WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SAMPLING COMPACTED ASPHALTIC MIXTURES FROM THE ROADWAY

1. PURPOSE

1.1 This procedure has been written to provide a means for sampling compacted roadway asphalt mixtures.

2. SCOPE

2.1 This method covers the procedure for sampling of asphaltic paving mixtures taken from the finished pavement for determination of the characteristics of the compacted mixture.

2.2 Samples obtained using this method will be collected for several reasons including but not limited to the following:

2.2.1 Visual examination.

2.2.2 Measurement for layer thickness.

2.2.3 Determination of bulk specific gravity, air voids, and other volumetric properties.

2.2.4 Determination of bond strength between constructed layers.

3. REFERENCED DOCUMENTS

3.1 WVDOH Standard Specifications – Current Edition

3.1.1 Section 410: Asphalt and Wearing Courses, Percent Within Limits (PWL)

3.2 Materials Procedures

3.2.1 MP 401.02.31, Quality Control and Acceptance of Asphalt Mixtures

3.2.2 MP 401.07.20, Sampling Loose Asphaltic Mixtures

3.2.3 MP 401.07.22, Measurement for Thickness of Asphalt Pavement Using Drilled Cores

3.2.4 MP 401.07.23, Interface Bond Shear Strength of Multi-layered Asphalt Pavement Specimens

3.2.5 MP 401.13.50, Determination of Percent Within Limits

3.3 AASHTO Procedures

3.3.1 AASHTO T331, Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method

4. EQUIPMENT AND TOOLS

4.1 Powered core drill, water cooled, equipped to core cylindrical samples.

4.2 Diamond drill bit of six (6) inch inside diameter size.

4.3 Incidental materials and equipment.

4.4 Hand-held core sample extraction tool capable of grasping and removing a drilled cylindrical pavement core sample from the pavement without damage to the core sample.

Note: Worn drill bits of the same size as those used for coring have been successfully used by cutting slots vertically along the side of the casing to allow for expansion.

4.5 An ice cooler large enough to hold the sample without distortion after it is removed from the pavement.

Note: Large ice coolers (approximately 150 quart) have been used successfully to store and transport multiple pavement cores.

4.6 Small plastic bags for core specimens

4.7 Masking tape

4.8 A marking pencil, paint pen, lumber crayon, or other means suitable for labeling cores.

4.9 Markers for labeling plastic bags.

5. MAT DENSITY, BOND STRENGTH, AND THICKNESS CORE SAMPLES

5.1 Density acceptance of the asphalt mixture from the roadway shall be determined on the basis of test results from core samples for each Lot. One sample shall be taken from each Sublot. Samples are to be selected by means of a random sampling plan.

5.1.1 Random numbers used shall be generated from a calculator, software capable of generating random numbers, or from the Random Number Table attached to this MP. All random numbers shall be recorded and maintained in order to verify the means of sample locations.

5.2 At the Pre-Paving Meeting, WVDOH and Contractor personnel shall confer and agree on the sequence and widths of the paving operation in order for a sampling plan to be developed by the Division. The plan shall begin at the intended starting point and progress continuously until the end of the paving operation. Lots for

mainline travel lanes should not be extended onto outside shoulders. As paving progresses onto the outside shoulders, new lots shall be established along the shoulders. Ramps, turning lanes, and truck lanes are traveled lanes and shall be considered as mainline pavements.

5.3 All lots shall be calculated and laid out based on converting 2500 tons to square yardage using the project plan lift thickness and a project theoretical yield. The theoretical yield shall be based on 94% of the design maximum theoretical density from the approved JMF (Form T400) for asphaltic mixture designs. The lots shall be laid out using the full width of placement for each pull. However, no samples shall be taken from the inside shoulder adjacent to the median (generally four feet in width), or the outside 12 inches (one foot) of the unsupported or supported edge of a paving mat. The remaining dimension of width shall be considered testable and used to determine the random location of each sample. Partial lots shall be laid out and either considered separate lots or combined with the previous lots as per Table 410.7.1 of the WVDOH Standard Specifications.

5.3.1 Sample locations determined using random numbers shall be rounded to the nearest 1ft for both length and offset. If it is determined that the offset is zero or the maximum dimension in the testable width, the samples should be taken within either the first or last one foot respectively of material at each side of the testable width. Additionally, samples determined to fall at the same location as a sample removed from an underlying paving lift should be recalculated using a new random number for either width or length.

NOTE: It is likely that some lots will be laid out in the field beginning with a mat that is a different dimension than that where the lot ends. Such would be the case for a lot that starts within a mat being pulled along the median where the fast lane and inside shoulder are being pulled simultaneously (approximately 16 feet) but ends along the outside or slow lane (approximately 12 feet) on the other side of the median. In such a case, it will be necessary to calculate the area on the side of the median where the lot is started, then use the remaining area for the lot to determine the length of the remaining portion of the lot on the other side of the median.

5.4 Refer to the Illustrative Example included in this MP for examples of how to select samples using a random sampling plan for pavement courses. Density acceptance samples and bond strength samples should be cross-referenced to a corresponding mixture acceptance sample as per MP 401.07.20.

5.4.1 For purposes of identification, the sampling ID shall be consistent for projects. Along with the pertinent project identification data (as indicated in Section 410 of the Standard Specifications) that is needed for processing test results, it will be necessary to discern all samples on the project by lot, sublot, and type of sample. For mat density and bond strength samples obtained from the mat, and for joint density samples obtained from the longitudinal joint, they should follow the convention shown below. Please note that mat density and bond strength samples shall also be measured for thickness.

Layer/Lot Designation	Lot #	Sub Lot #	Type of Sample	Example Sample ID
B – Base I – Intermediate S – Surface/Wearing J – Joint Density Core	2	5	M – Mat B – Bond Core D – Density Core	B2-5M J2-5

5.5 Samples for mat density shall be used to determine the percent compaction of the finished mat by first determining the bulk specific gravity of each specimen as per AASHTO T331, and then by dividing by the corresponding daily theoretical maximum density of the paving mixture.

6. LONGITUDINAL JOINT DENSITY CORE SAMPLES

6.1 Samples shall be taken on the basis of a random sampling plan established for each lot. Lots shall be established as specified in Standard Specifications 410.7 - Acceptance Testing and will consist of 10,000 feet of constructed longitudinal joint. Each lot will be further divided into sublots consisting of 2,000 feet. Partial lots shall be addressed as described within Section 410.7 of the Standard Specifications. Lots along constructed joints between travel lanes shall not extend onto the constructed joint adjacent to the outside shoulders. New lots shall begin with the constructed joint adjacent to the outside shoulders.

6.2 One sample shall be taken from each sublot. Refer to Figure 3 for an example of how to select samples using a random sampling plan.

6.3 A core sample taken from a longitudinal vertical joint shall be centered on the line where the joint between the two adjacent lifts abut at the surface as illustrated in Figure 1 below. The center of all vertical joint cores shall be within one (1) inch of this joint line.

6.4 When the two lanes forming the longitudinal joint have daily theoretical maximum specific gravity values differing by more than 0.050, particular attention should be paid to these core locations. Examine each longitudinal joint core sample to ensure that approximately one-half of the longitudinal joint core sample is from each lane. If the materials in the longitudinal joint core are unbalanced, take a replacement sample at a location within twelve (12) inches longitudinally of the original sample location and adjust the location of the core drill relative to the joint line to ensure approximately equal material on each side of the joint will be obtained in the core sample.

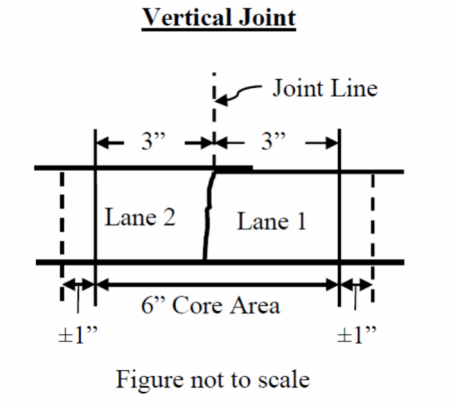

Figure 1 – Cross-sectional View, Position of Core Along Longitudinal Joint, Imperial Units

6.5 Samples for joint density shall be used to determine the percent compaction of the finished mat by first determining the bulk specific gravity of each specimen as per AASHTO T331, and then by dividing by the corresponding daily theoretical maximum densities of the paving mixture.

7. GENERAL CORING AND SAMPLING PROCEDURE

7.1 In the presence of the Engineer’s representative, the contractor shall core and identify the density acceptance samples as specified in Section 410.7 of the Standard Specifications.

7.2 Efforts should be taken to cool the pavement with ice or other suitable means prior to coring. Using the powered core drill, drill core samples to the specified diameter (6.0 ±0.125 inches) and to a depth sufficiently below the depth of the pavement course to be sampled. Ensure sufficient water is dispersed through the core bit during drilling to keep the drill bit and core sample cool enough in order to allow cutting through the pavement without damaging the sample and the core bit. Carefully and slowly lower the drill bit to the surface of the pavement course at the start of drilling to prevent the drill bit from moving and to obtain a smooth clean initial drill cut at the surface of the core sample. After drilling to a sufficient depth, carefully raise the core drill bit to prevent any damage to the core sample.

7.2.1 Additional care should be taken when laying out and drilling samples for bond strength testing. Prior to drilling the sample, mark the pavement within the area to be cored using a lumber crayon or other suitable means to indicate the direction of traffic. Efforts shall be taken to ensure the core location has cooled sufficiently, and the drill bit is plumb, so the sample is not skewed after removal. Skewed samples will likely not be suitable for testing in the shear testing apparatus. Drilling depth shall be such that the core is cut completely through the material immediately underlying the surface lift to prevent the core from pulling apart at the bonded surface during the removal process.

7.3 Carefully dislodge or break the core sample away from the underlying pavement layer. Do not distort, bend, crack, damage or physically change the physical condition of the core sample during this operation.

7.4 Using a hand-held core sample extraction tool, carefully grasp and remove the core sample from the pavement. Do not distort, bend, crack, damage or physically change the physical condition of the core sample during removal from the pavement.

7.5 Immediately after removing the core sample from the pavement, wash off the core sample with water to remove the fine material generated from the drilling operation. Air dry or towel dry the core sample sufficiently to allow identification of the Lot and sublot number on each core sample by using a paint pen, or other suitable means.

7.6 If a core sample includes materials other than the material or pavement course to be tested, clearly show and mark with a paint pen the section(s) of each core sample to be discarded. Core samples suspected of including more than one material and not clearly showing the section to test, and the section(s) to discard, will be considered non-conforming samples and will not be tested until the section to test is identified.

7.7 Once the core sample has been obtained and identified, the Division will take immediate possession of the core sample and store it in a proper environment. Overheating or impact can damage core samples and prevent accurate test results.

7.8 Samples should be placed in separate small plastic bags and stored out of direct sunlight and/or placed in a cooler with enough ice to prevent them from warming up. The sample bags can be marked ahead of time to further help identify individual samples once transported to the lab. Core samples should then be laid in the cooler with the top surface (flat) down on the bottom of the cooler to prevent movement.

7.9 During the same work shift for placement of the sampled asphalt concrete mix, each core hole location shall be backfilled with compacted mixture of the same material being used for paving, or other preapproved method. Efforts shall be taken to clean the hole of loose debris and any standing water shall be removed. If asphalt mixture is used for backfilling, the material shall be placed in lifts, as necessary, and substantial compactive effort shall be applied to each lift using a device comprised of a suitable handle with an attached tamping foot of a size slightly smaller than the core hole. Fuel or solvent based release agents are strictly prohibited during this process. Each core location shall be sealed with an approved crack/joint sealant prior to contract completion.

7.10 After the Lot is completed or has been terminated, or at the end of each day of placement, the Division personnel will transport the core samples from each day of production to the District Materials Laboratory or Materials Control, Soils & Testing Division for additional processing and evaluation.

Illustrative Example – Project and Lot Layout

An exactly four-mile-long project is to commence paving within the next couple of weeks along an interstate roadway. The division has contacted the contractor to determine the paving sequence and widths and has confirmed that the approved JMF maximum theoretical density is 2501 kg/m3. For theoretical yield on the project, 94% of 2501 kg/m3 is 2351 kg/m3. Dividing by 1000 and then multiplying by 62.4 PCF, the corresponding density in English units is 146.7 PCF. Using this value, and selecting the proper conversion factor from Table 1 below, the corresponding application rate per square yard at 1.5 inches thick is determined as follows:

Table 1 - Conversion of Design Bulk Density to In-Situ Application Rate

Project Design Thickness (inches)	Conversion for Application Rate (psy)
1.00	0.750
1.25	0.938
1.50	1.125
1.75	1.313
2.00	1.500
2.25	1.688
2.50	1.875
2.75	2.063
3.00	2.250

(Use English units) 146.7 pcf x 1.125 cf/SY = 165 psy (nearest pound)

The corresponding lot area for placement of the material in square yards is then calculated as follows:

(2500 tons x 2000 pounds per ton)/165 psy = 30,303 sy (nearest sy)

Work will begin on the inside fast lane next to the median. The first pull will be 16’ wide. The length of the lot, length per sublot, and total area per sublot is calculated as follows:

30,303 SY x 9 = 272,727 sf

272,727 sf/16 = 17,045’ Total lot length (nearest linear foot)

17,045/5 = 3409’ length per sublot

30,303/5 = 6,061 sy per sublot (nearest sy)

These values will be used to lay out the station for the beginning of each sublot, and to keep track of the breakdown of a sublot that begins on one side of median and then continues on the other side in an opposite direction. The area for each sublot is used when the situation above occurs and there is a change within the sublot to a pull of a different width.

The beginning and ending stations for each lot and sublot shall then be calculated and plotted in continuous fashion. Figure 2 shows a clean project layout using the widths for each pull, beginning and ending stations and how each lot/sublot progresses for a complete project. Daily stops can also be approximated, and then actual stops shown on a diagram to help keep track of

the entire project. Partial mat and joint lots were addressed along the main travel lanes and new lots were started along the shoulder.

Project Layout By Area - With Estimated Daily Paving Stops

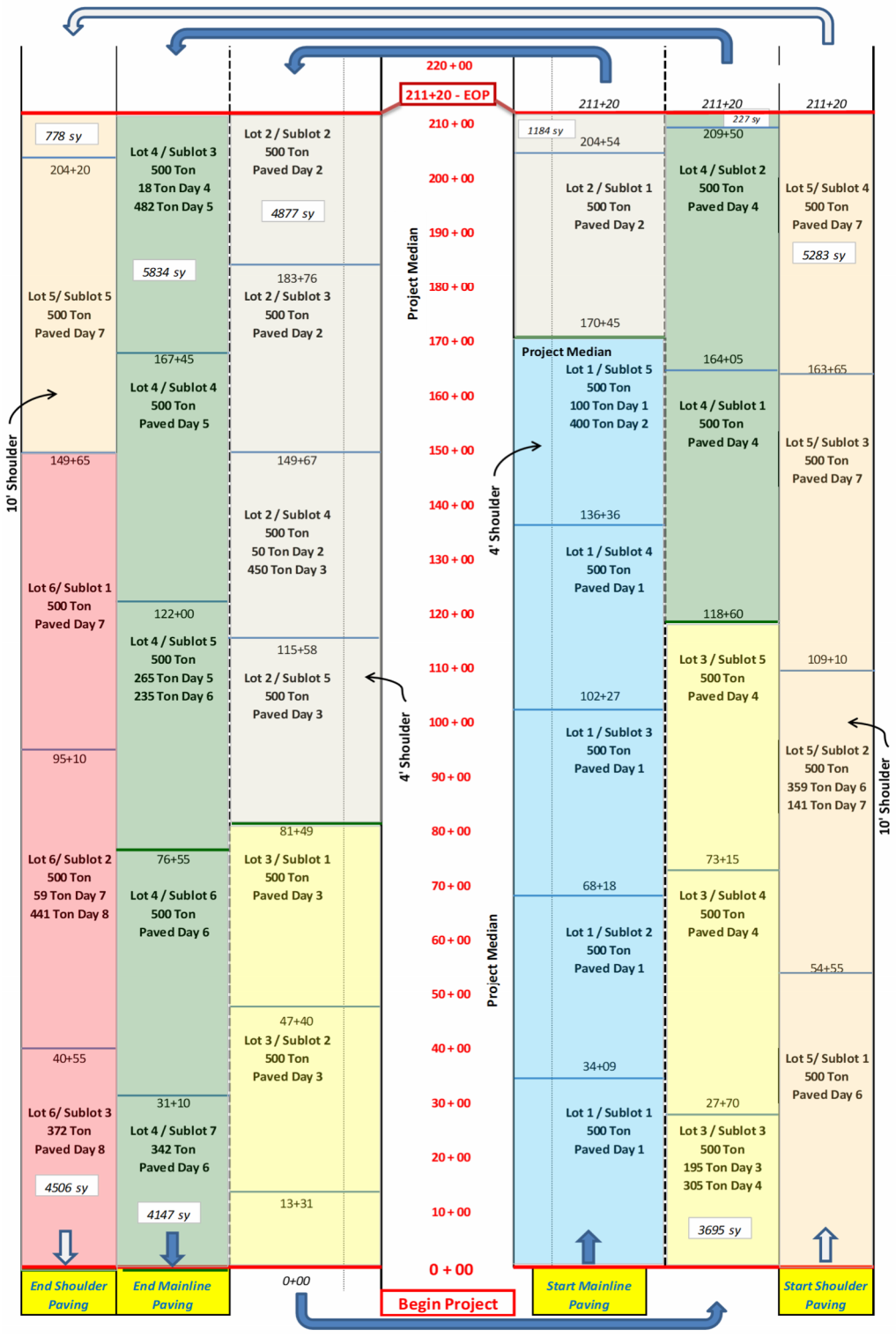

Figure 2

Using Lot 1 from Figure 2, the random sample locations are determined as shown below:

Lot #1-Density Cores

Sublot	Random Numbers		Length	Width
	X (length)	Y (width)		
1	0.632	0.287	0.632 (3409') = 2,155'	0.287 (11') = 3'
2	0.534	0.264	0.534 (3409') = 1,820'	0.264 (11') = 3'
3	0.871	0.159	0.871 (3409') = 2,969'	0.159 (11') = 2'
4	0.753	0.177	0.753 (3409') = 2,567'	0.177 (11') = 2'
5	0.277	0.530	0.277 (3409') = 944'	0.530 (11') = 6'

Lot #1- Bond Strength Cores

Sublot	Random Numbers		Length	Width
	X (length)	Y (width)		
1	0.149	0.155	0.149 (3409') = 508'	0.155 (11') = 2'
2	0.239	0.992	0.239 (3409') = 815'	0.992 (11') = 11'*
3	0.295	0.480	0.295 (3409') = 1,006'	0.480 (11') = 5'
4	0.517	0.473	0.517 (3409') = 1,762'	0.473 (11') = 5'
5	0.805	0.741	0.805 (3409') = 2,744	0.741 (11') = 8'

* Sample should be taken between 10'-11' offset

Using the offsets and lengths within each sublot, the stations and offsets for Mat Density and Bond Strength Core samples are determined as shown below.

Lot #1 - Corresponding Sample Stations for Mat Density –

Sublot	Beginning Station	Length	Sample Station
1	0+00	2,155	21+55, 3' offset
2	34+09	1,820'	52+29', 3 offset
3	68+18	2,969'	97+87, 2' offset
4	102+27	2,567'	127+94, 2' offset
5	136+36	944'	145+80, 6' offset

Lot #1 - Corresponding Sample Stations for Bond Strength

Sublot	Beginning Station	Length	Sample Station
1	0+00	508’	5+08, 2’ offset
2	34+09	815’	42+24, 10’ offset
3	68+18	1,006’	78+24, 5’ offset
4	102+27	1,762’	119+89, 5’ offset
5	136+36	2,744’	163+80, 8’ offset

For purposes of illustration, all locations for loose samples, mat density cores, and bond strength cores are shown in Figure 3 below. Refer to MP 401.07.20 for more information on obtaining loose samples of asphaltic mixture for determination of asphalt content and gradation.

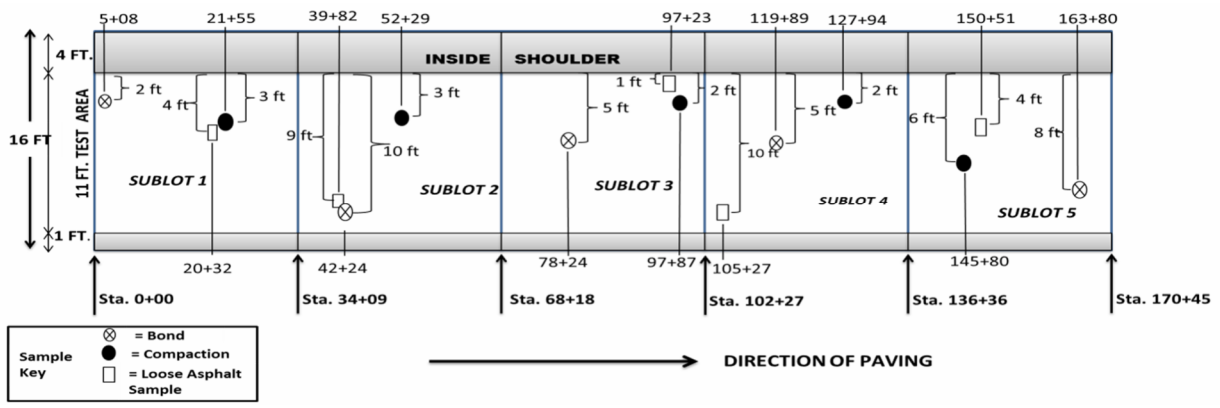

Figure 3

Using the same methodology and following the continuous lots in correspondence to paving sequence, the entire project layout for sampling can be completed as shown in Figure 4. Longitudinal joint lots begin at Station 0+00 between the fast and slow lanes and Joint Lot 1 ends at 10+00. Joint Lot 3 begins at Sta. 20+00 and continues to the other side of the median and extends the amount of the lot remaining.

After Figure 4, a summary is shown to help quantify the daily and total sampling efforts for the project.

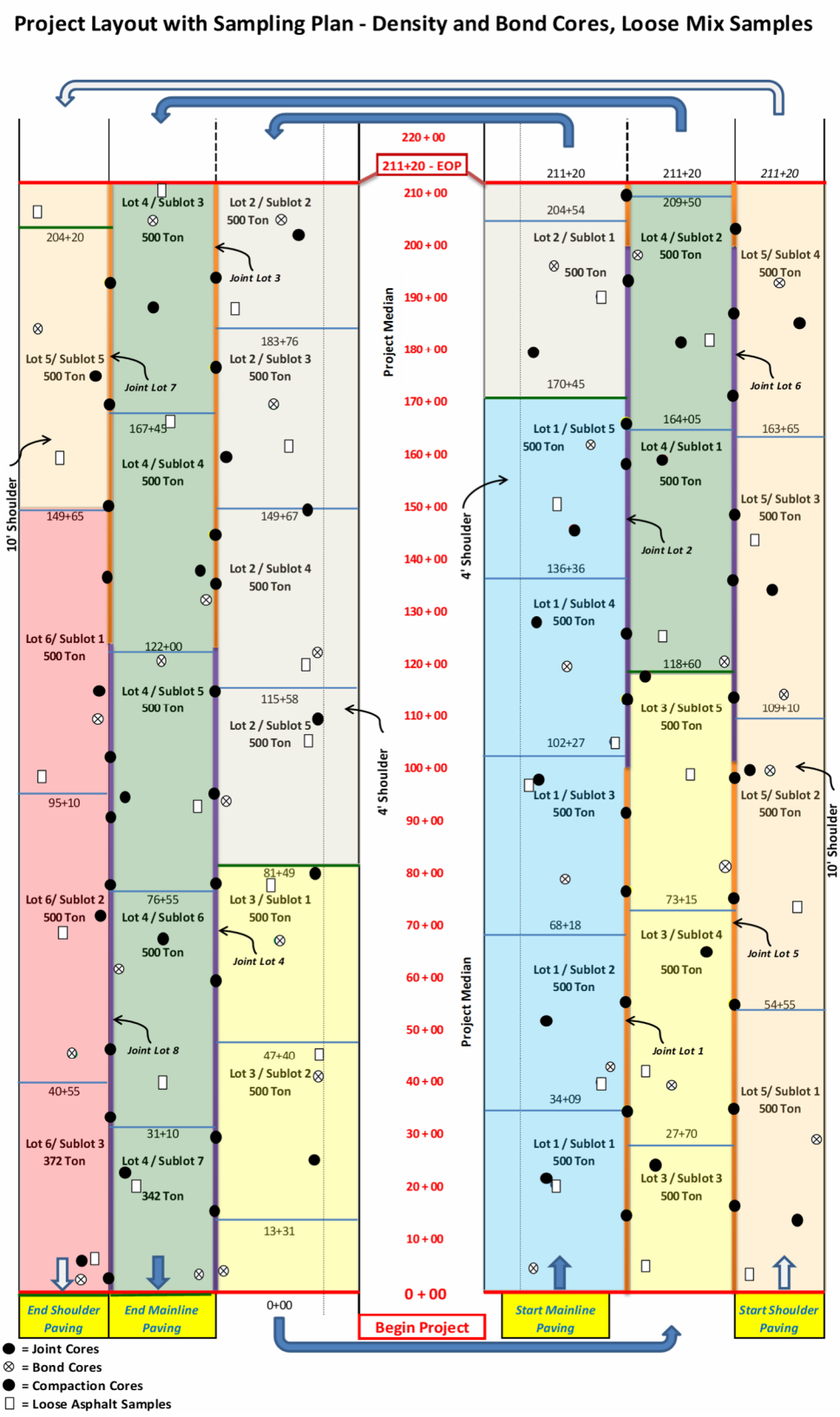
Project Layout with Sampling Plan - Density and Bond Cores, Loose Mix Samples
220 + 00
211+20 - EOP
210 + 00
200 + 00
190 + 00
180 + 00
170 + 00
160 + 00
150 + 00
140 + 00
130 + 00
120 + 00
110 + 00
100 + 00
90 + 00
80 + 00
70 + 00
60 + 00
50 + 00
40 + 00
30 + 00
20 + 00
10 + 00
0 + 00
Project Median
Project Median
4' Shoulder
4' Shoulder
10' Shoulder
10' Shoulder
211+20
211+20
211+20
204+20
Lot 4 / Sublot 3
500 Ton
Lot 2 / Sublot 2
500 Ton
Joint Lot 3
183+76
Lot 5/ Sublot 5
500 Ton
Joint Lot 7
Lot 2 / Sublot 3
500 Ton
167+45
Lot 4 / Sublot 4
500 Ton
149+65
149+67
Lot 2 / Sublot 4
500 Ton
Lot 6/ Sublot 1
500 Ton
122+00
Lot 4 / Sublot 5
500 Ton
115+58
Lot 2 / Sublot 5
500 Ton
95+10
81+49
Lot 6/ Sublot 2
500 Ton
76+55
Lot 4 / Sublot 6
500 Ton
Lot 3 / Sublot 1
500 Ton
Joint Lot 4
Joint Lot 8
47+40
Lot 3 / Sublot 2
500 Ton
40+55
31+10
Lot 6/ Sublot 3
372 Ton
Lot 4 / Sublot 7
342 Ton
13+31
0+00
End Shoulder Paving
End Mainline Paving
Begin Project
Start Mainline Paving
Start Shoulder Paving
204+54
Lot 2 / Sublot 1
500 Ton
209+50
Lot 4 / Sublot 2
500 Ton
Lot 5/ Sublot 4
500 Ton
Joint Lot 6
170+45
Lot 1 / Sublot 5
500 Ton
164+05
Lot 4 / Sublot 1
500 Ton
163+65
Lot 5/ Sublot 3
500 Ton
Joint Lot 2
136+36
Lot 1 / Sublot 4
500 Ton
118+60
Lot 3 / Sublot 5
500 Ton
109+10
102+27
Lot 1 / Sublot 3
500 Ton
Lot 5/ Sublot 2
500 Ton
73+15
68+18
Lot 3 / Sublot 4
500 Ton
Joint Lot 5
Lot 1 / Sublot 2
500 Ton
Joint Lot 1
54+55
34+09
Lot 5/ Sublot 1
500 Ton
27+70
Lot 1 / Sublot 1
500 Ton
Lot 3 / Sublot 3
500 Ton
= Joint Cores
= Bond Cores
= Compaction Cores
= Loose Asphalt Samples

Figure 4

Table 2 – Testing Summaries from Daily and Total Production

	Loose Sample	Density Core *	Bond Core *	Joint Cores
Day 1	4	4	4	0
2100 Ton	4 --> Lot 1	4 --> Lot 1	4 --> Lot 1	
Day 2	4	5	4	0
1950 Ton	1 --> Lot 1	1 --> Lot 1	1 --> Lot 1	
	3 --> Lot 2	4 --> Lot 2	3 --> Lot 2	
Day 3	4	3	5	0
2145 Ton	2 --> Lot 2	1 --> Lot 2	2 --> Lot 2	
	2 --> Lot 3	2 --> Lot 3	3 --> Lot 3	
Day 4	5	5	4	11
2323 Ton	3 --> Lot 3	3 --> Lot 3	2 --> Lot 3	5 --> Lot 1
	2 --> Lot 4	2 --> Lot 4	2 --> Lot 4	5 --> Lot 2
				1 --> Lot 3
Day 5	2	2	3	5
1265 Ton	2 --> Lot 4	2 --> Lot 4	3 --> Lot 4	4 --> Lot 3
				1 --> Lot 4
Day 6	5	4	3	9
1918 Ton	3 --> Lot 4	3 --> Lot 4	2 --> Lot 4	5 --> Lot 4
	2 --> Lot 5	1 --> Lot 5	1 --> Lot 5	4 --> Lot 5
Day 7	3	5	4	13
2200 Ton	1 --> Lot 5	2 --> Lot 5	2 --> Lot 5	1 --> Lot 5
	2 --> Lot 6	3 --> Lot 6	2 --> Lot 6	5 --> Lot 6
				5 --> Lot 7
				2 --> Lot 8
Day 8	3	2	3	4
812 Ton	3 --> Lot 6	2 --> Lot 6	3 --> Lot 6	4 --> Lot 8
		* *Measured for Thickness*		
Totals :	**30**	**30**	**30**	**42**
	6 Lots	**6 Lots**	**6 Lots**	**8 Lots**
	60 Cores Measured for Thickness			

Table 3 - Random Numbers

.858	.082	.886	.125	.263	.176	.551	.711	.355	.698
.576	.417	.242	.316	.960	.819	.444	.323	.331	.179
.687	.288	.835	.636	.596	.174	.866	.685	.066	.170
.068	.391	.739	.002	.159	.423	.629	.631	.979	.399
.140	.324	.215	.358	.663	.193	.215	.667	.627	.595
.574	.601	.623	.855	.339	.486	.065	.627	.458	.137
.966	.529	.757	.308	.025	.836	.200	.055	.510	.656
.608	.910	.944	.281	.539	.371	.217	.882	.324	.284
.215	.355	.645	.460	.719	.057	.237	.146	.135	.903
.761	.883	.771	.388	.928	.654	.815	.570	.539	.600
.869	.222	.115	.447	.658	.989	.921	.924	.560	.447
.562	.036	.302	.673	.911	.512	.972	.576	.838	.014
.481	.791	.454	.731	.770	.500	.980	.183	.385	.012
.599	.966	.356	.183	.797	.503	.180	.657	.077	.165
.464	.747	.299	.530	.675	.646	.385	.109	.780	.699
.675	.654	.221	.777	.172	.738	.324	.669	.079	.587
.279	.707	.372	.486	.340	.680	.928	.397	.337	.564
.338	.917	.942	.985	.838	.805	.278	.898	.906	.939
.316	.935	.403	.629	.130	.575	.195	.887	.142	.488
.011	.283	.762	.988	.102	.068	.902	.850	.569	.977
.683	.441	.572	.486	.732	.721	.275	.023	.088	.402
.493	.155	.530	.125	.841	.171	.794	.850	.797	.367
.059	.502	.963	.055	.128	.655	.043	.293	.792	.739
.996	.729	.370	.139	.306	.858	.183	.464	.457	.863
.240	.972	.495	.696	.350	.642	.188	.135	.470	.765

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MP 401.07.21 Steward – Asphalt Section
MAM: J