#200	0.8	0.2	2.5	0.7	6.8	3.3	76.3	0.8	4.9	3 - 6

Hot Mix Design Data: Marshall Method

AC Specific Gravity	1.028
Mixing Temp., F	325
Compaction Temp., F	285
Asphalt Contnet, %	4.8
Marshal Stability. Lbs	3293
Flow Value, .01 in.	8.8
Air Voids, %	3.3
VMA, %	14.6
Unit Weight, lbs/cu ft	159.8
Max. Theor. Specific Gravity	2.649

BREAK DATA

F/HWD Round Up Break Data

P-501

Beams

Casted	Sample ID	Break Date	Day	Load, lbs	Flexural, psi	Avg. Flex.
4/29/2010	Slab 1	5/6/2010	7	8190	680	684
4/29/2010	Slab 3	5/6/2010	7	7160	600	
5/3/2010	Slab 4	5/10/2010	7	8170	681	
5/3/2010	Slab 2	5/10/2010	7	9310	776	
4/29/2010	Slab 1&3	5/13/2010	14	8130	677	681
4/29/2010	Slab 3	5/13/2010	14	8680	723	
5/3/2010	Slab 2&4	5/17/2010	14	7500	625	
5/3/2010	Slab 4	5/17/2010	14	8370	697	
4/29/2010	Slab 1&3	5/27/2010	28	9200	766	707
4/29/2010	Slab 1	5/27/2010	28	8610	717	
5/3/2010	Slab 2&4	6/1/2010	29	7680	640	
5/3/2010	Slab 2	6/1/2010	29	8440	703	

Cylinders

Casted	Sample ID	Break Date	Day	Load, lbs	Compressive, psi	Avg. Comp.
4/29/2010	Slab 1	5/6/2010	7	87640	3100	3385
4/29/2010	Slab 3	5/6/2010	7	90140	3190	
5/3/2010	Slab 4	5/10/2010	7	98220	3474	
5/3/2010	Slab 2	5/10/2010	7	106750	3776	
4/29/2010	Slab 1&3	5/13/2010	14	102820	3637	3651
4/29/2010	Slab 3	5/13/2010	14	108830	3850	
5/3/2010	Slab 2&4	5/17/2010	14	93230	3298	
5/3/2010	Slab 4	5/17/2010	14	107970	3819	
4/29/2010	Slab 1&3	5/27/2010	28	105480	3713	3828
4/29/2010	Slab 1	5/27/2010	28	101870	3603	
5/3/2010	Slab 2&4	6/1/2010	29	103430	3659	
5/3/2010	Slab 2	6/1/2010	29	122550	4335	

Econocrete

Breaks	Compressive Strength, psi				Avg. Compressive Strength, psi
	Truck -1		Truck -2		
3 Days	263	266	504	-	344
7 Days	366	338	648	746	525

PSPA DATA

F/HWD PSPA Data

Average PSPA Modulus Values

Top of Econocrete	2440 psi
Top of P-403	28 psi
Top of P-154	73 psi
Top of Dupont Clay	27 psi
Top of Existing Subgrade	38 psi

P-154 DENSITY DATA

P-154 Density Data

Sand Cone Method

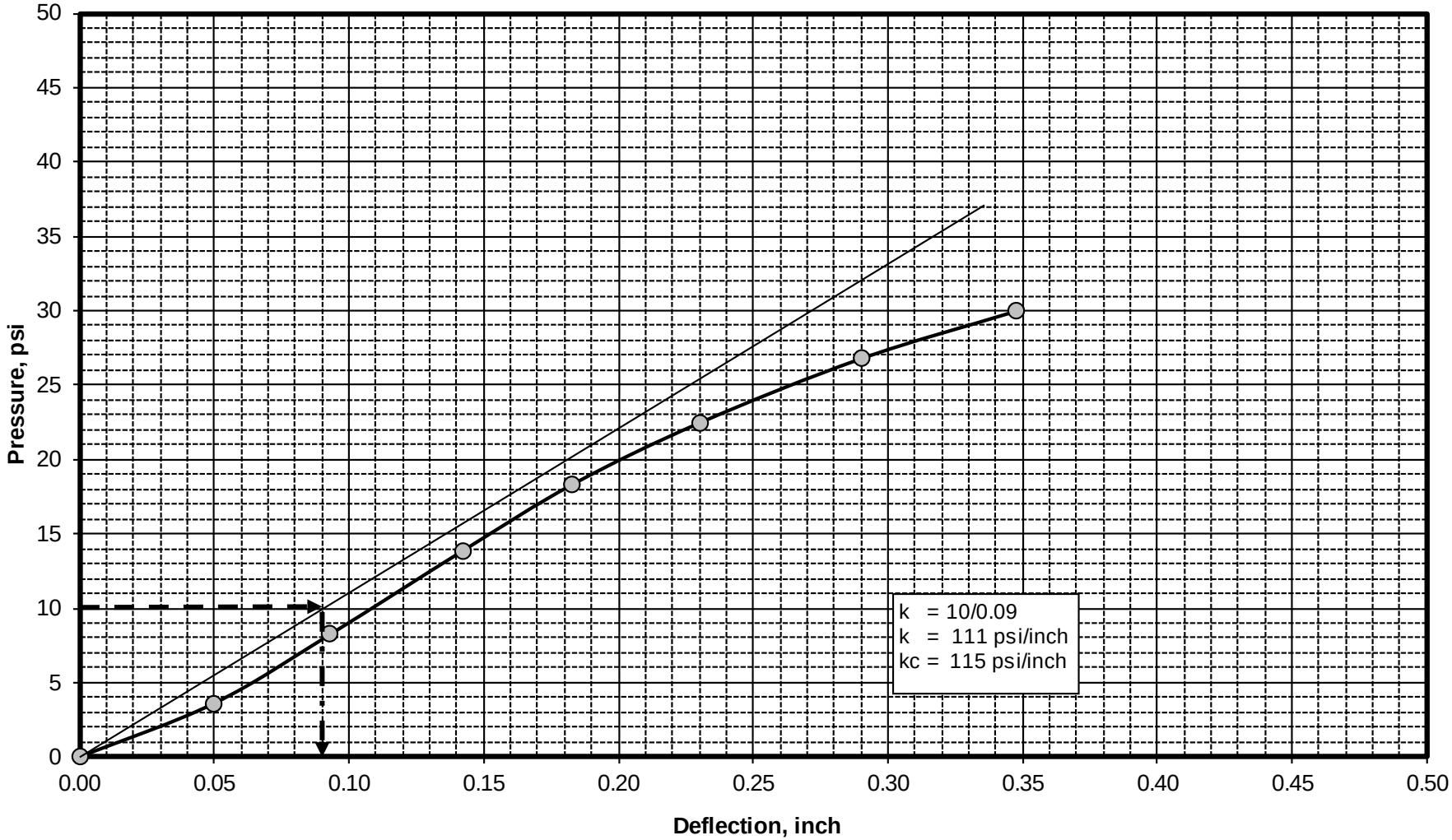
	Lift 1	Lift 2
Wet Density (lbs/cu. ft.)	137.71	141.84
Dry Density (lbs/cu. ft.)	129.93	133.90
Percent Moisture	5.98	5.93
Max. Dry Density (lbs/cu. ft.)	133.80	133.80
Percent Compaction	97.11	100.08

Nuclear Density Gauge

	Lift 1	Lift 2
Avg. Dry Density (lbs/cu. ft.)	129.9	132
Avg. Percent Moisture	4.9	4.9
Percent Compaction	97.1	98.7

DUPONT CLAY PLATE LOAD DATA

PLATE LOAD TEST - FWD RODEO AREA
Subgrade Top: 840 South
04/12/2010



DUPONT CLAY CBR, DENSITY, AND VANE SHEAR DATA

Dupont Clay CBR, Density, and Vane Shear Data

CBR and Drive Cylinder Data

	Lift 1	Lift 2	Lift 3	Lift 4	Lift 5	Lift 6	Lift 7
Avg. CBR	5.35	5.12	5.38	6.02	5.70	6.71	5.30
Avg. Percent Moisture		33.54	31.55	30.01	33.06	33.57	
Avg. In-Situ Wet Density (lbs/cu. ft.)		115.61	117.39	116.10	115.52	115.19	
Avg. In-Situ Dry Density (lbs/cu. ft.)		85.57	89.24	89.31	86.82	86.24	

Vane Shear Data

	Lift 1	Lift 2	Lift 4	Lift 5	Lift 6	Lift 7
Avg. Vane Shear Reading	81	72	79	69	75	77
Avg. Actual Vane Shear Reading	161	144	159	137	151	153
Avg. CBR	9.8	8.1	9.7	7.5	8.8	9.0