IMPLEMENTING SUPERPAVE IN MICHIGAN

Prepared By
PAVEMENT MANAGEMENT SERVICES, INC.
Jeff Click, President
Douglas Coleman, P.E.
Willard Thompson, MDOT
Ryan Rizzo, FHWA

Testing and Research Section
Construction and Technology Division
Research Project No. RC-1364

This report, authorized by the transportation director, has been prepared to provide technical information and guidance for personnel in the Michigan Department of Transportation, the FHWA, and other reciprocating agencies. The cost of publishing 75 copies of this report at $14.36 per copy is $1,076.73 and it is printed in accordance with Executive Directive 1991-6.

Technical Report Documentation Page

1. Report No. Research Report RC-1364	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Implementing Superpave in Michigan		5. Report Date 1997
7. Author(s) Jeff Click, Pavement Management Services Doug Coleman, P.E. Willard Thompson, MDOT Ryan Risso, FHWA		6. Performing Organization Code
9. Performing Organization Name and Address Pavement Management Services, Inc. 4733 Thornapple Lane Lansing, Michigan		8. Performing Org Report No. RC-1364
12. Sponsoring Agency Name and Address Michigan Department of Transportation Construction and Technology Division P.O. Box 30049 Lansing, MI 48909		10. Work Unit No. (TRAIS) 11. Contract/Grant No.
15. Supplementary Notes		13. Type of Report & Period Covered Technical - 1997 14. Sponsoring Agency Code

16. Abstract

Michigan Department of Transportation (MDOT) assembled a team comprised of personnel from a qualified consultant, staff from its Construction and Technology Division, and Federal Highway Administration. This team was called the Superpave Implementation Team.

The teams's objective was to monitor all aspects of construction, mix design, materials processing, mixture production, OC/QA testing and placement of bituminous mixture for the superpave projects.

The team's methodology was to identify any problems encountered, propose solutions, implement the proposed changes, document the problems and successes, and share the knowledge gained on one project with subsequent projects. Team members interviewed both contractor and MDOT personnel about their experiences, concerns and recommendations.

This report discusses MDOT's implementation procedures, project construction history, any problems or successes encountered, and any conclusions and recommended changes to the specifications and/or test procedures.

The team monitored all eight superpave projects that were worked on in 1997. Figure 1 give a brief description of the superpave projects and where they were located.

17. Key Words		18. Distribution Statement	
superpave		No restrictions. This document is available to the public through the Michigan Department of Transportation.	
19. Security Classification (report) Unclassified	20. Security Classification (Page) Unclassified	21. No of Pages	22. Price

Form DOT F 1700.7 (8-72)

Table of Contents

List of Tables

List of Figures

List of Appendix

INTRODUCTION

In 1987 the Strategic Highway Research Program (SHRP) began developing a new system for specifying asphalt pavement design. The product of this research is called Superpave, short for Superior Performing Asphalt Pavements. A unique feature of the Superpave system is that it is a performance-based specification system. The system contains asphalt binder specification, an asphalt mix design and analysis specification, and the computer software that integrates the entire system.

In 1993 the Federal Highway Administration (FHWA) issued its report on Superpave and started its implementation procedure nationally. The Michigan Department of Transportation (MDOT) established an implementation plan in November 1996 (Appendix A). The current MDOT implementation Plan is that 40 percent of 1998 mainline projects will be Superpave, 90 percent of the 1999 mainline projects will be Superpave and then 100 percent of the year 2000 mainline projects will be Superpave.

MDOT assembled a team comprised of personnel from a qualified consultant, staff from its construction and technology division and FHWA. This team was called the Superpave Implementation Team.

The team's objective was to monitor all aspects of construction, mix design, materials processing, mixture production, QC/QA testing and placement of bituminous mixture for the Superpave projects.

The team's methodology was to identify any problems encountered, propose solutions, implement the proposed changes, document the problems and successes, and share the knowledge gained on one project with subsequent projects. Team members interviewed both contractor and MDOT project personnel about their experiences, concerns and recommendations.

This report discusses MDOT's implementation procedures, project construction history, any problems or successes encountered, and any conclusions and recommended changes to the specifications and/or test procedures.

The team monitored all eight Superpave projects that were worked on in 1997. Figure 1 gives a brief description of the Superpave projects and where they were located.

LIST OF PROJECTS

Route	Location	Description of Work	ESAL	Tonnage
US-2	Dickinson Co.	Bituminous reconstruction and passing relief lanes	0.5	25,000
US-2	Delta Co.	Bituminous cold milling and resurfacing	2.8	12,000
I-75	Cheboygan Co.	Bituminous base crushing and shaping and resurfacing	2.3	89,000
US-23	Arenac Co.	Bituminous resurfacing	1.7	98,000
US-131	St. Joseph Co.	Bituminous resurfacing	4.6	68,000
M-53	Macomb Co.	Bituminous cold milling, widening and resurfacing	0.7	10,700
US-12	Wayne Co.	Bituminous cold milling and resurfacing	3.8	19,500
I-275	Monroe Co.	Rubblizing existing concrete pavement and bituminous resurfacing	8.4	35,600

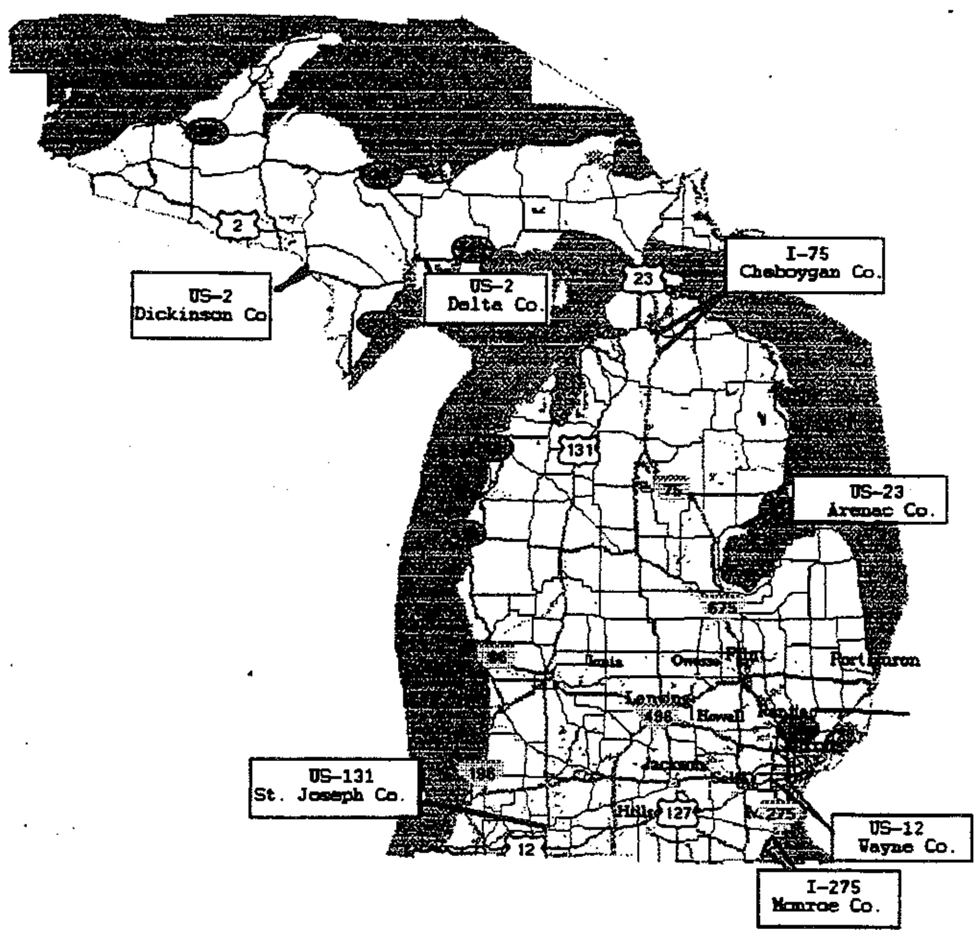


Figure 1
PROJECT LOCATIONS

BINDER SELECTION

In 1994 MDOT installed eight pavement temperature monitoring stations, and also began testing penetration graded asphalt binders under the performance graded (PG) binder specification. In the fall of 1996, using data from both of the above sources, MDOT specified three PG grades to be used in 1997.

The design grades chosen for the different areas of Michigan were as follows; PG 52-34 for the western Upper Peninsula, PG 52-28 for the eastern Upper Peninsula and the northern Lower Peninsula, PG 58-28 for the southern Lower Peninsula. A problem occurred during the first couple months of using the performance graded binders. The binders, selected for the different regions, had a softer consistency than was originally anticipated. MDOT revised its design grades so that PG 52-28 would be used throughout the Upper Peninsula and PG 58-28 would be used throughout the Lower Peninsula.

A certification system was established for the performance graded binders. Daily binder samples were taken at the asphalt mixture plant for certification verification testing.

The MDOT binder acceptance program included testing the penetration of the asphalt cement recovered from a daily sample of the mixture taken at the plant site. The implementation plan called for this acceptance procedure to be used for two years, after which acceptance will be based on the recovered binder meeting the performance grade specification.

The binders sampled on the eight Superpave projects were not tested for PG properties; each project had penetration testing performed on both the original and recovered binder. Table 1 shows the average of this test data for each mixture. The percent of recycled asphalt pavement (RAP) specified by the mix design is also listed in Table 1. The actual amount of RAP used may have varied from the percentage specified by the mix design.

Four of the eight Superpave projects had daily test results that failed to meet the contract specifications. In all but one case the recovered penetration was too high (binder was too soft). The mixture that was produced with these binders could be more susceptible to flushing and rutting. The daily penetration test results are included with the individual project data in Appendix D.

TABLE 1
PG BINDER TEST DATA

	Original Penetration Grade Supplied			Recovered Penetration Grade Specified		
Mixture	PG46-34	PG52-28	PG58-28	PG52-28	PG58-28	% RAP Used
US-2 3E1 (19mm)			136		73	
US-2 4E1 (12.5mm)						
US-2 3E3 (19mm)		202		105		
US-2 4E3 (12.5mm)		202		97		
I-75 3E3 (19mm)	339			121		25
I-75 4E3 (12.5mm)	372			136		30
US-23 2E3 (25mm)		216		128		
US-23 3E3 (19mm)		241		134		
US-23 4E3 (12.5mm)		244		132		
US-131 3E10 (19mm)		169			81	15
M-53 2E1(25mm)			111		57	
M-53 3E1(19mm)			107		63	
US-12 3E10 (19mm)			105		67	15
US-12 4E10 (12.5mm)			104		69	10
I-275 2E10 (25mm)		233			79	20
I-275 3E10 (19mm)		232			77	20
	355	217	113	122	71	Average
				65-135	55-115	Specification

AGGREGATES

On seven of the eight projects the aggregates used came from sources the contractor would normally use. One contractor had to use sources they wouldn't typically use because their normal aggregates had high absorption and they could not get a gradation to pass the Superpave specifications.

The contractors were solely responsible for selection, sampling and testing of the aggregates before they did the mix design. There was no indication of aggregate shortage; however, the contractors and aggregate suppliers were concerned about the amount of sand, minus 4.75mm material, that was being generated at the pits that could not be used in the Superpave mixtures.

Table 2 shows the properties of the aggregates used on the Superpave projects. A review of this data shows that the aggregates used had superior properties to the Superpave requirements. This is demonstrated by the crush content. For the less than 1 million ESAL and less than 3 million ESAL projects the required crush contents for top and leveling mixtures are 65 percent and 75 percent respectively. The minimum submitted crush content for a less than 1 million ESAL project was 84 percent. The minimum submitted crush content for a less than 3 million ESAL project was 92 percent. Since it is the first year of Superpave it is very difficult to determine whether or not this trend will continue.

There has been a lot of discussion about the flat and elongated particle specification. The question remains whether or not 3 to 1 or 5 to 1 is the correct ratio. MDOT measured flat and elongated using a 5 to 1 ratio. As can be seen from Table 2, the flat and elongated specification was never violated. The highest percentage was 1.9 percent, well below the 10 percent maximum.

The aggregates used had a wide variation in asphalt absorption. The asphalt absorption ranged from .59 to 1.49. Under MDOT's old procedure the asphalt absorption was not calculated; rather, it was assumed to be 1.00. As can be seen, this assumption would not always be valid.

The second to last row shows the percentage of aggregate passing the 75um sieve. The Superpave mixtures required much cleaner aggregates than a typical Marshall mix design. The range for a Superpave mixture was 3.4 percent to 4.6 percent passing the 75um sieve. A typical Marshall mix design would have 5.0 percent to 6.0 percent passing the 75um sieve.

TABLE 2
AGGREGATE PROPERTIES

	% Stone Quarry	% Sand Quarry	% Crush.	FAA	L.A.	% Soft Stone	Flat & Elong.	G_{sb}	% A.C. Absorb.	% pass 4.75 mm	% pass 75 um	% RAP
<1Million Spec.			65 Min.	40 Min.	40 Max	10 Max						
M-53 2E1	0	0	82.5	41	24	4.3	0.4	2.649	0.59	24.5	3.4	0
US-2 3E1	15	10	84.0	45.5	34	0.2	0.3	2.696	0.91	43.4	3.5	0
M-53 3E1	0	15	88.2	41.5	24	1.6	0.5	2.647	0.86	28.7	3.6	0
US-2 4E1	12	8	94.6	46.1	34	0	0.4	2.695	0.99	52.0	3.8	0
<3 Million Spec.			75 Min	40 Min.	35 Max	5 Max	10% Max					
US23 2E3	60	28	98.4	42.9	26	0	1.9	2.574	1.16	32.7	3.9	0
US-2 3E3	14	25	99.2	42.5	29	0.1	0.6	2.650	0.87	42.6	4.0	0
I-75 3E3	0	0	95/90	42.8	26	0.6	0	2.639	0.6	38.0	3.8	25
US-23 3E3			98.5	43.7				2.565	1.39	39.0	2.9	0
US-2 4E3	22	43	99.0	43.3	29	0.1	0.4	2.647	0.98	53.8	4.1	0
I-75 4E3	0	0	91.9	42.9	26	0.6	1.6	2.635	0.7	51.9	4.5	30
US-23 4E3			97.2	43.6				2.552	1.49	61.5	3.6	0
<10 Million Spec			85/80 Min	45 Min	35 Max	5 Max	10% Max					
I-275 2E10	100	100	99/99	46.7	28	0.4	0.3	2.752	0.59	38.0	3.9	20
US-131 3E10	2	28	96/90	46.7	31	4.4	1.8	2.662	1.06	50.6	4.5	15
US-12 3E10	100	100	99/99	45.6	31	0.2	1.8	2.590	1.37	41.7	4.4	15
I-275 3E10												
US-12 4E10	84	89	99/99	45.4	31	0.7	0.3	2.616	1.32	50.4	4.6	10
Average									0.99			
Range									.59-1.49			

MIX DESIGN

In the winter of 1996, in anticipation of the 1997 Superpave projects, MDOT sponsored a one-week, hands-on training course for contractors. Most contractors had an opportunity to send at least one representative to this class. In addition, MDOT had an open offer to send personnel to the contractor's plant or laboratory to help train their personnel and set up the Superpave equipment.

The mix design review process for Superpave was set up similar to the current process for Marshall mix designs. The contractor is responsible for performing a complete mix design. The contractor must submit samples of aggregate, mixture, TSR samples and complete mix design paperwork to the Construction and Technology (C&T) Laboratory. The requirements for a submittal are included in Appendix C.

Once the mix design was submitted to the C&T Laboratory the samples and paperwork were checked for completeness and then verification testing was performed. If the contractor's test data was verified and all parameters met specification a Job Mix Formula (JMF) was prepared so that field production could begin. If the mix design was not verified the contractor was required to submit a new design.

The actual test procedures and mixture requirements were set up very close to those taught at the Asphalt Institute which uses the SPS-2 manual. MDOT wanted to retain all of the Superpave mixture and aggregate requirements until there was a valid reason to change them.

MDOT specifications required the contractor to stay within the Superpave gradation control points and to avoid the restricted zone. All of the mix designs avoided the restricted zone. All but one of the mix designs were very coarse and went below the restricted zone.

All mix designs tested met the N_{ini} and N_{max} requirements. The N_{max} was usually close to the specification limit (98 percent) but the N_{ini} never seemed to be a controlling factor.

Six of the 17 mix designs incorporated recycled asphalt pavement (RAP). The amount varied from 15 percent to 30 percent. Five of these mix designs were verified on the first submittal.

On the eight Superpave projects there were a total 17 mix designs. Fourteen of the 17 mix designs were verified on the first submittal. This 82 percent passing rate for mix designs was better than that for Marshall mix designs which is around 78 percent. One of the three mix designs that was not approved was submitted with the wrong aggregates and was, therefore, never reported out. Of the two mix designs that did not verify on the first attempt one was verified upon the second submittal.

Table 3 illustrates the close correlation between the MDOT C&T Laboratory and contractor's test data for the submitted mix designs.

On average, MDOT and the contractor were within 0.008 on compacted density, 0.005 on theoretical maximum specific gravity (G_{mm}) and 0.37 on air voids. The average correlations were very close and well below the allowable verification tolerances.

Of special interest this year was the test for aggregate bulk specific gravity (G_{sb}). This test was a relatively new test to MDOT and most contractors and, because of the nature of the test, was more variable. However, the correlation for this particular test was very good.

Table 3
Mix Design Verification

Project	Mix Type	Mix Design	Difference between MDOT and Contractor				Fail
			Compacted Density	G_{mm}	Air Voids	G_{sb}	
Verification tolerance			0.020	0.013	1.00	0.028	
US-2 Dickinson Co.	3E1	97MD166	0.010	0.003	0.4	0.002	
	4E1	97MD230	0.003	0.014	0.6	0.006	X
*	4E1	97MD241	0.021	0.009	0.7	0.006	X
US-2 Delta Co.	3E3	97MD139	0.021	0.011	0.0	0.004	X
	3E3	97MD172	0.012	0.005	0.6	0.004	
	4E3	97MD164	0.001	0.010	0.6	0.008	
I-75 Cheboygan Co.	3E3	97MD131	0.002	0.001	0.1	0.002	
	4E3	97MD228	0.004	0.001	0.2	0.014	
US-23 Arenac Co.	2E3	97MD179	0.018	0.004	0.5	0.016	
	3E3	97MD200	0.012	0.004	0.4	0.019	
	4E3	97MD235	0.006	0.006	0.7	0.000	
US-131 St. Joseph Co.	3E10	97MD193	0.011	0.011	0.8	0.015	
M-53 Macomb Co.	2E1	97MD202	0.007	0.007	0.4	0.017	
	3E1	97MD209	0.004	0.004	0.1	0.020	
	4E1	97MD218	0.001	0.004	0.1	0.003	
US-12 Wayne Co.	3E10	97MD168	0.008	0.002	0.1	0.005	
	4E10	97MD225	0.000	0.003	0.1	0.018	
I-275 Monroe Co.	2E10	97MD196	0.011	0.001	0.7	0.007	
**	3E10	97MD226					
		STD	0.007	0.004	0.27	0.007	
		Average	0.0082	0.005	0.37	0.009	

*Contractor was allowed to use this mix to complete project.
**Mix design was submitted with the incorrect aggregates and was never reported out. Contractor attempted to produce mixture, but could not.

MIXTURE PRODUCTION

Plant production of Superpave mixtures was monitored using MDOT's QC/QA specification with the exception of replacing the Marshall hammer with the Superpave gyratory compactor. The specifications used to control these projects are included in Appendix C. The contractor takes a random sample of mixture every sublot of production and runs the following tests:

1. Theoretical Maximum Density (Rice).
2. Percentage compaction at N_{max} using the gyratory compactor.
3. Mixture aggregate gradation and asphalt content.
4. Percent crushed faces and soft particle count.

Mixture voids, VMA, VFA, N_{ini}, N_{des} and fines-to-asphalt ratio were calculated. When the contractor had completed testing five sublots (a lot), a MDOT inspector would randomly select one of the sublots and run the same tests the contractor performed.

MDOT's test results were compared to the contractor's results for verification. During this study, on some projects the MDOT inspector would run his test at the same frequency as the contractor; this was done to resolve any problems that might arise before a large quantity of mixture was placed that might not meet specifications.

The contractor was allowed to ask for a JMF adjustment if their test data indicated they were consistently producing a specification mixture but exceeded the tolerances from the JMF. Five of the approved mix designs were produced as designed; the others had minor changes in gradation, TMD or VMA. In most cases these changes were caused by aggregate blend changes to meet the design gradation. Table 4 is a summary of field changes that were approved.

TABLE 4
JMF CHANGES

Mix/ Item	Change of Plant	TMD	VMA	%AC	G_{sb}	4.75 mm	600 mm	75 um	Aggregate Blends #1	#2	#3	#4	#5
US-2 3E1	X												
US-2 4E3													
From		155.3	14.8	5.5		53.8							
To		155.6	14.2	5.3		54.0							
US-23 3E3													
From		153.1	13.1	5.3	2.565	39.0	12.7	2.9	25	29	20	15	11
To		152.6	13.5	5.4		43.5	13.0	3.7	15	29	33	15	8
To					2.558								
US-23 4E3													
From					2.552	61.3	16.6						
To					2.555	56.0	14.6						
US-131 3E10													
From		157.3	13.8	5.2									
To		158.1	13.6	4.9									
US-12 4E10													
From								4.6					
To								5.2					
I-275 2E10													
From	A 2E10								26	10	28	16	20
To	A 3E10								10	26	28	16	20

The contractors produced and tested 68 lots (328 sublots) while MDOT ran 81 tests. This is a higher retest ratio than normal; however, if the results of two mixtures from the US-23 project are removed, the test ratio becomes 56 to 60, which is closer to normal. The verification problem on US-23 was resolved after a technician from the central lab visited the project and went over the testing procedures with both MDOT and contractor technicians. The problem seemed to be caused by confusion about what was considered cure time for the samples. This issue is more important on projects that have mixtures with high absorption; care must be taken to ensure that most of the asphalt absorption has been satisfied before running the acceptance test. In general there was no problem between test results that were run at the same time and those that were run a couple of days later.

The contractors used Pine gyratory compactors on six projects and Troxler gyratory compactors on the other two projects. Both compactors worked well with no operational problems. The Troxler was a little inconvenient in that the sample heights had to be entered into a computer to calculate densities and get a data printout. This could become a problem as more gyratory compactor models are approved for field use. A simple computer program should be developed so that all gyratory compactors handle the sample heights the same way.

Table 5 is a summary of the contractors' quality control testing and incentives or disincentives earned on uniformity of mixture production and in-place density. The top data is the average value of all the contractors' QC data. Beneath that is the standard deviation of their QC data which is an indication of how uniform their mixture production was. The bottom two sections show how many lots were in bonus or disincentive for mixture uniformity and density.

The project specifications reward contractors who produce the mixture consistently. The contractors can earn a 4 percent bonus if the absolute deviation of their test results is less than the running average test tolerances specified. Of the 68 lots produced, 40 were subject to the bonus and 11 were subject to a disincentive.

The Table 5 data show that in general these Superpave projects were in compliance with the specifications. Several of the mixtures had a single property that was out of specification, two had high fines-to-asphalt ratio, one had a low VMA and one had high air voids.

It appears that a contractor can consistently produce Superpave mixtures and expect to be verified by MDOT. The fines-to-asphalt ratio should be added as an acceptance parameter.

TABLE 5

Item	US-2		US-2		I-75		US-23			US-131	M-53		US-12		I-275		Average
	3E1	4E1	3E3	4E3	3E3	4E3	2E3	3E3	4E3	3E10	2E1	3E1	3E10	4E10	2E10	3E10	
Thickness	37.5mm	37.5mm	50mm	37.5mm			125mm	50mm	37.5mm	50mm	100mm	44mm	50mm	37.5mm	87.5mm	50mm	
Ave. of QC Data																	
%AC	4.8	5.4	4.9	5.4	4.7	5.2	4.8	5.5	6	4.9	4	4.9	5.7	6	4.36	4.32	
Absorb	0.91	0.99	0.87	0.98	0.8	0.72	1.16	1.39	1.49	1.08	0.59	0.86	1.37	1.32	0.59	0.7	0.975
TMD(Gmm)	159.4	158.2	156.4	155.6	155.4	154.4	153.7	152.5	150.9	158	157.7	156.3	153.2	153.9	162.3	162.4	
%Gmm Nini	86.7	87.2	85.4	85.4	85.4	85.3	85	85.7	86.1	84.3	83.2	84.7	84.1	84.1	86.8	86.3	85.356
%Gmm Nmax	97.7	97.8	97.6	97	97.7	97.7	97.9	97.6	97.5	97.4	94.4	96.2	97.7	97.7	97.9	97.3	97.319
Air Voids	3.98	3.8	3.52	3.62	3.88	3.97	4	4.12	3.89	4.15	7.3	3.9	4	4.16	3.79	3.66	
VMA	13.4	14.4	13.3	14.12	13.5	14.5	12.5	13.5	14.6	13.3	15.1	13.5	14.2	15.1	13.1	12.8	
VFA	70.3	73.7	73.5	74.4	71.4	72.7	67.8	69.6	73.3	68.7	52.4	72.8	71.8	72.6	71.1	71.6	
Fines/Asphalt	1.3	0.84	0.9	0.96	0.69	0.88	1.01	0.92	0.81	1.3	1.1	1	1.19	1.18	1.16	1.19	1.027
No Design	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	0	17
No JMFs	2	0	1	2	1	1	1	3	3	2	2	2	2	2	2	1	27
Tons Placed	14277	11969	2009	9709	52692	39626	17476	52202	33272	31840	889	1777	8274	7309	9812	9502	302635
STD of QC Data																	Weighted
TMD	0.411	0.3	0.22	0.328	0.248	0.135	0.217	0.231	0.232	0.099			0.513	0.600	0.698	0.586	0.3078
VMA	0.431	0.339	0.157	0.154	0.364	0.192	0.552	0.371	0.721	0.282	1.37	1.68	0.896	0.476	0.657	0.587	0.4524
VFA	3.529	2.439	1.369	2.28	2.793	1.425	3.949	2.375	2.602	2.813	10.62	15.8	4.033	5.806	4.525	5.949	3.297
Air Voids	0.556	0.407	0.189	0.322	0.456	0.248	0.658	0.411	0.445	0.395	2.17	2.57	0.769	0.988	0.634	0.886	0.531
Fines/Asphalt	0.082	0.095	0.139	0.113	0.08	0.044	0.304	0.118	0.136	0.1	0.11	0.04	0.326	0.079	0.124	0.063	
%AC	0.209	0.121	0.09	0.131	0.12	0.06	0.077	0.101	0.104	0.162	0.31	0.28	0.379	0.260	0.266	0.223	0.152
25mm											1.55						
19mm	0.629		1.506				4.009	1.632			0.19				1.257	1.751	
12.5mm	2.204	1.298	2.734	1.989	1.784	1.209	8.344	3.305	1.352	2.758	1.77	4.29	4.811	1.122	2.949	3.119	
9.5mm	2.356	1.862	3.285	2.389	2.122	1.895	6.723	4.399	2.188	2.952	3.62	1.83	5.478	2.428	2.602	4.830	
2.36mm	1.019	1.643	1.927	1.271	1.797	1.715	3.552	2.076	2.439	1.389	2.51	3.44	3.128	3.138	1.441	3.878	2.054
75um	0.194	0.391	0.499	0.457	0.271	0.194	1.125	0.445	0.573	0.385	0.01	0.43	0.828	0.466	0.270	0.222	0.404
# test	17	15	3	11	49	35	17	35	30	45	3	4	13	10	22	17	327
Lots	3	3	1	2	10	7	3	9	6	9	1	1	3	2	5	3	68
MDOT test	3	2	1	3	10	7	5	16	6	11	2	3	2	2	5	3	81
Mixture																	
Bonus Lots	2		1	2	9	7	0	4	5	8	0	0	2	0	0	0	40
Deduct Lots				0	1	0	0	0	1	0	1	0	1	0	5	3	11
Binder																	
Deduct.	1	0	0	0	0	3	2	4	2	0	1	0	0	0	0	0	13
Density	91.54	92.08		92.9	93.77	93.59	92.81	93.74	93.34	94.2	94.1	93.11	93.97	93.54	93.22	93.18	93.273
6% bonus					1	1	1	3		5			1				12
4% bonus					3	1			1	2							7
2% bonus				1	5	3		1	2	2				1		1	16
Full pay		1		1	1	1	1	2	2		1	1	1	1	4	2	19
10% Deduct						1	1	3	1						1		7
25% Deduct	3	2											1				6
SUBLOTS																	
Removal	3							1					1				5

PAVING AND COMPACTION

Placement and compaction of these Superpave mixtures was accomplished with normal paving equipment, with the exception that more and heavier rollers were generally used. The contractors used vibratory, static and pneumatic rollers. Some projects used pneumatic rollers as breakdown followed by vibratory rollers; others used vibratory rollers as breakdown followed by pneumatic rollers. It did not appear that one method was more successful than the other.

The more important factor was getting as much compactive effort as possible on the mixture while it was still hot. It is very important to monitor mixture temperature and set up the rolling pattern based on these temperatures. It appeared that on all of these projects there was a temperature zone where the mixture appeared to be tender. Typically, between 200°F to 170°F compaction could not be increased and may have decreased. It is advisable to stay off the mixture in these temperature zones. It appears that if a contractor uses a density gauge for field control and monitors mixture temperatures they could achieve the required 92.0 percent density, and in most cases earn some incentive pay.

Table 5 lists the average in-place density, the mixture placement thickness, and the amount of mixture subject to a price incentive or a price reduction. As can be seen from the data, 68 lots were placed and 54 of these were full-pay or some incentive and 13 lots were subject to a price reduction. These numbers cannot be compared to normal MDOT projects because the acceptance densities are different than the normal specification. The Superpave specification has a lower bonus density, 92.5 percent of the TMD, but a higher percentage of the mixture is required to be at that density – 75 percent of the cores. The density incentive specification was lowered for Superpave projects to encourage the contractors to obtain the highest density possible. The projects with the highest density were being paved over a rigid pavement, and the project with the lowest density was being paved over an aggregate base. It should also be noted that the project with the lowest density was placing a 3E1 mixture 1.5" thick. It appears that mixtures should not be placed in lifts thinner than 2 times the maximum size, or three times nominal maximum size; therefore, a 3E1 mixture should not be placed thinner than 2".

SURFACE DISTRESS

The Superpave mixtures were placed with little or no segregation; however, the mixture can segregate if the contractor does not follow good paving practices. No special techniques or equipment were employed on these projects to reduce segregation.

These eight projects had mixture being placed over aggregate bases, over old flexible pavements with no joint repairs, over old concrete pavements with no joint repairs, and over crushed and shaped asphalt pavements.

The mixtures placed over pavements that had no joint repairs had more surface distresses than those placed on the aggregate or crushed bases; this is also typical on projects using normal mixtures. The one project that had a smoothness specification included as part of the project received a bonus for 95 percent of the ride quality incentive. No flushing or rutting was observed on any of the projects.

Superpave mixtures cannot compensate for badly-deteriorated pavements any more than conventional mixtures can.

PROBLEMS ENCOUNTERED

The team observed several problem situations during the project reviews. In most cases the situation was resolved by the project engineer with very little effect on the Superpave mixture production or placement. Following is a list of the problem situations:

1. On one project, the contractor was unable to achieve passing density, although substantial effort was made. The project engineer increased the lift thickness at which the contractor was placing the mixture, but it did not appear to solve the problem.

2. On one project, the contractor could not get his mix design approved by the MDOT lab. The project engineer allowed the contractor to use the unapproved mix design and that mixture met all Superpave properties.

3. On one project, the MDOT inspector had problems verifying the contractor's QC test results. This continued until a technician from the central lab visited the project and reviewed the testing procedures with both contractor and MDOT technicians. It was determined that the problem was caused by a difference in the mixture cure time. Once the problem was identified, the state began verifying the contractor's QC test results.

4. On one project, the contractor has yet to produce a specification mixture, and does not know what the problem is or how to correct it. The contractor would produce one or two sublots a day, review test data, make changes to the mixture and then make two more sublots. This continued until the project was shut down for the winter. At this point the contractor does not know what to do and feels he needs a new mix design.

5. On one project, a contractor with an approved mix design for a 2E10 mixture was unable to produce a mixture that met the specification for that mixture type; it did, however, meet the specification for a 3E10. Since the project called for a 2E10 and a 3E10 mixture, the project engineer allowed the contractor to use the mixture being produced for both the 2E10 and 3E10 mixes.

PROJECT SUMMARIES

Project No. 1: US-2, Dickinson County Length: 5.97 miles

Average Daily Commercial Traffic: 390 vehicles
Design ESALs: 0.5 million
Binder used: PG58-28 from Koch; No RAP
The project called for:

13,000 tons of 3E1 (19mm) mixture
12,000 tons of 4E1 (12.5mm) mixture

The mix designs were prepared and submitted by the contractor. MDOT verified the 3E1 mixture but on two attempts could not verify the 4E1 mixture.

The plant used was a drum plant with a baghouse; the baghouse material was rejected. The contractor's personnel were doing QC testing. Belt samples were used for aggregate gradation control, and mixture samples, taken from the hauling unit, were tested at the plant site for mixture volumetrics. A MDOT inspector did QA testing on splits of the contractor's QC samples. No mixture production, sampling or testing problems were reported.

The 3E1 leveling course was placed 1.5" thick over an aggregate base and the 4E1 top course was also placed 1.5" thick.

Paving equipment consisted of a standard 10' paver with hydraulic extensions. There was no heat or vibration on the screed.

The contractor was having trouble achieving acceptable density; he was placing the 3E1 mixture on an aggregate base which was very smooth and not tacked. The course thickness of 1.5" appeared to be thinner than a 3E1 mixture should be placed. The mixture was expanding as it was being compacted, and this caused the lift to be even thinner. The 1.5" lift thickness is less than is currently specified for MDOT projects.

The contractor was using three rollers, none of which was ballasted. The breakdown roller was a dual drum static roller, the intermediate roller was a pneumatic roller, and the finish roller was a dual drum vibratory roller operated in the static mode.

The team visited this project only once for a very short time, and the contractor was placing small quantities of mixture. Neither temperature nor density monitoring was being done.

When reviewing all test data from the project for the 3E1 mixture, it was noted that some of the mixture met neither project specifications nor Superpave requirements. Some of the mixture failed density and should have been removed. All mixture placed was subject to price reductions because of low in-place density and low recovered penetration of the asphalt binder. The fines-to-asphalt ratio and the 2.36mm sieve did not meet Superpave requirements. The 4E1 mixture design was never approved by MDOT. However, the contractor still used the design. Two of the three lots of the 4E1 produced are subject to a mixture price reduction because of in-place density. The gradation was out of specification on the 2.36mm sieve.

Table 6 is a summary of the project test data.

TABLE 6
US-2 PRODUCTION SUMMARY

@ Design Gyrations	3E1 (19mm) Mix				4E1 (12.5mm) Mix			
	JMF	QC Data	Diff.	STD	JMF	QC Data	Diff.	STD
G_{mm}	2.553	2.555	+0.002	0.0066	2.529	2.535	+0.006	0.005
VMA	13.4	13.39	-0.01	0.43	14.8	14.45	-0.35	0.34
Air Voids	4	3.98	-0.02	0.55	4.0	3.81	-0.19	0.41
% Asphalt	4.8	4.77	-0.03	0.21	5.5	5.39	-0.11	0.12
VFA	70.2	70.31	+0.11	3.53	73.3	73.69	+0.39	2.44
Fines/AC	0.89	1.3	+0.41	0.08	0.83	0.85	+0.02	0.09
25mm	100	100	0	0	100	100	0	0
19mm	98.6	99.7	+0.9	0.63	100.0	100	0	0
12.5mm	82.9	80.29	-2.61	2.20	93.8	91.95	-1.85	1.30
9.5mm	73	70.44	-2.56	2.36	83.2	80.59	-2.61	1.86
4.75mm	43.2	40.86	-2.34	1.81	52.0	49.31	-2.69	3.03
2.36mm	23.4	22.02	-1.38	1.02	28.8	27.95	-0.85	1.64
1.18mm	16.6	15.75	-0.85	0.62	18.9	19.53	+0.63	1.21
600um	12	11.83	-0.17	0.57	13.5	14.17	+0.67	0.81
300um	7.1	8.14	+1.04	0.36	8.8	9.26	+0.46	0.63
150um	3.8	5.13	+1.33	0.28	5.4	5.57	+0.17	0.57
75um	3.4	3.55	+0.15	0.19	3.8	3.78	-0.02	0.39
% Compact.		91.52				92.08		
No. of Tests		17				11		

Project No. 2: US-2, Delta County Length: 3.3 miles
Average Daily Commercial Traffic: 1000 vehicles
Design ESALs: 1.4 million
Binder used: PG52-28 from Amoco; No RAP
The project called for:
2,000 tons of 3E3 (19mm) mixture
10,000 tons of 4E3 (12.5mm) mixture

The project called for two courses: a 3E3 leveling course on an aggregate base in a widening trench and a 4E3 top course over an existing flexible pavement.

The mix designs were prepared and submitted by the contractor. MDOT did not verify the 3E3 mix design on the first attempt, and the contractor had to submit a second design. The 4E3 mix design was verified on the first attempt.

The contractor used a drum plant with a baghouse; the baghouse material was rejected. The contractor's personnel did QC testing. Samples were taken at the plant site from the hauling units. The NCAT ignition oven was used for aggregate gradation and the percent asphalt cement was calculated from the mixture maximum density. MDOT personnel using split samples of the contractor's QC samples did QA testing. No mixture production or testing problems were reported.

Paving equipment consisted of a standard 10' paver with hydraulic extensions. There was no heat on the screed and vibration was set at 70 percent.

At the time of our visit, the contractor was placing the 4E3 mixture 15' wide, 1.5" thick, over an older flexible pavement. Four rollers were used. Breakdown was accomplished with a dual drum vibratory roller in low amplitude and high frequency. Following breakdown were two intermediate pneumatic rollers followed by a tricycle steel-wheeled roller. The finish rolling was accomplished with a dual drum static roller. The contractor did not appear to be having any problems achieving acceptable density but he did think that achieving incentive density would be difficult. Of the three lots of mixture produced, the contractor received a 2 percent incentive for density on one lot and full pay on the other two lots.

The contractor was monitoring mixture and air temperature, and the roller patterns were based on the mixture temperature. The mixture was being placed at 300°F and the finish rolling was completed at 150°F.

On our visit to the project, we observed that the paver placement rate exceeded the plant production rate. This caused the paver to stop between loads of mix, thereby creating the potential for poor ride quality. The paving foreman was requested to reduce the paver speed to coincide with plant production which improved the pavement surface.

Reviewing the test data for this project showed that all tested mixture appeared to meet both the project specifications and the Superpave requirements.

Table 7 is a summary of the contractor's QC test.

TABLE 7
US-2 PRODUCTION SUMMARY

@ Design Gyrations	3E3 (19mm) Mix				4E3 (12.5mm) Mix			
	JMF	QC Data	Diff.	STD	JMF	QC Data	Diff.	STD
G_{mm}	2.506	2.506	0	0.0035	2.494	2.494	0	0.0053
VMA	13.5	13.28	-0.22	0.16	14.2	14.12	-0.08	0.15
Air Voids	4.0	3.52	-0.48	0.19	4.0	3.62	-0.38	0.35
% Asphalt	4.9	4.94	+0.04	0.09	5.3	5.37	+0.07	0.14
VFA	71.4	73.49	+2.09	1.37	72.5	74.37	+1.87	2.47
Fines/AC	0.98	0.90	-0.08	0.14	0.94	0.96	+0.02	0.13
25mm	100	100	0	0	100	100	0	0
19mm	97.2	95.47	-1.73	1.51	100	100	0	0
12.5mm	81.0	78.54	-2.46	2.73	91.6	91.01	-0.59	1.96
9.5mm	63.6	62.98	-0.62	3.29	79.4	77.50	-1.9	2.55
4.75mm	42.8	41.24	-1.56	2.69	54.0	54.83	+0.83	2.30
2.36mm	28.9	27.85	-1.05	1.93	36.3	36.46	+0.16	1.78
1.18mm	18.7	18.32	-0.38	1.05	22.7	22.69	-0.01	1.29
600um	12.6	12.8	+0.2	0.81	14.7	15.04	+0.34	0.80
300um	8.6	8.52	-0.08	0.71	9.6	9.50	-0.1	0.54
150um	5.6	5.13	-0.47	0.56	5.8	5.72	-0.08	0.57
75um	4.0	3.70	-0.3	0.50	4.1	4.24	+0.14	0.51
% Compact.		N/A				92.9		
No. of Tests		3				11		

Project No. 3: I-75, Cheboygan County Length: 10.4 miles
Average Daily Commercial Traffic: 1400 vehicles
Design ESALs: 2.3 million
Binder used: PG46-34 from Amoco; 30 percent RAP to meet a PG52-28
The project called for:
51,000 tons of a 3E3 (19mm) mixture
39,000 tons of a 4E3 (12.5mm) mixture

The project called for two courses: a 3E3 leveling course over a crushed and shaped flexible pavement placed 2" thick and a 4E3 top course placed 1.5" thick.

The mix designs were prepared and submitted by the contractor. MDOT verified both designs on the first attempt.

The plant used was a drum plant with a wet wash. Aggregate samples were taken from the belt and mixture samples were taken from the hauling unit at the plant site. Contractor personnel did QC testing. MDOT personnel using splits of the contractor's QC samples did QA testing. The mixture contained 30 percent RAP which was not included with the belt sample; therefore, the mixture gradation shown does not include the RAP material. The MDOT lab results are the actual mixture gradation. No mixture production, sampling or testing problems were observed or reported.

Paving equipment consisted of a standard 10' paver with hydraulic and rigid extensions. No heat was on the screed and vibration was approximately 50 percent.

The project called for crushing and shaping an old flexible pavement and then placing a 3E3 leveling course and a 4E3 top course. The contractor placed the 3E3 mixture 2" thick, and then placed the 4E3 mixture 1.5" thick. Four rollers were used. Breakdown was accomplished with a dual drum vibratory roller set in low amplitude and high frequency. Following breakdown were two intermediate rollers, a very large pneumatic followed by another dual drum vibratory with the same frequency and amplitude as the breakdown roller. The finish rolling was accomplished with a dual drum vibratory roller operated in the static mode. The contractor was having no trouble achieving acceptable density but did comment that more compactive effort was being used to compact the bituminous layer than was used to compact the crushed base being paved over. One of the company owners said he thought the density requirements were too high and unachievable. This is not typical of this contractor who will normally do everything to get as much density as possible. Of the 17 lots produced, the contractor received density incentive on 14.

The contractor was not monitoring mixture or air temperature; he was using a density gauge to monitor compaction. The contractor was rolling in the shoulder rumble strip in the normal manner; the mixture temperature was 280°F.

A problem with the subbase on this project developed late in the paving process. An area on the north end of the project settled abruptly. This did not tear the pavement but it did cause some ride quality problems. The interesting thing about this failure is that it did not occur until the contractor was compacting the top course. Soil borings were taken in these areas but no definitive answer has been found as to why this failure occurred.

The project test data show mixture was produced very uniformly; however, one lot was subject to a price reduction because the VMA was low. More evaluation is needed because the fines-to-asphalt ratio was too high when the RAP material and plant breakdown were added to the contractor's test results. The gradation limit on the 2.36mm sieve was also out of Superpave requirement. Ride quality data should be evaluated but was not available. The contractor stated he earned a majority of the potential incentive.

The binder test results are also positive. MDOT requested a PG52-28 binder, hoping to get a binder similar to the old AC-5 after adding 30 percent RAP. The penetration of binder recovered from plant mixture was generally within specification but much softer than MDOT would have accepted in the past. Three days of production were subject to a mixture price reduction because the recovered penetrations were too high. The PG binder testing should be done on the binders recovered from these mixtures.

Table 8 is a summary of the contractor's QC test results.

TABLE 8
I-75 PRODUCTION SUMMARY

@ Design Gyrations	3E3 (19mm) Mix				4E3 (12.5mm) Mix			
	JMF	QC Data	Diff.	STD	JMF	QC Data	Diff.	STD
G_{mm}	2.490	2.491	+0.001	0.0040	2.474	2.474	0	0.0021
VMA	13.7	13.5	-0.2	0.36	14.6	14.5	-0.1	0.19
Air Voids	4.0	3.88	-0.12	0.46	4.0	3.97	-0.03	0.25
% Asphalt	4.7	4.68	-0.02	0.12	5.2	5.20	0	0.06
VFA	70.5	71.37	+0.87	2.79	72.3	72.66	+0.36	1.42
Fines/AC	0.92	0.69	-0.23	0.07	1.00	0.86	-.014	0.04
25mm	100	100	0	0	100	100	0	0
19mm	100	100	0	0	100	100	0	0
12.5mm	81.5	82.97	+1.47	1.78	92.3	92.19	-0.11	1.21
9.5mm	64.8	64.93	+0.13	2.12	79.1	78.93	-0.17	1.90
4.75mm	33.0	29.93	-3.07	1.89	50.0	48.27	-1.73	1.39
2.36mm	20.9	19.17	-1.73	1.80	25.6	25.08	-0.52	1.71
1.18mm	17.2	15.98	-1.22	1.66	16.9	17.5	+0.6	1.57
600um	11.2	11.74	+0.54	1.32	12.6	12.98	+0.38	1.12
300um	5.1	5.48	+0.38	0.49	6.6	6.96	+0.36	0.65
150um	3.3	3.41	+0.11	0.30	4.3	4.66	+0.36	0.31
75um	2.8	2.82	+0.02	0.27	3.7	3.87	+0.17	0.19
% Compact.		93.77				93.59		
No. of Tests		49				35		

Project No. 4: US-23, Arenac County Length: 17.9 miles
Average Daily Commercial Traffic: 800 vehicles
Design ESALs: 1.7 million
Binder used: PG52-28 from Amoco; No RAP
The project called for:
20,000 tons of 2E3 (25mm) mixture
45,000 tons of 3E3 (19mm) mixture
33,000 tons of 4E3 (12.5mm) mixture

The 2E3 base course was placed in a trench 2.5" thick for the widened sections. A 3E3 leveling course was placed 1.5" thick over a flexible pavement and a 4E3 top course was placed 1.25" thick.

The mix designs were prepared and submitted by the contractor. MDOT verified all the designs on the first attempt.

The contractor used a drum plant with a baghouse; the baghouse material was rejected. QC testing was done by contractor personnel with mixture samples taken from the hauling units at the plant site. Gradation testing was done using the NCAT ignition oven; the percent asphalt was calculated from the mixture maximum density. A MDOT inspector using splits of the contractor's QC samples did QA testing.

The contractor had a concern with the length of time he had to allow the mixture to cure before he could run his QC test. This issue appeared to be causing some problems with MDOT verifying the contractor's test results. The contractor was curing samples for four hours and MDOT would reheat its sample for three hours then split it and cure the sample for another four hours. This problem occurred on the base and leveling mixture; but, after some personnel changes, MDOT had no trouble verifying the contractor on the top course. On projects with high absorption, the cure time must be addressed within the first lot of testing.

Paving equipment consisted of a standard 10' paver with hydraulic extensions. No heat or vibration was used on the screed. The contractor had installed auger extensions and tunnel extensions.

The contractor placed the 2E3 mixture in a five-foot trench on each shoulder, then placed the 3E3 and the 4E3 mixtures 32' wide. Five rollers were used, all of which were ballasted. Breakdown was accomplished with a dual drum vibratory roller set on low amplitude and high frequency.

Following breakdown were three intermediate rollers, two pneumatic rollers and a tricycle steel-wheeled roller. The finish rolling was accomplished with a dual drum static roller. Each roller operator had a mixture temperature measuring device and a pre-assigned temperature zone to work within. The leveling course was placed over an existing bituminous pavement; the older pavement had many transverse cracks that were not repaired before this overlay. When the top course was placed, care was taken to ensure a good ride and very little segregation. Both auger extensions and tunnel extensions were used on the paver. Further, the paver never ran the hopper empty and would smoothly transition between trucks.

The contractor felt the lift thicknesses called for were too thin to get proper compaction. Of the 18 lots of mixture produced, eight lots earned the density bonus and five lots were subject to a price reduction because of low density. The contractor also voiced a concern about the coarseness of Superpave mixtures in that natural aggregate sources typically generate excessive quantities of sand that cannot be incorporated into the Superpave mixtures.

Reviewing the project test data showed a verification problem on the contractor's 2E3 and the 3E3 mixtures. MDOT test results showed a problem with air voids and the fines-to-asphalt ratio. The recovered penetration data showed eight days of mixture production subject to a mixture price reduction. All the in-place density data were not available at the time of evaluation; however, at least one lot of mixture was subject to a price reduction. The gradation data were very good but the contractor was allowed two JMF changes.

Table 9 is a summary of the contractor's QC test results.

TABLE 9
US-23 PRODUCTION SUMMARY

@ Design Gyrations	2E3 (25mm) Mix			
	JMF	QC Data	Diff.	STD
G_{mm}	2.465	2.463	-0.002	0.0034
VMA	12.3	12.52	+0.22	0.55
Air Voids	4.0	4.04	+0.04	0.66
% Asphalt	4.7	4.78	+0.08	0.08
VFA	67.8	67.8	-0.0	3.95
Fines/AC	1.09	1.02	-0.07	0.30
25mm	100	100	0	0
19mm	73.6	79.2	+5.60	4.01
12.5mm	60.4	63.9	+3.5	6.34
9.5mm	52.2	53.4	+1.2	6.72
4.75mm	32.7	33.0	+0.3	5.55
2.36mm	20.0	20.8	+0.8	3.55
1.18mm	14.6	15.4	+0.8	2.54
600um	12.0	12.1	+0.1	2.04
300um	7.6	7.3	-0.3	1.55
150um	4.6	4.6	-0.0	1.24
75um	3.9	3.7	-0.2	1.13
% Compact.		93.50		
No. of Tests		17		

@ Design Gyrations	3E3 (19mm) Mix				4E3 (12.5mm) Mix			
	JMF	QC Data	Diff.	STD	JMF	QC Data	Diff.	STD
G_{mm}	2.446	2.444	-0.002	0.0038	2.415	2.419	+0.004	0.0037
VMA	13.5	13.51	+0.01	0.45	14.5	14.56	+0.06	0.72
Air Voids	4.0	4.12	+0.12	0.48	4.0	3.89	-0.11	0.44
% Asphalt	5.4	5.45	+0.05	0.11	6.1	6.00	-0.1	0.10
VFA	70.1	69.6	-0.5	2.74	73.8	73.29	-0.51	2.60
Fines/AC	0.73	0.92	+0.19	0.19	0.77	0.81	+0.04	0.81
25mm	100	100	0	0	100	100	0	0
19mm	95.3	97.0	+1.70	1.49	100	100	0	0
12.5mm	82.0	79.12	-2.88	3.66	93.8	95.06	+1.26	1.35
9.5mm	70.0	68.93	-1.07	4.57	87.7	86.28	-1.42	2.19
4.75mm	43.5	43.43	-0.07	4.01	56.0	55.28	-0.72	3.07
2.36mm	29.0	26.42	-2.58	2.52	38.0	34.73	-3.27	2.44
1.18mm	19.0	18.05	-0.95	1.72	23.8	22.64	-1.16	2.10
600um	13.0	13.17	+0.17	1.29	14.6	15.74	+1.14	1.52
300um	9.0	8.15	-0.85	0.87	9.0	8.98	-0.02	0.94
150um	5.5	5.06	-0.44	0.65	3.7	4.97	+1.27	0.57
75um	3.7	3.86	+0.16	0.53	3.6	3.74	+0.14	0.57
% Compact.		93.34				93.43		
No. of Tests		47				30		

Project No. 5: US-131, St. Joseph County Length: 21.4 miles
Average Daily Commercial Traffic: 2400 vehicles
Design ESALs: 4.6 million
Binder used: PG52-28 from Laketon; 15 percent RAP for a PG58-28
The project called for:
40,000 tons of 3E10 (19mm) mixture
28,000 tons of 4E10 (12.5mm) mixture

The project called for two courses over the existing concrete pavement with no joint repair. The leveling course, a 3E10 mix, was placed 3" thick and the top course would not be placed until the 1998 construction season.

The mix design was prepared and submitted by the contractor. MDOT verified the mix design.

The contractor used a drum plant with baghouse; the baghouse material was rejected. Contractor personnel did the QC testing. Belt samples were used for aggregate control, and mixture samples were taken from the hauling unit at the plant site. MDOT personnel ran QA tests on splits of the contractor's QC samples. No mixture production or testing problems were reported.

Paving equipment consisted of a standard 10' paver with hydraulic extensions. No heat was on the screed and the screed vibration was approximately 50 percent.

The contractor placed the 3E10 mixture 3" thick over an old rigid pavement. Five rollers were used, all ballasted. Breakdown was accomplished with two pneumatic rollers. Following breakdown were two intermediate rollers, both dual drum vibratory, set in low amplitude and high frequency. Finish rolling was accomplished with a dual drum static roller. The concrete pavement being overlaid had no preparation, so some joints and cracks could be seen in the new overlay. This also occurred on the project where the contractor was placing a normal MDOT mixture. These conditions had nothing to do with Superpave mixtures.

Achieving acceptable density was not a problem for the contractor. The mixture was being placed at 280°F behind the paver and the finish rolling was completed at about 150°F.

Reviewing the project test data revealed that the gradation failed to meet Superpave requirements on the 2.36mm sieve and both the MDOT plant inspector and MDOT central lab had the fines-to-asphalt ratio too high.

Table 10 is a summary of the contractor's QC test.

TABLE 10
US-131 PRODUCTION SUMMARY

@ Design Gyrations	3E10 (19mm) Mix			
	JMF	QC Data	Diff.	STD
G_{mm}	2.520	2.531	+0.011	0.0062
Air Voids	4.0%	4.15%	+0.15	0.39
VMA	13.8	13.28	-0.52	0.28
Fines/Asphalt	1.08	1.27	+0.19	0.10
% Asphalt	5.2	4.87	-0.37	0.16
19mm	100	100	0	0
12.5mm	83.2	83.21	+0.01	2.76
9.5mm	66.8	68.41	+1.61	2.95
4.75mm	50.6	50.8	+0.2	3.08
2.36mm	26.5	22.46	-4.04	1.39
1.18mm	13.8	12.76	-1.04	0.88
600um	10.5	9.80	-0.70	0.76
300um	7.3	7.57	+0.27	0.64
150um	5.1	6.14	+1.04	0.57
75um	4.5	4.80	+0.30	0.39
% Compact.		94.20		
No. of Tests		45		

Project No. 6: M-53, Macomb County Length: 3.0 miles

Average Daily Commercial Traffic: 420 vehicles

Design ESALs: 0.7 million

Binder used: PG58-28 from Marathon

The project called for:

- 2,000 tons of 2E1 (25mm) mixture
- 6,000 tons of 3E1 (19mm) mixture
- 4,700 tons of 4E1 (12.5mm) mixture

The mix designs were prepared and submitted by a consultant for the contractor. MDOT verified the mix designs on the first submittal.

The plant was a drum plant with a baghouse; the baghouse material was rejected. Mixture samples were taken from the hauling unit at the plant site. Consultant personnel did QC sampling and testing. MDOT personnel did QA testing.

The existing roadway was to have 1.5" of old mixture milled off. A 2E1 mix was to be placed 3" thick in a 5' widening trench, then a 3E1 leveling course and a 4E1 top course were to be placed over the total roadway width. The contractor placed the 2E1 mixture and a small amount of the 3E1 mixture before the weather became too cold to place mixture.

The contractor placed the 2E1 mix over a sand subbase that did not appear to have adequate compaction; the mixture was being pushed down into the sand. No one was monitoring air or mixture temperature and the density technician did not know what density he should be measuring. No informational cores were taken. The contractor was placing the mix with a shoulder spreader and using three rollers for compaction. Breakdown was accomplished with a dual drum vibratory roller operated in static mode. The second roller was a dual drum static and the last roller was very small. The mixture being placed looked very dry. The plant operator said the mixture contained the right amount of asphalt but the QC test results showed 8 percent air voids. In fact, the MDOT inspector's gyratory sample fell apart while cooling. The gradation of the mix was very coarse and did not meet specifications.

Reviewing the test data for this project revealed little; there was no consistency in the test data. The air voids, VMA, TMD and the 2.36mm sieve were all out of specification. MDOT's test results showed that the fines-to-asphalt ratio was too high. All mixture produced was subject to a mixture price reduction for many different violations.

Table 11 is a summary of the contractor's QC test results.

TABLE 11
M-53 PRODUCTION SUMMARY

@ Design Gyrations	2E1 (25mm) Mix				3E1 (19mm) Mix			
	JMF	QC Data	Diff.	STD	JMF	QC Data	Diff.	STD
G_{mm}	2.502	2.527	+.027	0.0011	2.508	2.505	-.003	0.0011
VMA	13.4	15.07	+1.67	1.37	13.4	13.53	+0.1	1.68
Air Voids	4.0	7.27	+3.37	2.17	4.0	3.90	-0.1	2.57
% Asphalt	4.6	3.97	-1.37	0.30	4.8	4.93	+0.1	0.28
VFA	70.8	52.41	-18.4	10.62	69.9	72.64	+2.7	15.80
Fines/AC	0.84	1.12	+0.28	0.11	0.90	0.97	+0.07	0.04
25mm	95.7	94.79	-0.9	1.56	100	100	0	0
19mm	89.2	86.08	-3.1	0.19	100	100	0	0
12.5mm	70.3	69.03	-1.3	1.77	86.3	85.11	-1.2	4.30
9.5mm	41.7	37.35	-4.4	3.62	50.2	41.85	-8.4	8.82
4.75mm	24.5	20.56	-3.9	3.30	28.7	27.08	-1.6	3.65
2.36mm	20.4	17.72	-2.7	2.52	23.0	23.09	+0.1	3.44
1.18mm	16.7	15.36	-1.3	2.14	16.9	19.15	+2.3	2.83
600um	12.9	12.58	-0.3	1.59	12.1	15.95	+3.9	2.34
300um	7.9	8.65	+0.8	0.90	8.3	11.10	+2.9	1.67
150um	4.5	5.45	+0.8	0.17	4.9	5.88	+1.0	0.67
75um	3.4	3.80	+.04	0.07	3.6	4.00	+0.4	0.43
% Compact.		94.11				93.11		
No. of Tests		3				4		

Project No. 7: US-12, Wayne County Length: 2.8 miles
Average Daily Commercial Traffic: 1100 vehicles
Design ESALs: 3.8 million
Binder used: PG58-28 from Marathon; 15 percent RAP to meet a PG58-28
The project called for:
12,000 tons of 3E10 (19mm) mixture
7,500 tons of 4E10 (12.5mm) mixture

The existing bituminous pavement was milled down to the existing concrete pavement, approximately 3.5". A 3E10 leveling course was placed 2" thick and then the 4E10 top course was placed 1.5" thick.

The mix designs were prepared and submitted by a consultant for the contractor. MDOT verified the mix designs on the first submittal.

The plant used was a drum plant with a baghouse; the baghouse material was rejected. Mixture samples were taken from the hauling unit at the plant site. Consultant personnel did QC sampling and testing. MDOT personnel did QA testing on split samples of the consultant's QC samples. The first four sublots of the project were very inconsistent. At this point, the contractor stopped production, reworked material stockpiles and, when production resumed, the inconsistency problem had been corrected.

Paving equipment consisted of a standard 10' paver with hydraulic extensions. No heat or vibration was applied to the screed.

The contractor's operation was limited by traffic restrictions. Milling could be done only in certain areas and those areas had to be surfaced before any further milling could take place. This may have been a benefit to the contractor because it kept his mixture production to small quantities, allowing him to make corrections to his operation without worrying about compacting a large quantity of mixture.

The contractor used three rollers, two vibratory and one static. None was ballasted. Breakdown was accomplished with a vibratory roller set in low frequency and low amplitude. The team suggested to the operator that he increase frequency to high and this improved density. The intermediate roller was a dual drum vibratory set the same as breakdown. The finish roller was a dual drum static.

A density gauge was being used, but only behind the last roller. The finish roller operator was monitoring the mixture temperature with a measuring device. Dump trucks were used to haul the mixture and no tailgate control was used. The paver hopper was emptied and the wings dumped after every load. After the team talked to the contractor's personnel, these poor practices were corrected.

Reviewing the project test data indicated that the mixture is subject to a price reduction for in-place density. The MDOT tests showed that the fines-to-asphalt ratio was high and the air voids were out of the contract specifications.

Table 12 is a summary of the contractor's QC test results.

TABLE 12
US-12 PRODUCTION SUMMARY

@ Design Gyrations	3E10 (19mm) Mix				4E10 (12.5mm) Mix			
	JMF	QC Data	Diff.	STD	JMF	QC Data	Diff.	STD
G_{mm}	2.508	2.455	-0.53	0.0082	2.463	2.466	+0.003	0.0096
VMA	13.4	14.2	+0.8	0.89	15.0	15.05	+0.05	0.476
Air Voids	4.0	4.02	+0.02	0.77	4.0	4.16	+0.16	0.99
% Asphalt	4.8	5.66	+0.86	0.36	6.0	5.97	-0.03	0.27
VFA	69.9	71.44	+1.54	4.05	73.2	72.6	-0.6	4.58
Fines/AC	0.90	1.19	+0.29	0.31	0.97	1.18	+0.21	0.08
25mm	100	100	0	0	100	100	0	0
19mm	100	100	0	0	100	100	0	0
12.5mm	86.3	82.67	-3.65	4.91	97.7	97.12	-0.58	1.12
9.5mm	50.2	68.61	+18.41	5.50	87.1	86.65	-0.45	2.43
4.75mm	28.7	39.08	+10.38	4.62	50.4	50.32	-0.08	4.10
2.36mm	23.0	23.98	+0.98	3.11	28.0	28.36	+0.36	3.16
1.18mm	16.9	17.61	+0.71	2.24	20.3	18.64	-1.66	2.01
600um	12.1	13.86	+1.76	2.39	13.3	13.41	+0.11	1.40
300um	8.3	10.15	+1.85	1.29	9.7	9.75	+0.05	0.94
150um	4.9	6.42	+1.52	0.89	5.9	6.93	+1.03	0.61
75um	3.6	5.10	+1.5	0.80	5.2	5.56	+0.36	0.47
% Compact.		93.97				93.54		
No. of Tests		13				11		

Project No. 8: I-275, Monroe County Length: 2.3 miles

Average Daily Commercial Traffic: 3900 vehicles

Design ESALs: 8.4 million

Binder used: PG52-28 from Amoco; 20 percent RAP to meet a PG58-28

The project called for:

15,000 tons of 2E10 (25mm) mixture

12,000 tons of 3E10 (19mm) mixture

8,600 tons of 4E10 (12.5mm) mixture

The project called for rubblizing the old concrete pavement, placing a 2E10 mix 3" thick, a 3E10 leveling course 2" thick, and a 4E10 top course 1.5" thick.

The mix designs were prepared and submitted by a consultant for the contractor. MDOT verified the 2E10 design but did not verify the 3E10 design.

The plant was a drum plant with a baghouse; the baghouse material was rejected. Mixture samples were taken from the hauling unit at the plant site. The contractor's personnel did QC sampling and testing. MDOT personnel did QA testing on splits of the contractor's QC samples. It was noted that the contractor was not producing a 2E10 mixture; the gradation had changed enough so that a 3E10 gradation was being produced. The project engineer allowed the contractor to place this mixture for both the 2E10 and the 3E10 mixtures specified.

Paving equipment consisted of a standard 10' paver with hydraulic extensions. No heat or vibration was applied to the screed.

The contractor was placing the 2E10 mixture 5" thick, 12' wide. Three rollers were being used. None was ballasted. Breakdown was accomplished with a dual drum vibratory set in low amplitude and high frequency. The intermediate roller was the same as breakdown. Finish rolling was accomplished with a dual drum static roller. A density gauge was being used to measure compaction. The contractor felt he was achieving proper densities. The mix temperature was not being monitored in the field. On the last day of paving, this mix was being placed when the air temperature was about 35°F and the mixture was being placed in a wedge with the outside edge being only an inch thick. This outside mix was cold 100' behind the paver.

Reviewing the project test data showed that the 2E10 mixture was never produced and the 3E10 mixture's VMA was out of project specifications. The MDOT tests showed the mixture fines-to-asphalt ratio out of Superpave specifications and that one of the two lots is subject to a price reduction for low in-place density.

Table 13 is a summary of the contractor's QC test results.

TABLE 13
I-275 PRODUCTION SUMMARY

@ Design Gyrations	2E10 (25mm) Mix				3E10 (19mm) Mix			
	JMF	QC Data	Diff.	STD	JMF*	QC Data	Diff.	STD
G_{mm}	2.593	2.601	+0.008	0.011	2.593	2.601	+0.008	0.009
VMA	13.6	13.09	-0.51	0.66	13.6	12.82	-0.78	0.57
Air Voids	4.0	3.79	-0.21	0.63	4.0	3.66	-0.34	0.73
% Asphalt	4.5	4.36	-0.14	0.27	4.5	4.31	-0.19	0.22
VFA	70.5	71.11	+0.61	4.58	70.5	71.59	+1.09	5.14
Fines/AC	0.99	1.16	+0.17	0.12	0.99	1.19	+0.20	0.07
25mm	100	100	0	0	100	100	0	0
19mm	96.0	97.64	+1.69	1.26	96.0	96.18	+0.18	1.75
12.5mm	74.0	77.49	+3.49	2.95	74.0	78.43	+4.43	3.12
9.5mm	65.0	66.74	+1.74	2.60	65.0	70.08	+5.08	4.83
4.75mm	38.0	37.86	-0.14	2.37	38.0	42.62	+4.62	5.47
2.36mm	25.6	24.86	-0.74	1.44	25.6	27.87	+2.27	3.88
1.18mm	17.9	17.29	-0.61	0.95	17.9	18.93	+1.03	2.42
600um	13.6	12.72	-0.88	0.70	13.6	13.58	-0.02	1.38
300um	9.2	8.89	-0.31	0.49	9.2	9.31	+0.11	0.73
150um	5.3	6.09	+0.79	0.39	5.3	6.22	+0.92	0.37
75um	3.9	4.37	+0.47	0.27	3.9	4.34	+0.44	0.22
% Compact.		93.22				93.19		
No. of Tests		22				17		

* NOTE: The same mixture was used for the 3E10 and the 2E10.

COST

Table 14 shows the contract prices for Superpave mixtures along with what non-Superpave mixtures would cost. Three issues need to be considered when looking at these prices. First, it's something new. Second, the contractors had a lot of work. And third, the size of some of the projects was small. This table indicates that Superpave mixes should not cost significantly more than normal MDOT mixes. Although no 30 million ESAL projects were let at this time, these projects could cost more than normal MDOT mixes.

TABLE 14
SUPERPAVE MIXTURE BID PRICES

	CONTRACT TONNAGE							AVERAGE	Norm Mixe
<1 million	<5,000	<10,000	<15,000	<20,000	<25,000	<50,000	>50,000		
2E (25mm)	$33.10							$33.10	$20.0
3E (19mm)		$32.35	$25.46					$28.91	$22.0
4E(12.5mm)	$32.95		$23.53					$28.24	$24.0
<3 million									
2E (25mm)				$22.04				$22.04	$22.
3E (19mm)	$26.33					$21.44	$18.68	$22.15	$26.0
4E(12.5mm)		$26.77				$20.00	$22.88	$23.22	$28.0
<10 million									
2E (25mm)				$33.60				$33.60	$24.0
3E (19mm)		$29.94	$32.50			$22.65		$28.36	$28.0
4E(12.5mm)	$31.75	$33.80			$25.08			$30.21	$30.0
Average	$31.03	$30.72	$27.16	$27.82	$25.08	$21.36	$20.78		

CONCLUSIONS

The following conclusions can be made regarding Superpave mixtures:

- Verification of the contractor submitted Superpave mix designs does not appear to be a problem.

- Superpave mixes generally require more compactive effort than normal MDOT mixes.

- The PG binders appear to allow compaction at lower temperatures than asphalt cements used previously.

- PG binders appear to be softer than the asphalt cements they replaced.

- The 75um (dust) material created in the plant must be removed from the mixture or the aggregates used must be very clean.

- Obtaining acceptable (>92.0 %) density was not a problem as long as the lift thickness was greater than 3 times the nominal maximum aggregate size.

- In general, contractors could consistently produce Superpave mixtures.

SUPERPAVE ISSUES

There are many Superpave issues that should be further investigated. The following is a list of these issues.

How difficult will it be to construct a 30 million ESAL project.

- The soft stone requirement is very restrictive.

- Are the materials available in large enough quantities?

1. What are the production tolerances? How far from specification can the mixture be and still be considered a Superpave mixture?

2. Should the fine aggregate angularity specification be a field control item?

3. Do all aggregate blend changes require new designs or only a new aggregate specific gravity?

4. Should air voids be controlled by the gyratory at N_{des} or at N_{MAX}?

5. Will small projects be Superpave designs or Marshall designs?

6. What modifications need to be made to field control testing when dealing with highly absorptive aggregates?

7. Mixture tenderness:

   A. Is this tenderness caused by mixture temperature?
   B. Is this tenderness an asphalt binder issue?
   C. Is this tenderness caused by aggregate properties?
   D. Is this tenderness an issue that affects pavement performance?

8. Can contractors expect to use as much RAP with Superpave mixtures as they used in the past without additional processing? (The only project to use over 10 percent RAP successfully had a special stockpile.)

9. Are Superpave mix design verification tolerances appropriate?

10. What is the proper lift thickness for each mixture type?

11. How can Superpave mixtures be used on short-term maintenance fixes, i.e. eight-year maintenance fixes?

12. Are 4 percent air void designs appropriate for all projects on Michigan highways? Will traffic compact Superpave mixes to the design voids? What traffic compaction can be expected?

13. How does the density of the aggregate base or the crushed and shaped base affect the ability to acquire proper density in the Superpave mixture?

RECOMMENDATIONS

It is recommended that MDOT continue to look at Superpave projects with the following guidelines to the contractors and project engineers:

1. Belt samples will not be allowed for project control on Superpave projects.

2. One additional gyratory specimen will be compacted at N_{des}.

3. Projects with two courses should have test sections set up so that the leveling course can be placed at different thicknesses, and then the top course over these sections would be placed in different thicknesses. These test sections would be evaluated for compactive effort needed versus course thickness.

4. MDOT should do a study or have a study done on the best way to measure core density. During this study it was noticed that none of the plant inspectors handled the cores in the same manner nor did they dry the cores off properly after weighing them in water before weighing them in air. The practices observed will always give a higher density than the true density.

5. A new procedure needs to be implemented to get mixture production test data back to the Lansing bituminous office in a more timely manner.

6. The mixture cure time before field control tests are performed needs to be better defined.

8. The in-place density acceptance criteria should be reviewed to ensure that what is being accepted will perform as expected. The incentive bonus also needs to be reevaluated. How much is it worth to have higher in-place density?

9. Guidelines need to be developed for cost effective use of Superpave mixtures.

10. At least one project should be set up using a short design life for maintenance fixes and then monitored for performance.

11. A standard gyratory computer software program needs to be developed. This will become more important as more compactors are approved.

12. The fines-to-asphalt ratio should be added to the specifications as an acceptance parameter.

APPENDIX A
MDOT IMPLEMENTATION PLAN

ENGINEERING OPERATIONS COMMITTEE
MEETING MINUTES
NOVEMBER 5, 1996, 9:00 A.M.
CONSTRUCTION CONFERENCE ROOM

Present:	T. A. Coleman	C. Roberts	P. F. Miller
	J. J. Kanillopoolos (J. D. Culp)	C. J. Arnold	J. Steele (T. Fort)
	A. D. Clover (L. R. Brown)	W. C. Turner	J. W. Reincke
	D. C. Spangenberg (S. E. Hohl)		
Guest:	D. L. Coleman	G. M. Mayes	

OLD BUSINESS

1. **Approval of the Minutes of the September 5, 1996, Meeting -T. A. Coleman**

Minutes of the September 5, 1996, meeting were approved as written.

2. **Status Report on Warranties: Bituminous Construction Projects or Concrete - P. F. Miller/W. C. Turner**

The Construction and Design Divisions provided an update on ongoing activities regarding contract warranties. Both divisions will continue their efforts; Construction will meet with industry representatives to discuss requirements of specifications (special provisions) for overlays. Ed Winkler was requested to coordinate MDOT/industry committee activities regarding concrete and bituminous warranties, and present a status report at the December meeting.

3. **Use of Lightweight Trailer Sign Support - J. J. Kanillopoolos**

The 1996 Standard Specifications for Construction allow the use of trailers weight 350 pounds or less as portable sign supports. However, the FHWA had requested we eliminate this support from all federal-aid contracts. Recent meetings held with industry and FHWA representatives have lead to an agreeable position, which allows the use of lightweight trailer signs while testing is being conducted for a Montana design. They also require placement of these trailers out of the clear zone, when not in use.

ACTION: The Construction Division, coordinating with the Traffic and Safety Division, will write an information letter on use of lightweight trailer sign supports in the right-of-way.

III. Reduce speed limits only at areas and times when work is actually occurring. This may be accomplished by use of flashing lights on signs, indicating speed limit is in effect.

It was recommended that the Traffic and Safety, Construction, and Maintenance Divisions, with district representation, provide a joint instructional memorandum to the districts on the need and method for setting realistic work zone speed limits.

ACTION: The EOC approved the proposed recommendation as presented. The Traffic and Safety Division will modify the Traffic and Safety Design notes to reflect this policy change.

7. **Superpave Implementation - D. Coleman**

An overview was presented of the needs to set up a statewide plan for implementing Superpave Bituminous Mixtures. The following proposal was presented for consideration and approval:

1996 Did one project, SPS-9, I-196, Grand Rapids
Used performance graded binders on several projects.

1997 Use performance graded binders on all projects.
Set up 18 project (2 per district) using Superpave designs.
- Different Traffic Volumes
- Different Type Fixes
- What Information Should be on Design Plans
- How Construction Practices are Affected
- What In-Place Densities Should be Required
- Proper QC/QA Procedures

Winter 1997/98 MDOT and industry meet to develop a plan for full implementation by the beginning of 1999 Construction Season. Including the final specification covering all bituminous mixtures and construction mixtures, binders, QC/QA and ride quality.

ACTION: The EOC approved the proposed Superpave implementation plan as presented.

NEW BUSINESS

No agenda items were presented.

Calvin Roberts

Calvin Roberts, Secretary
Engineering Operations Committee

Attachment

cc: EOC Members
District Engineers

R. A. Welke	R. J. Risser, Jr. (MCPA)	L. K. Heinig	T. Adams (MCA)
D. L. Coleman	A. C. Milo (MRBA)	G. H. Grove	R. D. Till
D. L. Smiley	J. Becsey (MAPA)	R. W. Muller	R. E. Nordlund
L. E. DeFrain	G. L. Mitchell	G. J. Bukoski	C. W. Whiteside
I. B. Patel	M. Newman (MAA)	J. Steele (FHWA)	K. Rothwell
S. Bower	M. Frierson	R. J. Lippert, Jr.	C. Libiran

APPENDIX B
SUPERPAVE PROJECT
SPECIAL SPECIFICATIONS

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

SPECIAL PROVISION FOR SUPERPAVE MIXTURES

C:APPR:EDW:MLL 1-28-97

a. Description.-This special provision modifies the current Special Provision for Bituminous Mixture and Pavement Density Acceptance, SP4.00 (C) and the 1990 Standard Specifications for Construction as required herein.

In the Special Provision for Bituminous Mixture and Pavement Density Acceptance, SP4.00(C), add the following sections:

To subsection **4.02.02.B "Equipment.-"** add the following:

A Superpave Gyratory Compactor with at least two 6 inch molds will be provided by the Contractor for air void control. (Only one compactor is needed if the state inspector is allowed to use the Contractor's). The proposed gyratory compactor must meet the SHRP SUPERPAVE criteria. Following is an alphabetical list of manufactures of the SHRP SUPERPAVE Gyratory Compactor:

Pine Instruments Company
101 Industrial Drive
Grove City, Pennsylvania 16127
Att: Matt Cyphert (412) 458-6391

Troxler Electronic Laboratories, Inc.
3008 Cornwallis Road
P.O. Box 12057
Research Triangle Park, North Carolina 27709
Att: Eric Dunlap (919) 549-8661

The Contractor is to provide a computer, monitor, accessories and software that is compatible to operate the manufacturer's SHRP SUPERPAVE Gyratory Compactor software program.

To subsection **4.02.04.B "Bituminous Mixtures (Loose)."** add the following:

The following items will be determined by both the Marshall hammer and the Gyratory compactor methods:

Voids in Mineral Aggregate (VMA)
Bulk Density
Air Voids

The Gyratory compactor values will be used for project control and payment.

To section **4.02.10.B "Bituminous Quality Initiative:....."** delete subsections B.1, B.1.a, B.1.b, and B.1.c and replace with the following:

1. Pavement Density: The Contractor will be paid on additional percentage of the contract unit price of the **Bituminous Mixture** if the lot core densities meet the following:

   a. 75% of lot cores are greater than 92.5% of the TMD, an additional 2% will be paid.
   b. 75% of lot cores are greater than 93.0% of the TMD, an additional 4% will be paid.
   c. 75% of lot cores are greater than 93.5% of the TMD, an additional 6% will be paid.

In the 1990 Standard Specifications delete the following:

In **Section 4.00.11 Rolling.-** in paragraph 5, delete the sentence:

"Pneumatic-tired rollers will not be permitted on top courses."

MICHIGAN
DEPARTMENT OF TRANSPORTATION

BUREAU OF HIGHWAYS

SPECIAL PROVISION FOR SUPERPAVE BITUMINOUS MIXTURES

a. Description.-This work shall consist of furnishing bituminous mixture using Superpave Mixture Design Methods. The bituminous mixture will be provided according to the requirements of the current Standard Specifications except where modified herein.

b. Mix design.-The bituminous mixture design will be provided by the Contractor. The design will be submitted and evaluated according to the Manual for Submitted Mix Design Processing.

c. Recycled Mixtures.-The Contractor may substitute Reclaimed Asphalt Pavement (RAP) for a portion of the new materials required to produce bituminous mixture. The mixture will be designed and produced to meet all of the criteria herein.

d. Materials.-The mixture will consist of aggregates of the highest quality available to meet the minimum specifications herein. Tables 1-6 &10 provide the required aggregate properties, Tables 7-8 provide the Mix Design Criteria and Volumetric Properties and Table 9 provides the Superpave Gyratory Compactor (SGC) compaction criteria. Criteria specified below apply to the combined aggregate blend. **For information only:** Top course will be either a mixture number 5 or 4, the leveling course will be mixture number 3 and base course a mixture number 2.

Table 1 Crush Minimum Criteria

Estimated Traffic (million ESAL)	Top & Leveling Courses	Base Course
< 0.3	55/-	-
< 1.0	65/-	-
< 3.0	75/-	50/-
< 10	85/80	60/-
< 30	95/90	80/75
<100	100/100	95/90
≥100	100/100	100/100

Note: "85/80" denotes that 85 percent of the coarse aggregate has one fractured face and 80 percent has two fractured faces.

Table 2 Fine Aggregate Angularity Minimum Criteria

Estimated Traffic (million ESAL)	Top & Leveling Courses	Base Course
< 0.3	-	-
< 1.0	40	-
< 3.0	40	40
< 10	45	40
< 30	45	40
<100	45	45
≥100	45	45

Table 3 Sand Equivalent Minimum Criteria

Estimated Traffic (million ESAL)	Top & Leveling Courses	Base Course
< 0.3	40	40
< 1.0	40	40
< 3.0	40	40
< 10	45	45
< 30	45	45
<100	50	50
≥100	50	50

Table 4 L.A. Abrasion Maximum Criteria

Estimated Traffic (million ESAL)	Top & Leveling Courses	Base Course
< 0.3	45	45
< 1.0	40	45
<3.0	35	40
< 10	35	40
< 30	35	35
<100	35	35
≥100	35	35

Table 5 Soft Particles Maximum Criteria

Estimated Traffic (million ESAL)	Top & Leveling Courses	Base Course
< 0.3	10.0	10.0
< 1.0	10.0	10.0
< 3.0	5.0	5.0
< 10	5.0	5.0
< 30	1.0	1.0
<100	.5	.5
≥100	.5	.5
Note: "Soft Particles Maximum" is the sum of the shale, siltstone, structurally weak and clay-ironstone particles.		

Table 6 Flat and Elongated Particles Maximum Criteria

Estimated Traffic (million ESAL)	Top & Leveling Courses	Base Course
< 0.3	-	-
< 1.0	-	-
< 3.0	10	10
< 10	10	10
< 30	10	10
<100	10	10
≥100	10	10
Note: Maximum 10% by weight with a 1 to 5 aspect ratio.		

Table 7 Superpave Mix Design Criteria

Design Parameter	Mixture Number			
	5	4	3	2
Percent of Maximum Specific Gravity (%G_{mm}) at the design number of gyrations, (N_d)	= 96.0 %			
%G_{mm} at the initial number of gyrations, (N_i)	≤ 89.0 %			
%G_{mm} at the maximum number of gyrations, (N_m)	≤ 98.0 %			
VMA min % at N_d (based on aggregate bulk specific gravity, (G_{sb})	15.0	14.0	13.0	12.0
VFA at N_d	See Table 8			
Fines to effective asphalt binder ratio ($P_{0.075}/P_{be}$)	0.6 - 1.2			
Tensile strength ratio (TSR)	80 % min			

Table 8 VFA Minimum and Maximum Criteria

Estimated Traffic (million ESAL)	Top Course	Leveling & Base Courses
< 0.3	70-80	70-80
< 1.0	65-78	65-78
< 3.0	65-78	65-78
< 10	65-78	65-75
< 30	65-78	65-75
<100	65-78	65-75
≥100	65-78	65-75

Table 9 Superpave Gyratory Compactor (SGC) Compaction Criteria

Estimated Traffic (million ESAL)	Number of Gyrations		
	N_i	N_d	N_m
< 0.3	7	68	104
< 1.0	7	76	117
< 3.0	7	86	134
< 10	8	96	152
< 30	8	109	174
<100	9	126	204
≥100	9	142	233

Note: Compact all mixture specimens fabricated in the SGC to N_m. Use height data provided by the SGC to calculate volumetric properties at N_i and N_d.

Table 10 Aggregate Gradation Requirements

Standard Sieve	Percent Passing Criteria *(control points)*			
	Mixture Number			
	5 9.5mm	4 12.5mm	3 19mm	2 25mm
37.5 mm				100
25.0 mm			100	90 - 100
19.0 mm		100	90 - 100	90 max
12.5mm	100	90 - 100	90 max	
9.5mm	90 - 100	90 max		
4.75mm	90 max			
2.36mm	32 - 67	28 - 58	23 - 49	19 - 45
1.18mm				
600 μm				
300 μm				
150 μm				
75 μm	2.0 - 10.0	2.0 - 10.0	2.0 - 8.0	1.0 - 7.0
Sieve	**Restricted Zone**			
4.75mm				39.5
2.36mm	47.2	39.1	34.6	26.8 - 30.8
1.18mm	31.6 -37.6	25.6 -31.6	22.3 -28.3	18.1 - 24.1
600 μm	23.5 - 27.5	19.1 - 23.1	16.7 - 20.7	13.6 - 17.6
300 μm	18.7	15.5	13.7	11.4
Note: The final gradation blend must pass between the control points established. In addition, it has to be outside of the area bounded by the limits set for the restricted zone.				

e. Measurement and Payment.-

Contract Items (Pay Item)	Pay Unit
Bituminous Mixture - 5 E(*)	metric ton
Bituminous Mixture - 4 E(*)	metric ton
Bituminous Mixture - 3 E(*)	metric ton
Bituminous Mixture - 2 E(*)	metric ton

* Determined by the ESALs (million) on the total estimated traffic per lane over the design life.

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

SPECIAL PROVISION
FOR
BITUMINOUS MIXTURE AND PAVEMENT DENSITY ACCEPTANCE

4.02.01 Description.-This special provision defines and describes the quality control responsibilities of the Contractor and the quality assurance responsibilities of the Engineer. Unless otherwise modified herein, the 1990 Standard Specifications for Construction shall apply. In cases where this special provision may conflict with another special provision or supplemental specification, this special provision will prevail.

Definitions:

Bituminous Mix Design.-The Laboratory evaluation of aggregate(s), mineral filler (if required), reclaimed asphalt pavement (RAP), and asphalt binder to determine if the stated mixture design criteria is in compliance.

Job Mix Formula (JMF).-The field application of a bituminous mix design for a bituminous mixture on a specific project. This may involve adjustments to the mix design criteria to optimize the field application.

Target Value.- A designated JMF mixture parameter that may be adjusted, if approved by the Engineer. (See Table I)

JMF Adjustment.-A JMF adjustment may be retroactive for one LOT's production, for items with target values, based on the Contractor's ability to produce the revised JMF.

Voids in Mineral Aggregate (VMA).-The volume of void space between the aggregate particles of a compacted paving mixture that includes the air voids and the asphalt binder (including the absorbed asphalt binder), expressed as a percent of the total volume of mixture.

Theoretical Maximum Density (TMD).-The ratio of the weight in air of a unit volume of a noncompacted bituminous paving mixture at a stated temperature to the weight of an equal volume of water at a stated temperature.

Effective Specific Gravity (Gse).-The ratio of the oven dry weight in air of a unit volume of an aggregate (excluding voids permeable to asphalt) at a stated temperature to the weight of an equal volume of water at a stated temperature.

Single Test Tolerance.-The allowable deviation a single test result will be allowed to vary from the Job Mix Formula (JMF). Unless other units are stated, all tolerances will be stated as percentage points.

SUBLOT.-A variable increment of mixture production.

Running Average of Five.-The average value for the last five consecutive SUBLOT test results.

LOT.-A LOT will be five (5) continuous SUBLOTS, of any one particular mixture. When combining SUBLOTS into LOTS at the end of production, if 1 or 2 SUBLOTS are remaining, they shall be added to the previous LOT. If 3 or more SUBLOTS are remaining they will be considered a complete LOT.

LOT Average.-A LOT Average will be the average of five SUBLOTS. Any SUBLOTS removed will not be used in calculating a LOT Average.

LOT Average Absolute Deviation.-All Contractor quality control test results will be compared to the JMF and the difference calculated. The average of the differences for each value of the five SUBLOT test results, without regard to the sign (+/-), will be the LOT Average Absolute Deviation.

Trial Run.-The Contractor may elect, with prior approval of the Engineer, to produce and test the mixture(s) as specified by the bituminous mix design(s) for the project prior to placing the mixture(s). The testing frequency will be as specified under SUBLOTS in this special provision. Requests for JMF Adjustments may be made based on the Trial Run testing. All costs associated with any Trial Run testing will be borne by the Contractor.

Rounding of Numbers.-Expression of numerical requirements shall be done in accordance with ASTM E29-93a, Rounding Method.

4.02.02 Testing Facilities and Equipment.-The Contractor shall provide for the Engineer's exclusive use, a fully equipped field laboratory meeting all the requirements of the current Manual for the Certification of Hot Mix Asphalt Plants, as listed under Testing Facilities and Equipment. The field laboratory shall be in place, fully equipped, completely operational, and approved by the engineer at least 3 working days prior to any mixture production.

4.02.03 Sampling.-The Contractor shall be responsible for obtaining all samples. The Engineer will assure that samples are taken in accordance with approved methods and by a mutually acceptable random sampling system. These samples shall include, but not be limited to Aggregate, Bituminous Mixture (Loose and Compacted), Asphalt Binder, and Mineral Filler.

A. Aggregate (Blended).-A minimum of one blended aggregate sample per production day. Sampling shall be in accordance with ASTM D 75. The sample size and method of sample size reduction shall be in accordance with MDOT's Aggregate Procedure Manual. One-half of the initial split shall be placed in a large canvas sample bag, identified and given to the Engineer.

B. Bituminous Mixture (Loose).-A sample shall be taken randomly from each SUBLOT of mixture sent to the project.

1. SUBLOTS may vary in size up to 1200 tons:

   a. The initial SUBLOT increment shall be agreed upon by the Contractor and Engineer prior to the start of production. All testing for the initial LOT must be completed and results provided to the Engineer prior to any further production, unless prior approval is received from the Engineer.

   b. If the LOT Averages for the initial LOT are within the specified tolerances and no JMF changes are requested, production will be allowed to continue. The testing frequency may be adjusted as mutually agreed upon.

   c. If the belt sample method (ASTM D75) is chosen as a quality control method by the contractor, both the belt sample method and an approved extraction method, or the incineration method (MTM 319) of testing shall be completed for the first lot of production for each bituminous mixture. All JMF changes that are requested shall be made using the data from the extraction method. JMF change requests referencing data from the belt sample method will not be allowed.

   d. The SUBLOT increment may be adjusted based on a trial run.

   e. A minimum of three samples shall be taken for each bituminous mixture. Testing shall be as agreed upon with the Engineer prior to the start of production.

2. Mixture samples shall be taken from truck transports as per ASTM D 979. The sample shall be of sufficient quantity to provide the Contractor with adequate material for testing and provide the Engineer with a minimum 15,000 gram split. The Engineer's sample shall be placed in a canvas bag and identified. The mixture temperature shall be taken and documented at the time of sampling.

3. The Contractor shall take a daily sample of each type of mixture, in addition to the SUBLOT samples. The Engineer will identify the sample and ship to the Laboratory for testing of the recovered asphalt binder penetration.

C. **Bituminous Mixture (Compacted)**.-The Contractor shall obtain three 6-inch cores from each SUBLOT of mixture placed. These cores shall be taken from locations randomly selected, longitudinally and laterally, and marked by the Engineer throughout the SUBLOT. Only one core will be taken from each site. The cores will be taken after final rolling (all roller marks have been eliminated from the mixture). The cores must be labeled and any previous pavement, base aggregate, or bond coat material shall be sawed off the bottom. The cores shall be delivered to the Engineer within one day of mixture placement. Cores shall not be taken from hand patching areas or commercial/private driveways. If shoulders with a rumble strip are being cored and the random site falls within the rumble strip area, then the site will be moved transversely to the nearest smooth surface.

It is the Contractor's responsibility to insure that the cores are not damaged during removal from the pavement or during transport to the field laboratory. If, at the time of coring, a core is determined not to be representative, the Engineer shall decide if re-coring is necessary. Informational cores may be taken with prior approval from the Engineer. All informational cores shall be presented to the Engineer upon completion of the density testing. The core holes shall be filled with hot mixture and thoroughly compacted within 24 hours. The method of filling holes and obtaining compaction shall be agreed upon prior to production.

D. **Asphalt Binder** -The Contractor shall take a daily sample of asphalt binder. The Engineer will identify the sample and transmit it to the Laboratory for testing of the original viscosity or original penetration.

E. **Mineral Filler**.-The Contractor shall take one sample of mineral filler (if used) per project. The Engineer will submit it to the Laboratory for testing of gradation and if fly ash is used, testing for free carbon content. A one quart friction top can will be used for this sample.

4.02.04 Contractor's Quality Control Testing:

A. **Aggregate (Blended)**.-The following tests shall be completed as specified and at a frequency that is mutually agreed upon with the Engineer.

1. Gradation (ASTM C 136, ASTM C 117)
2. Crushed Particle Content (MTM 117)
3. Deleterious Particle Content (MTM 110)
4. Angularity Index (MTM 118)

See Option II, III, and IV under Bituminous Mixture (Loose) (Section 4.02.04).

B. **Bituminous Mixture (Loose)**.-The bituminous mixture (loose) shall be tested once per SUBLOT for the following parameters:

1. Voids in Mineral Aggregate (VMA) *
2. Theoretical Maximum Density, (TMD) (ASTM D 2041)
3. Marshall Density (ASTM D 1559 para. 4.5), and Air Voids *
4. Composition of Mixture:

*Calculated Values

Option I: Gradation of aggregate (ASTM C 136,C 117) , asphalt binder content (ASTM D 2172), and crushed particle content (MTM 117). (Extraction method)

Option II: Asphalt binder content (ASTM D 4125-83 Nuclear Asphalt Content Gauge), blended aggregate gradation (ASTM C 136,C 117), and crushed particle content (MTM 117) from belt samples taken on a per SUBLOT basis in sequence with the mixture sample.

Option III: Asphalt binder content based on plant recordation (System approved by the Engineer), blended aggregate gradation (ASTM C 136, C 117), and crushed particle content (MTM 117) from belt samples taken on a per SUBLOT basis in sequence with the mixture sample.

Option IV: Asphalt binder content is determined by a calculated value using the SUBLOT TMD and mix design Effective Specific Gravity (Gse) of the blended aggregate. Crushed particle content (MTM 117) and the blended aggregate gradation shall be determined from belt samples taken on a per SUBLOT basis in sequence with the mixture sample.

Option V: Asphalt binder content is determined by the Incineration Method (MTM 319). Crushed particle count (MTM 117) and blended aggregate gradation (ASTM C 136,C 117) shall be determined from the incinerated aggregate after cooling or from belt samples taken on a per SUBLOT basis in sequence with the mixture sample.

For Options II, III, and IV, a minimum of one extraction or MTM 319 per day shall be completed and if Reclaimed Asphalt Pavement (RAP) is used, then one extraction per day on the RAP shall be completed.

The Test Method for Determining Aggregate Gradation for Bituminous Mixture (MTM 311, or MTM 319) or (ASTM 2172) may be substituted for the belt sample in Options II, III, and IV.

The approval to utilize Option II, Option III, Option IV, or Option V shall be requested from the Engineer IN WRITING prior to the start of mixture production.

4.02.05 Quality Control Tolerances.-Table I defines tolerance limits for both single test (SUBLOT) results and the running average of five from the JMF for the bituminous mixture being produced. If the Contractor's test results on any of the measured parameters exceed these limits, the Contractor will immediately notify the Engineer, investigate the cause of the deviation, explain to the Engineer the probable cause(s) of the deviation, any corrective action they deem necessary (including cold feed adjustments), and what will be the disposition of any mix produced and not placed. The JMF may only be adjusted if the revised JMF meets the mixture requirements of Tables 7.10-1 and 7.10-2 of the "Special Provision for Plant Mixed Bituminous Mixtures". If the Engineer agrees with the Contractor's evaluation, the suggested corrective action (if any) shall be implemented. If the next test of any measured parameter for that mixture exceeds any of the quality control tolerances, mixture production will STOP. Failure to stop will lead to a price reduction or could lead to removal and replacement at the contractor's cost. The Contractor will immediately notify the Engineer and investigate the cause of the excessive deviation. The Contractor will present to the Engineer the probable cause of the deviation and the corrective action necessary to bring the mixture back into compliance. The Engineer will evaluate the Contractor's proposal and either request further examination of the deviation or concur with the Contractor's proposal and allow production to restart. The Contractor's proposal and the Engineer's response will be documented. The Engineer may approve the JMF adjustment to be retroactive for one LOT's production.

If at any point during production the Contractor fails to comply with the specifications, or makes changes that effect the JMF, the Engineer may require the Contractor to go back to the initial SUBLOT increment. (Section 4.02.03)

TABLE I			
QUALITY CONTROL TOLERANCE (+ OR -)			
PARAMETER	SINGLE TEST (SUBLOT)	RUNNING AVERAGE OF FIVE	
Air Voids	1.00%	0.50%	
Voids in Mineral Aggregate (VMA) *	1.20%	0.60%**	
Theoretical Maximum Density (TMD) *	1.20 #/ft^3	0.60 #/ft^3	
Asphalt Binder Content *	0.50%	0.30%	
Crushed Particle Content *	15.0%	10.0%	
Aggregate Gradation * (% Passing) ***			
Sieve Size			
No.4 *		3.00%	6
No. 30 *		2.00%	4
No. 200 *		0.70%	1.4

*Items with Target Values
**Or Less determined by VMA Value from Table 7.10-1 Mix Design Criteria.
***Quality Control Tolerances Only. Not to be used for Measurement and Payment.

4.02.06. Mixture Verification/Acceptance Testing- On the completion of each LOT, the Engineer will randomly select one SUBLOT sample. The SUBLOT selected shall be tested using the same test methods as the Contractor (Section 4.02.04), except as modified below.

If Option II is selected and approved for asphalt binder content determination, a nuclear asphalt content gauge will be used by the Engineer for verification testing of the asphalt content of the mixture. The Contractor shall provide all the materials necessary to complete a nuclear asphalt content gauge calibration for each type of mixture to be tested. These materials and a field laboratory shall be available at least one week prior to mixture production.

If Option III or IV is selected and approved for asphalt binder content determination, the Engineer will use the SUBLOT TMD and the mix design Gse of the blended aggregate for verification testing of the asphalt content of the mixture.

If Option V is selected and approved for asphalt binder content determination either an approved asphalt incineration oven shall be provided by the contractor for the Engineer's use in the field laboratory or the Contractor shall agree to allow the Engineer the use of their incineration oven for verification/acceptance testing. The Engineer's usage will be at a mutually accepted time.

4.02.07 Verification/Acceptance Tolerances.-Quality assurance and acceptance for the final in-place product will be based on the Contractor's quality control test results when they are verified by the Engineer's tests. Verification Testing will be done at the field laboratory.

TABLE II
Verification / Acceptance Tolerances (+ or -)

PARAMETER	TOLERANCE
Air Voids	1.00%
Voids in Mineral Aggregate (VMA)	1.20%
Theoretical Maximum Density (TMD)	1.20 #/ft³
Asphalt Binder Content	0.50%
Crushed Particle Content	15.0%

A LOT will be considered verified if the Engineer's test results are within the verification tolerances specified in Table II as measured from the Contractor's quality control test results for the selected SUBLOT. If the Engineer's test results do not verify the Contractor's quality control test results, the Contractor shall be notified and immediate attention should be directed to all testing equipment and procedures used by both the Contractor and the Engineer. Once it is determined that all testing equipment is properly calibrated and operating, and proper procedures had been followed, then a second SUBLOT from the remaining four shall be randomly selected and all parameters tested. Only those parameters which failed to verify on the previous SUBLOT shall be reviewed for verification. If there is verification on the second SUBLOT, then the LOT will be considered verified. If the Engineer's test results from the second SUBLOT fail to verify the respective SUBLOT test results of the Contractor, the Engineer will evaluate the data available (Contractor's and Engineer's) and determine which set of results best represents the mixture. If the Engineer's test results are selected as being most representative, then the results from the average of the Engineer's two tests will be used for the LOT Average.

The testing on the asphalt binder for both the original penetration or viscosity and recovered penetration, will be tested by the Laboratory.

Pavement Density acceptance will be tested by the Engineer within 2 work days of receiving the core samples from the Contractor. Testing will be in accordance with ASTM D 2726. The SUBLOT Pavement Density will be the average of the three cores.

4.02.09 Project Documentation.-The format of all reports and charts submitted by the Contractor shall be approved by the Engineer before mixture production is permitted to commence. Suggested formats of reports and charts are available from the Engineer. Documentation shall include, but not be limited to, the following two types:

A. Daily:

1. Daily test results including; SUBLOT data, LOT Average and LOT Average Absolute Deviation shall be submitted to the Engineer within 24 hours of the time the tests are completed. (The Engineer will forward a copy to the Laboratory.)

2. Control charts, which display all quality control test results, averages, tolerances, and aggregate gradation sieves per the applicable Composition of Bituminous Mixture Table 7.10-2. All data shall be calculated and plotted upon completion of tests. These charts shall be available for review and duplication upon request from the Engineer.

B. Project Summation:

1. Control charts.

2. A tabulation of all test data; including SUBLOT data, LOT Averages, LOT Average Absolute Deviation, project mixture parameter averages and standard deviations, and a projection of which LOTS are subject to any Price Adjustments (Section 4.02.10). (The Engineer will forward a copy to the Laboratory.)

4.02.10 Measurement and Payment.-The completed work as measured for BITUMINOUS MIXTURE AND PAVEMENT DENSITY ACCEPTANCE will be paid for at the Contract unit prices for the following contract items (pay items).

Pay Item	Pay Unit
Quality Control Testing	Ton
Bituminous Quality Initiative	Dollars

A. Quality Control Testing: Quality Control Testing will be measured in the total tons tested and placed. Payment will be for all equipment, personnel, and any other necessary materials.

B. Bituminous Quality Initiative: If Bituminous Quality Initiative is not included in the contract as a pay item, there will be no payment for this item of work. All Bituminous Quality Initiatives are cumulative.

1. Pavement Density: The Contractor will be paid an additional 6 percent of the contract unit price of the Bituminous Mixture if the LOT Average and Lot Cores meet ALL of the following:

   a. The Lot Average Pavement Density is equal to or greater than 94.0 percent*.
   b. The conditions of the Pavement Density Core Table are satisfied.

   * A mixture requiring an air void target value lower than 3.0 percent for nontraffic areas, will require a corresponding increase in the pavement density values.

   c. The mixture within the LOT is not subject to any price adjustments for asphalt binder content, air voids, VMA, or TMD.

2. Bituminous Mixture: The Contractor will be paid an additional 4 percent of the contract unit price of the Bituminous Mixture if the LOT Average Absolute Deviation for each measured parameter of the LOT does not exceed the Quality Control running average tolerance, provided there are no Laboratory test failures on the asphalt binder and provided that the LOT Average VMA is equal to or greater than the minimum design value for the bituminous mixture as per table 7.10-1 Mix Design Criteria.

C. Bituminous Mixture Adjustment: Negative price adjustments for the Bituminous Mixture Contract Unit Price will be cumulative (Pavement Density + Bituminous Mixture + Failure To Suspend Operations + Asphalt Binder Penetration\Viscosity\Recovered Penetration). The largest adjustment allowable in each case will be used.

1. PAVEMENT DENSITY (10 Percent Maximum Sum).-A negative 10 percent adjustment for the Bituminous Mixture Contract Unit Price will be imposed for either of the following pavement density conditions:

   a. The Lot Average Pavement Density is less than 92.0 percent* but equal to or greater than 91.0 percent.
   b. The conditions of the Pavement Density Core Table are satisfied.

   * A mixture requiring an air void target value lower than 3.0 percent for nontraffic areas, will require a corresponding increase in the pavement density values.

2. BITUMINOUS MIXTURE (10 Percent Maximum Sum).-A maximum negative 10 percent adjustment for the Bituminous Mixture Contract Unit Price will be imposed under the following conditions:

   a. The Lot Average for asphalt binder content is within the following deviation:

Asphalt Binder Content	Greater Than	But Less Than Or Equal To	% Decrease
Deviation from the JMF	0.3	0.5	10

   b. The Lot Average for crushed particle content is within the following deviation:

Crushed Particle Content	Greater Than	But Less Than Or Equal To	% Decrease
Deviation from the JMF	10	15	10

   c. The Lot Average for Air Voids (%) is within the following deviation:

Air Voids	Greater Than	But Less Than or Equal to	% Decrease
Deviation From JMF	0.5	0.6	2
	0.6	0.7	4
	0.7	0.8	6
	0.8	0.9	8
	0.9	1.0	10

d. The Lot Average for TMD($\#/ft^3$) is within the following deviation:

Theoretical Maximum Density	Greater Than	But Less Than or Equal to	% Decrease
Deviation From JMF	0.7	0.8	2
	0.8	0.9	4
	0.9	1.0	6
	1.0	1.1	8
	1.1	1.2	10

e. The Lot Average for VMA(%) is within the following deviation:

VMA Deviation Below Minimum Value of Table 7.10-1 Mix Design Criteria	Greater Than	But Less Than or Equal to	% Decrease
	0.0	0.1	2
	0.1	0.2	4
	0.2	0.3	6
	0.3	0.4	8
	0.4	0.5	10

3. PAVEMENT DENSITY (25 Percent Maximum Sum).- A negative 25 precent adjustment for the Bituminous Mixture Contract Unit Price will be imposed for either of the following pavement density conditions:

   a. The Lot Average Pavement Density is less than 91.0 percent but equal to or greater than 90.0 percent.

   b. The conditions of the Pavement Density Core Table are satisfied.

4. BITUMINOUS MIXTURE (25 Percent Maximum Sum).- A maximum negative 25 percent adjustment for the Bituminous Mixture Contract Unit Price will be will be imposed for any of the following:

   a. The Lot Average Air Void's deviation from the JMF is greater than 1.0 percent.

   b. The Lot Average TMD's deviation from the JMF is greater than 1.2 $\#/ft^3$.

   c. The Lot Average Percent Asphalt Binder Content's deviation from the JMF is greater than 0.5 percent.

   d. The Lot Average Crushed Particle Content's deviation from the JMF is greater than 15.0 percent.

   e. The Lot Average for VMA (%) is within the following deviation:

VMA Deviation Below Minimum Value of Table 7.10-1 Mix Design Criteria	Greater Than	Less Than or Equal to
	0.5	0.6

5. PAVEMENT DENSITY (50 Percent Maximum Sum).-A negative 50 percent adjustment for the Bituminous Mixture Contract Unit Price will be imposed if during initial base or leveling course mixture production any SUBLOT value for pavement density is less than 90.0 percent.

6. FAILURE TO SUSPEND OPERATIONS (25 Percent Maximum Sum).-If during Quality Control Testing (see 4.02.05) a deviation occurs that requires production to be suspended and the Contractor continues to operate, then the tonnage for that SUBLOT and any subsequent tonnage will be subject to this negative adjustment until all measured parameters are within quality control tolerances.

7. ASPHALT BINDER PENETRATION\VISCOSITY\RECOVERED PENETRATION.- As per the current Standard Specifications for Construction.

D. **Removal**: The cost of the mixture removed and the removal cost will be borne by the Contractor.

1. If a SUBLOT value, other than the initial base or leveling course production for pavement density is less than 90.0 percent of the running average for the TMD, all mixture for that SUBLOT will be removed.

2. If the total negative adjustment is 60 percent or more, these areas will be evaluated by the Engineer. If, in the Engineer's judgement, the defective areas warrant removal, the Contractor shall remove and replace the effected pavement with pavement meeting the contract specification requirements.

3. The Engineer reserves the right to evaluate any SUBLOT whose test results on the asphalt binder content, VMA, or Air Voids, exceed the Quality Control Tolerances for single test or running average of five. If in the opinion of the Engineer the in-place mixture will not perform in accordance with normal standards the mixture will be removed.

PAVEMENT DENSITY CORE TABLE

# of Lot Cores	6% Bituminous Quality Initiative**		10% Negative Adjustment	25% Negative Adjustment**
Criteria note: both criteria apply for the 6% Bituminous Quality Initiative	Minimum Number of Cores equal to or greater than 94.0%*	Minimum Number of Cores equal to or greater than 92.0%*	Minimum Number of Cores less than 92.0%* *	Minimum Number of Cores less than 91.0%
3	2	2	2	2
4	2	3	2	2
5	3	4	2	2
6	4	4	3	2
7	4	5	3	2
8	5	6	3	2
9	6	7	3	2
10	6	8	3	3
11	7	8	4	3
12	8	9	4	3
13	8	10	4	3
14	9	11	4	3
15	10	12	4	4

* A mixture requiring an air void target value lower than 3.0 percent for nontraffic areas, will require a corresponding increase in the pavement density value.

** If the Lot cores satisfy both the 6 percent Bituminous Quality Initiative criteria and the 25 percent Negative Adjustment criteria, the following shall apply:

1. If all other conditions of 4.02.10 B.1. are satisfied, the contractor shall not receive the 6 percent Pavement Density Bituminous Quality Initiative nor shall the contractor be assessed the 25 percent Negative Adjustment. The Contractor may receive the 4 percent Bituminous Mixture Quality Initiative if so applicable.

2. If all other conditions of 4.02.10 B.1 are not satisfied, the contractor shall be assessed the 25 percent Negative Adjustment.

STATE OF MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

SPECIAL PROVISION FOR PRICE ADJUSTMENTS ON ASPHALT BINDER

In the Michigan 1990 Standard Specifications for Construction, in section **4.00.19-Measurement and Payment**, under the subsection **"Price Adjustments:"**, delete subsection **"2. Tests on Asphalt Recovered from Bituminous Mixtures.-"** ,and replace with the following:

2. **Asphalt Binders.** Original samples of asphalt binder will be taken prior to incorporation into the mixture. The original samples will be used for Asphalt Binder Certification verification. Asphalt binder samples will also be recovered from the daily mixture sample.

   Tests on Asphalt Recovered from Bituminous Mixture.-When the penetration results on recovered asphalt are found to fall within the ranges indicated in Table 1, the contract unit price for the mixture involved will be decreased by the percentages shown in the Table.

Table 1
Price Adjustment for Bituminous Pavement Where Asphalt Recovered from the Mixture is Deficient in Penetration Requirements

Design Grade of Asphalt Cement	10% Decrease Penetration Above	25% Decrease Penetration Below	** Penetration Below
PG 58-28	115 dmm	55 dmm	45 dmm
PG 52-28	135 dmm	65 dmm	50 dmm
PG 52-34	180 dmm	80 dmm	60 dmm

**The mixture produced will be evaluated by the Engineer and if in the Engineer's judgement the defective pavement warrants removal, the Contractor shall remove and replace the affected area at the Contractor's expense. If it is determined that the removal is not required, the contract unit price of the affected mixture will be reduced by 50 percent.

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

SPECIAL PROVISION
FOR
RIDE QUALITY (ENGLISH)

a. Description

This specification is to provide an incentive for contractors to construct the smoothest riding pavements possible. This specification provides two methods of measuring the ride quality of concrete and bituminous pavements. The contractor has the option of using either method. Once a method has been selected by the Contractor, it may not be changed without authorization from the Engineer. The ride quality of pavements will be determined on the finished surface only. This Special Provision deletes paragraph five of Section 4.00.03-2, Section 4.00.12, and Section 4.50.13, paragraphs two, three, and four of the 1990 Standard Specifications.

b. Methods of Determining Pavement Smoothness

1. California Type Profilograph

Ride quality of the pavement, expressed in inches per mile, will be determined from a mechanically produced profilogram (trace) or from a computerized version of the California type profilograph.

2. GM Type Rapid Travel Profilometer

Ride quality of the pavement, expressed as RQI (Ride Quality Index) units, or inches per mile will be determined by proper reduction of the true profile obtained by a GM Type of Rapid Travel Profilometer. The contractor has the option of using either unit of measurement. Once the unit of measurement has been chosen by the contractor, it may not be changed without authorization from the Engineer.

c. Equipment

The contractor will certify in writing that the equipment, manufacturers calibration procedures and visual inspections are in compliance with this special provision. A manufacturers operating manual and a metric tire pressure gauge will be available at the site.

1. California Type Profilograph

The contractor will furnish a California type profilograph, which is either mechanical or computerized. The profilograph will produce a profilogram with a true 1:1 vertical scale and a true 1 inch to 25 feet horizontal scaling. The profilogram will have roadway stations recorded thereon.

If the profilograph is equipped with an on-board computer, the following conditions will apply: Vertical displacement will be sampled every 3 inches or less along the roadway. The profile data will be bandpass filtered in the computer to remove all spatial wavelengths shorter than 2 feet and longer than 110 feet. This will be accomplished by a third order, low pass Butterworth filter set at 2 feet and a third order, high pass Butterworth filter set at 110 feet. The resulting band limited profile will then be computer analyzed according to the California Profilograph reduction process to produce the required inches per mile statistic. This will be accomplished by fitting a linear regression line to each 528 feet of contiguous pavement section. This corresponds to the perfect placement of the blanking bar by a human trace reducer. Scallops are then detected and totalized according to the California protocol. Bump analysis will take place according to the California Profilograph reduction process.

The computerized profilograph will produce a plot of the profile and a printout which will give the following data: Stations every 100 feet, bump or dip height and length of specification (3/10 of an inch and 25 feet respectively), the blanking band width, date of measurement, overall inches per mile for that measurement, total length of that measurement, and the raw inches for each tenth mile segment.

The calibration procedure for the mechanical machine will consist of profiling two replicate runs on a designated roadway of 1,000 feet in length. Horizontal calibration will be checked by running the profilograph over the 1,000 feet length and measuring the length of the resulting output on the profilogram. A 1,000 feet run must produce 40 inches (± 1/8 inch) of profilogram output. Vertical calibration will be checked by running the test wheel over a block of known thickness (usually 1 inch) and measuring the displacement it produces on the profilogram. There will be no visible tolerance allowed on the vertical calibration.

Calibration of the computerized versions will have a run made over a distance of a measured 2/10 of a mile (1,056 lft). The computer must print out a distance equal to the measured distance ±5 ft. The vertical calibration will be as per the manufacturer's specification.

If the horizontal or vertical checks do not meet specifications, the machinery must be corrected. In addition to the calibration procedures, a visual inspection of the profilograph must be conducted. This would include condition of the test tire and bogey wheels, tire pressure (25 psi ± 1 psi), tracking of the paper on the spool and paper drum, condition of chains and cables, tracking of the device down the road, and general condition of the test device. This calibration procedure is the same for either type of profilograph.

2. GM Type Rapid Travel Profilometer

The contractor will furnish a profilometer based on the General Motors Rapid Travel concept. The unit will produce a true profile for spatial wavelengths from 2 to 110 feet. The unit must also be able to generate the equivalent California Profilograph plot and values as well as locations of bumps or dips over 3/10 of an inch/25 feet. The unit will also be capable of producing a plot of the true profile with a range from 2 feet to 110 feet wavelengths.

The digitized profile will be processed by dividing it into three spatial wavelength bands by using third order Butterworth high and low pass filters. The three bands are 50 to 25 feet, 25 to 5 feet, and 5 to 2 feet. Variance of the profile in each band is then computed:

$$Var_i = \frac{\Sigma x^2}{N} - \left(\frac{\Sigma x}{N}\right)^2$$

Where x is a profile elevation value in inches and N is the number of x values.

i = 1 for 50 to 25 feet, i = 2 for 25 to 5 feet and i = 3 for 5 to 2 feet.

RQI is then given by the formula:

$$RQI = 3.077 \ln (Var_1 \times 10^6) + 6.154 \ln (Var_2 \times 10^6) + 9.231 \ln (Var_3 \times 10^6) - 141.85$$

This provides a scale from 0 (a perfect road) to 100 (the roughest road).

This equipment will give a printout of the same information as the profilograph with the addition of the ride quality index for each tenth mile segment and for the total run.

These devices can be tested for overall operation by performing the "Bounce" test procedure included with the unit. In addition, any other tests prescribed by the manufacturer will be performed. Horizontal measurement will be checked over a measured distance of 2/10 of a mile (1,056 lft) and will read within ± 5 feet of the measured distance. The vertical calibration will be as per the manufacturer's specification.

d. Method of Testing - The contractor will submit a written plan for the ride quality measuring to the Engineer for approval prior to the start of paving operations. The contractors plan will include, but not be limited to calibration schedule, the length of the official test run, method of traffic control, and the testing time frame in relation to paving operations.

The Engineer will establish and mark the limits for Ride Quality Measurement including the POB, POE, and any excluded area.

The Contractor will notify the Engineer a minimum of 24 hours prior to any pavement corrections and determination of ride quality.

The run will not be considered an official run until the pavement profile is in compliance with the requirements for this special provision.

The Contractor will be responsible for starting the California type profilometer with the measuring wheel on the mark and ending on the mark at the end of the run. The GM type profilometer measurement should start 16.25 feet prior to the mark and end 16.25 feet after the mark at the end of the run. Profiles will be taken 3 feet from each side of each lane that is to be measured. Bridge decks will be excluded for payment of Ride Quality, but not for Ride Quality Measurement. This requires software, mechanical or electronic means of suspending calculation of the ride quality statistic during passage over such sections, while retaining linear measurement. All damage to the pavement surface caused by the profilometer will be repaired at no cost to the Department.

e. Method of Interpretation

1. Profile Index (inches per mile)

The trace generated by the mechanical profilograph will be analyzed by the Engineer using a 2/10 inch blanking band measuring each deviation above and below the band to the nearest 5/100 of an inch according to Michigan Test Method MTM 204-88. Deviations will be summed for each 1/10 of a mile and proportional lengths as follows:

Segments less than 1/10 of a mile shall be prorated to a 1/10 of a mile segment. Each run will be reported by the contractor to the nearest 1/100 of an inch as the average inches per mile of the two runs for each lane.

For computerized profilograph use, the Engineer will not need to reduce the trace. A copy of the official computer generated trace and printout will be submitted for project records and to determine the ride quality payment. Each run will be reported by the contractor to the nearest 1/100 of an inch as the average inches per mile of the two runs for each lane.

Pavement lanes constructed with 0 to less than 4 inches per mile will result in payment of varying percentages based on Table 1. Lanes with 4 to 10 inches per mile will not be eligible for any bonus payments for ride quality. Lanes with more than 10 inches per mile will not be acceptable. All areas with bumps or dips exceeding 3/10 of an inch/25 feet will be corrected. All pavements will be corrected to achieve a value of 10 inches per mile or less at no cost to the Department. Any tenth mile segments greater than 1.0 inch will require correction.

2. Ride Quality Index (RQI)

RQI will be calculated for each tenth mile segment. Partial segments will be computed as partial segments at the beginning and end of excluded sections and at the end of a run. Each run will be reported to the nearest one tenth of a RQI unit (e.g., 48.6), as the average of the two runs for each lane. The contractor will provide to the Engineer a trace and a printout which gives the same information as described for the profilograph.

Pavement lanes constructed with an RQI from 22 to less than 45 will result in payment of varying percentages based on Table 2. Lanes with RQIs of 45 to 53 will not be eligible for any bonus payments for ride quality. Pavement lanes with a RQI more than 53 are not acceptable. All pavement lanes will be corrected to achieve an RQI value of 53 or less at no cost to the Department.

All areas with bumps or dips exceeding 3/10 of an inch/25 feet will be corrected.

f. Methods of Correction

1. Bituminous Pavements - Corrections to the pavement will be by one of the following methods:

a. Diamond Grinding
b. Cold Milling (Not allowed on surface courses)
c. Wedging (Not allowed on surface courses)
d. Removal and replacement of a minimum of 1 and 1/4 inches of bituminous a full lane width by the length required (a minimum of 100 feet)

Bumps and dips which measure over 3/10 of an inch in 25 feet must be corrected by the method(s) specified above. All corrections are at the contractor's expense.

2. Concrete Pavements -Bumps or dips which measure over 3/10 of an inch in 25 feet must be corrected. Restoration of the transverse grooves in these areas will not be necessary provided that the grinding equipment establishes a grooved surface in the longitudinal direction. The contractor will determine those areas which need correction. All corrections to concrete pavements will be by diamond grinding for a full lane width and are at the contractor's expense.

g. Method of Measurement - The item of RIDE QUALITY MEASUREMENT will be measured as Lane Miles. The limits for Ride Quality Measurement will be based on 16.25 lineal feet before the POB and after the POE (see Figure 1).

Quantities for the item RIDE QUALITY - BITUMINOUS and RIDE QUALITY - CONCRETE will be determined by the area in square yards based on plan quantities or known changes. The limits for Ride Quality will be based on 16.25 lineal feet after the POB and before the POE. The limits for any excluded area will be 16.25 lineal feet before and after the section. Areas of ramps, tapers, bridge decks, and railroad crossings are not included under the item of Ride Quality (see Figure 1). Major intersections (at grade) with part width, maintained traffic, or staged construction may be considered as excluded areas As listed in the Ride Quality measurement plan. The excluded area will extend between the approach and departure spring points of the intersection.

Quantities for the item BUMP GRINDING will be determined by the area in square yards, outside the limits of RIDE QUALITY, as directed by the Engineer. See Figure 1.

h. Basis of Payment

Ride Quality Measurement-Bituminous . . . . . Lane Miles
Ride Quality Measurement-Concrete . . . . . . Lane Miles

Payment for the item RIDE QUALITY MEASUREMENT will include all costs of furnishing and operating the profilograph or rapid travel profilometer for the official run. If the Engineer requires excluded areas, ramps, tapers, approaches, or miscellaneous concrete pavement to be measured, they will be measured and paid for as Ride Quality Measurement.

No additional payment will be made for runs made by the contractor to determine the smoothness prior to corrections for the official runs.

Ride Quality-Bituminous . . . . Syds
Ride Quality-Concrete . . . . Syds
Bump Grinding . . . . Syds

Payment will be determined by the Engineer for the item RIDE QUALITY based on the inches per mile or RQI for the final weighted average for all values within each lane. The limits for Ride Quality will be based on 16.25 lineal feet after the POB and before the POE and 16.25 lineal feet before and after any excluded area. Each lane will be determined individually.

Incentive for pavements will be paid at the contract unit price for Ride Quality on the finished surface. The criteria for making incentive payments or no payments for this item will be:

1. For the California Type Profilograph (Mechanical & Computerized)

Incentive Payments.- A pavement lane having a range of 0 to less than 4 inches per mile will receive payments for Ride Quality based on the product of the number of square yards in the pavement lane (minus excluded areas) times the contract unit price for Ride Quality, multiplied by the appropriate pay factor from Table 1.

No Payment.-A pavement lane having a range of 4 to 10 inches per mile will not qualify nor receive any payment for Ride Quality.

2. For the GM Type Rapid Travel Profilometer

Incentive Payments.-A pavement lane having an RQI range of 22 (or less), to less than 45, or a range of 0 to less than 4 inches per mile, will receive payments for Ride Quality based on the product of the number of lane miles in the pavement lane (minus excluded areas) times the contract unit price for Ride Quality, multiplied by the appropriate pay factor from Tables 1 or 2.

No Payment.-A pavement lane having an RQI range of 45 to 53, or a range of more than 4 to 10 inches per mile, will not qualify nor receive any payment for Ride Quality.

Payment for the item, Bump Grinding will be used outside the limits of Ride Quality-Bituminous or Ride Quality-Concrete. Areas with bumps or dips exceeding 3/10 of an inch in 25 feet will be diamond ground as directed by the Engineer.

RIDE QUALITY - BITUMINOUS
RIDE QUALITY - CONCRETE
RIDE QUALITY MEASUREMENT
BUMP GRINDING

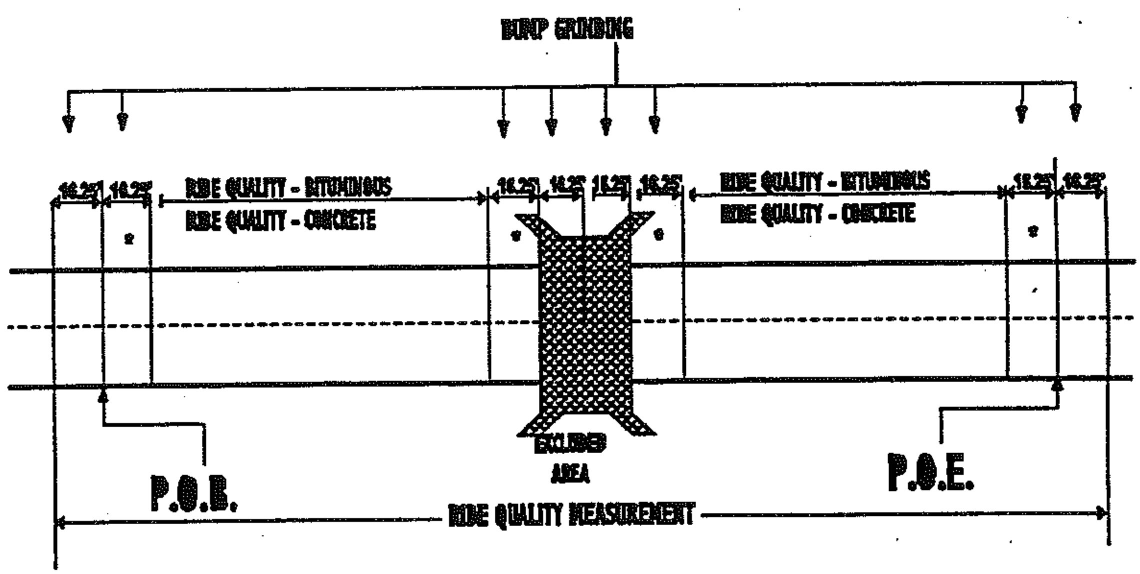


FIGURE 1

TABLE 1
PAY SCHEDULE FOR RIDE QUALITY USING PROFILE INDEX (Inches/Mile)
(FACTOR TO BE MULTIPLIED BY CONTRACT UNIT PRICE)

Profile	Pay	Profile	Pay	Profile	Pay	Profile	Pay	Profile	Pay	Profile	Pay	Profile	Pay	Profile	Pay	Profile	Pay
Index	Factor	Index	Factor	Index	Factor	Index	Factor	Index	Factor	Index	Factor	Index	Factor	Index	Factor	Index	Factor
In./m	%	In./m	%	In./m	%	In./m	%	In./m	%	In./m	%	In./m	%	In./m	%	In./m	%
0.00	100.00	0.45	88.75	0.90	77.50	1.35	66.25	1.80	55.00	2.25	43.75	2.70	32.50	3.15	21.25	3.60	10.00
0.01	99.75	0.46	88.50	0.91	77.25	1.36	66.00	1.81	54.75	2.26	43.50	2.71	32.25	3.16	21.00	3.61	9.75
0.02	99.50	0.47	88.25	0.92	77.00	1.37	65.75	1.82	54.50	2.27	43.25	2.72	32.00	3.17	20.75	3.62	9.50
0.03	99.25	0.48	88.00	0.93	76.75	1.38	65.50	1.83	54.25	2.28	43.00	2.73	31.75	3.18	20.50	3.63	9.25
0.04	99.00	0.49	87.75	0.94	76.50	1.39	65.25	1.84	54.00	2.29	42.75	2.74	31.50	3.19	20.25	3.64	9.00
0.05	98.75	0.50	87.50	0.95	76.25	1.40	65.00	1.85	53.75	2.30	42.50	2.75	31.25	3.20	20.00	3.65	8.75
0.06	98.50	0.51	87.25	0.96	76.00	1.41	64.75	1.86	53.50	2.31	42.25	2.76	31.00	3.21	19.75	3.66	8.50
0.07	98.25	0.52	87.00	0.97	75.75	1.42	64.50	1.87	53.25	2.32	42.00	2.77	30.75	3.22	19.50	3.67	8.25
0.08	98.00	0.53	86.75	0.98	75.50	1.43	64.25	1.88	53.00	2.33	41.75	2.78	30.50	3.23	19.25	3.68	8.00
0.09	97.75	0.54	86.50	0.99	75.25	1.44	64.00	1.89	52.75	2.34	41.50	2.79	30.25	3.24	19.00	3.69	7.75
0.10	97.50	0.55	86.25	1.00	75.00	1.45	63.75	1.90	52.50	2.35	41.25	2.80	30.00	3.25	18.75	3.70	7.50
0.11	97.25	0.56	86.00	1.01	74.75	1.46	63.50	1.91	52.25	2.36	41.00	2.81	29.75	3.26	18.50	3.71	7.25
0.12	97.00	0.57	85.75	1.02	74.50	1.47	63.25	1.92	52.00	2.37	40.75	2.82	29.50	3.27	18.25	3.72	7.00
0.13	96.75	0.58	85.50	1.03	74.25	1.48	63.00	1.93	51.75	2.38	40.50	2.83	29.25	3.28	18.00	3.73	6.75
0.14	96.50	0.59	85.25	1.04	74.00	1.49	62.75	1.94	51.50	2.39	40.25	2.84	29.00	3.29	17.75	3.74	6.50
0.15	96.25	0.60	85.00	1.05	73.75	1.50	62.50	1.95	51.25	2.40	40.00	2.85	28.75	3.30	17.50	3.75	6.25
0.16	96.00	0.61	84.75	1.06	73.50	1.51	62.25	1.96	51.00	2.41	39.75	2.86	28.50	3.31	17.25	3.76	6.0
0.17	95.75	0.62	84.50	1.07	73.25	1.52	62.00	1.97	50.75	2.42	39.50	2.87	28.25	3.32	17.00	3.77	5.7
0.18	95.50	0.63	84.25	1.08	73.00	1.53	61.75	1.98	50.50	2.43	39.25	2.88	28.00	3.33	16.75	3.78	5.50
0.19	95.25	0.64	84.00	1.09	72.75	1.54	61.50	1.99	50.25	2.44	39.00	2.89	27.75	3.34	16.50	3.79	5.25
0.20	95.00	0.65	83.75	1.10	72.50	1.55	61.25	2.00	50.00	2.45	38.75	2.90	27.50	3.35	16.25	3.80	5.00
0.21	94.75	0.66	83.50	1.11	72.25	1.56	61.00	2.01	49.75	2.46	38.50	2.91	27.25	3.36	16.00	3.81	4.75
0.22	94.50	0.67	83.25	1.12	72.00	1.57	60.75	2.02	49.50	2.47	38.25	2.92	27.00	3.37	15.75	3.82	4.50
0.23	94.25	0.68	83.00	1.13	71.75	1.58	60.50	2.03	49.25	2.48	38.00	2.93	26.75	3.38	15.50	3.83	4.25
0.24	94.00	0.69	82.75	1.14	71.50	1.59	60.25	2.04	49.00	2.49	37.75	2.94	26.50	3.39	15.25	3.84	4.00
0.25	93.75	0.70	82.50	1.15	71.25	1.60	60.00	2.05	48.75	2.50	37.50	2.95	26.25	3.40	15.00	3.85	3.75
0.26	93.50	0.71	82.25	1.16	71.00	1.61	59.75	2.06	48.50	2.51	37.25	2.96	26.00	3.41	14.75	3.86	3.50
0.27	93.25	0.72	82.00	1.17	70.75	1.62	59.50	2.07	48.25	2.52	37.00	2.97	25.75	3.42	14.50	3.87	3.25
0.28	93.00	0.73	81.75	1.18	70.50	1.63	59.25	2.08	48.00	2.53	36.75	2.98	25.50	3.43	14.25	3.88	3.00
0.29	92.75	0.74	81.50	1.19	70.25	1.64	59.00	2.09	47.75	2.54	36.50	2.99	25.25	3.44	14.00	3.89	2.75
0.30	92.50	0.75	81.25	1.20	70.00	1.65	58.75	2.10	47.50	2.55	36.25	3.00	25.00	3.45	13.75	3.90	2.50
0.31	92.25	0.76	81.00	1.21	69.75	1.66	58.50	2.11	47.25	2.56	36.00	3.01	24.75	3.46	13.50	3.91	2.25
0.32	92.00	0.77	80.75	1.22	69.50	1.67	58.25	2.12	47.00	2.57	35.75	3.02	24.50	3.47	13.25	3.92	2.00
0.33	91.75	0.78	80.50	1.23	69.25	1.68	58.00	2.13	46.75	2.58	35.50	3.03	24.25	3.48	13.00	3.93	1.75
0.34	91.50	0.79	80.25	1.24	69.00	1.69	57.75	2.14	46.50	2.59	35.25	3.04	24.00	3.49	12.75	3.94	1.50
0.35	91.25	0.80	80.00	1.25	68.75	1.70	57.50	2.15	46.25	2.60	35.00	3.05	23.75	3.50	12.50	3.95	1.25
0.36	91.00	0.81	79.75	1.26	68.50	1.71	57.25	2.16	46.00	2.61	34.75	3.06	23.50	3.51	12.25	3.96	1.00
0.37	90.75	0.82	79.50	1.27	68.25	1.72	57.00	2.17	45.75	2.62	34.50	3.07	23.25	3.52	12.00	3.97	0.75
0.38	90.50	0.83	79.25	1.28	68.00	1.73	56.75	2.18	45.50	2.63	34.25	3.08	23.00	3.53	11.75	3.98	0.50
0.39	90.25	0.84	79.00	1.29	67.75	1.74	56.50	2.19	45.25	2.64	34.00	3.09	22.75	3.54	11.50	3.99	0.25
0.40	90.00	0.85	78.75	1.30	67.50	1.75	56.25	2.20	45.00	2.65	33.75	3.10	22.50	3.55	11.25	4.00	0.0
0.41	89.75	0.86	78.50	1.31	67.25	1.76	56.00	2.21	44.75	2.66	33.50	3.11	22.25	3.56	11.00		
0.42	89.50	0.87	78.25	1.32	67.00	1.77	55.75	2.22	44.50	2.67	33.25	3.12	22.00	3.57	10.75		
0.43	89.25	0.88	78.00	1.33	66.75	1.78	55.50	2.23	44.25	2.68	33.00	3.13	21.75	3.58	10.50		
0.44	89.00	0.89	77.75	1.34	66.50	1.79	55.25	2.24	44.00	2.69	32.75	3.14	21.50	3.59	10.25		

TABLE 2
PAY SCHEDULE FOR RIDE QUALITY USING RIDE QUALITY INDEX (RQI)
(FACTOR TO BE MULTIPLIED BY CONTRACT UNIT PRICE)

Profile Index	Pay Factor	Profile Index	Pay Factor	Profile Index	Pay Factor	Profile Index	Pay Factor	Profile Index	Pay Factor	Profile Index	Pay Factor	Profile Index	Pay Factor	Profile Index	Pay Factor	Profile Index	Pay Factor
RQI	%	RQI	%	RQI	%	RQI	%	RQI	%	RQI	%	RQI	%	RQI	%	RQI	%
0.00	100.00	24.60	88.69	27.20	77.39	29.80	66.09	32.40	54.78	35.00	43.48	37.60	32.17	40.20	20.87	42.80	9.57
22.05	99.78	24.65	88.48	27.25	77.17	29.85	65.87	32.45	54.56	35.05	43.26	37.65	31.96	40.25	20.65	42.85	9.35
22.10	99.56	24.70	88.26	27.30	76.96	29.90	65.65	32.50	54.35	35.10	43.04	37.70	31.74	40.30	20.43	42.90	9.13
22.15	99.35	24.75	88.04	27.35	76.74	29.95	65.43	32.55	54.13	35.15	42.83	37.75	31.52	40.35	20.22	42.95	8.91
22.20	99.13	24.80	87.82	27.40	76.52	30.00	65.22	32.60	53.91	35.20	42.61	37.80	31.30	40.40	20.00	43.00	8.70
22.25	98.91	24.85	87.61	27.45	76.30	30.05	65.00	32.65	53.70	35.25	42.39	37.85	31.09	40.45	19.78	43.05	8.48
22.30	98.69	24.90	87.39	27.50	76.09	30.10	64.78	32.70	53.48	35.30	42.17	37.90	30.87	40.50	19.57	43.10	8.26
22.35	98.48	24.95	87.17	27.55	75.87	30.15	64.56	32.75	53.26	35.35	41.96	37.95	30.65	40.55	19.35	43.15	8.04
22.40	98.26	25.00	86.96	27.60	75.65	30.20	64.35	32.80	53.04	35.40	41.74	38.00	30.43	40.60	19.13	43.20	7.83
22.45	98.04	25.05	86.74	27.65	75.43	30.25	64.13	32.85	52.83	35.45	41.52	38.05	30.22	40.65	18.91	43.25	7.61
22.50	97.82	25.10	86.52	27.70	75.22	30.30	63.91	32.90	52.61	35.50	41.30	38.10	30.00	40.70	18.70	43.30	7.39
22.55	97.61	25.15	86.30	27.75	75.00	30.35	63.69	32.95	52.39	35.55	41.09	38.15	29.78	40.75	18.48	43.35	7.17
22.60	97.39	25.20	86.09	27.80	74.78	30.40	63.48	33.00	52.17	35.60	40.87	38.20	29.57	40.80	18.26	43.40	6.96
22.65	97.17	25.25	85.87	27.85	74.56	30.45	63.26	33.05	51.96	35.65	40.65	38.25	29.35	40.85	18.04	43.45	6.74
22.70	96.95	25.30	85.65	27.90	74.35	30.50	63.04	33.10	51.74	35.70	40.43	38.30	29.13	40.90	17.83	43.50	6.52
22.75	96.74	25.35	85.43	27.95	74.13	30.55	62.83	33.15	51.52	35.75	40.22	38.35	28.91	40.95	17.61	43.55	6.30
22.80	96.52	25.40	85.22	28.00	73.91	30.60	62.61	33.20	51.30	35.80	40.00	38.40	28.70	41.00	17.39	43.60	6.09
22.85	96.30	25.45	85.00	28.05	73.69	30.65	62.39	33.25	51.09	35.85	39.78	38.45	28.48	41.05	17.17	43.65	5.87
22.90	96.09	25.50	84.78	28.10	73.48	30.70	62.17	33.30	50.87	35.90	39.56	38.50	28.26	41.10	16.96	43.70	5.65
23.95	95.87	25.55	84.56	28.15	73.26	30.75	61.96	33.35	50.65	35.95	39.35	38.55	28.04	41.15	16.74	43.75	5.44
23.00	95.65	25.60	84.35	28.20	73.04	30.80	61.74	33.40	50.43	36.00	39.13	38.60	27.83	41.20	16.52	43.80	5.22
23.05	95.43	25.65	84.13	28.25	72.83	30.85	61.52	33.45	50.22	36.05	38.91	38.65	27.61	41.25	16.30	43.85	5.00
23.10	95.22	25.70	83.91	28.30	72.61	30.90	61.30	33.50	50.00	36.10	38.70	38.70	27.39	41.30	16.09	43.90	4.78
23.15	95.00	25.75	83.69	28.35	72.39	30.95	61.09	33.55	49.78	36.15	38.48	38.75	27.17	41.35	15.87	43.95	4.57
23.20	94.78	25.80	83.48	28.40	72.17	31.00	60.87	33.60	49.56	36.20	38.26	38.80	26.96	41.40	15.65	44.00	4.35
23.25	94.56	25.85	83.26	28.45	71.96	31.05	60.65	33.65	49.35	36.25	38.04	38.85	26.74	41.45	15.43	44.05	4.13
23.30	94.35	25.90	83.04	28.50	71.74	31.10	60.43	33.70	49.13	36.30	37.83	38.90	26.52	41.50	15.22	44.10	3.91
23.35	94.13	25.95	82.82	28.55	71.52	31.15	60.22	33.75	48.91	36.35	37.61	38.95	26.30	41.55	15.00	44.15	3.70
23.40	93.91	26.00	82.61	28.60	71.30	31.20	60.00	33.80	48.70	36.40	37.39	39.00	26.09	41.60	14.78	44.20	3.48
23.45	93.69	26.05	82.39	28.65	71.09	31.25	59.78	33.85	48.48	36.45	37.17	39.05	25.87	41.65	14.57	44.25	0.00
23.50	93.48	26.10	82.17	28.70	70.87	31.30	59.56	33.90	48.26	36.50	36.96	39.10	25.65	41.70	14.35	44.30	3.04
23.55	93.26	26.15	81.96	28.75	70.65	31.35	59.35	33.95	48.04	36.55	36.74	39.15	25.43	41.75	14.13	44.35	2.83
23.60	93.04	26.20	81.74	28.80	70.43	31.40	59.13	34.00	47.83	36.60	36.52	39.20	25.22	41.80	13.91	44.40	2.61
23.65	92.82	26.25	81.52	28.85	70.22	31.45	58.91	34.05	47.61	36.65	36.30	39.25	25.00	41.85	13.70	44.45	2.39
23.70	92.61	26.30	81.30	28.90	70.00	31.50	58.69	34.10	47.39	36.70	36.09	39.30	24.78	41.90	13.48	44.50	2.17
23.75	92.39	26.35	81.09	28.95	69.78	31.55	58.48	34.15	47.17	36.75	35.87	39.35	24.57	41.95	13.26	44.55	1.96
23.80	92.17	26.40	80.87	29.00	69.56	31.60	58.26	34.20	46.96	36.80	35.65	39.40	24.35	42.00	13.04	44.60	1.74
23.85	91.96	26.45	80.65	29.05	69.35	31.65	58.04	34.25	46.74	36.85	35.43	39.45	24.13	42.05	12.83	44.65	1.52
23.90	91.74	26.50	80.43	29.10	69.13	31.70	57.83	34.30	46.52	36.90	35.22	39.50	23.91	42.10	12.61	44.70	1.30
23.95	91.52	26.55	80.22	29.15	68.91	31.75	57.61	34.35	46.30	36.95	35.00	39.55	23.70	42.15	12.39	44.75	1.09
24.00	91.30	26.60	80.00	29.20	68.69	31.80	57.39	34.40	46.09	37.00	34.78	39.60	23.48	42.20	12.17	44.80	0.87
24.05	91.09	26.65	79.78	29.25	68.48	31.85	57.17	34.45	45.87	37.05	34.57	39.65	23.26	42.25	11.96	44.85	0.65
24.10	90.87	26.70	79.56	29.30	68.26	31.90	56.96	34.50	45.65	37.10	34.35	39.70	23.04	42.30	11.74	44.90	0.44
24.15	90.65	26.75	79.35	29.35	68.04	31.95	56.74	34.55	45.43	37.15	34.13	39.75	22.83	42.35	11.52	44.95	0.22
24.20	90.43	26.80	79.13	29.40	67.83	32.00	56.52	34.60	45.22	37.20	33.91	39.80	22.61	42.40	11.30	45.00	0.00
24.25	90.22	26.85	78.91	29.45	67.61	32.05	56.30	34.65	45.00	37.25	33.70	39.85	22.39	42.45	11.09		
24.30	90.00	26.90	78.69	29.50	67.39	32.10	56.09	34.70	44.78	37.30	33.48	39.90	22.17	42.50	10.87		
24.35	89.78	26.95	78.48	29.55	67.17	32.15	55.87	34.75	44.56	37.35	33.26	39.95	21.96	42.55	10.65		
24.40	89.56	27.00	78.26	29.60	66.96	32.20	55.65	34.80	44.35	37.40	33.04	40.00	21.74	42.60	10.44		
24.45	89.35	27.05	78.04	29.65	66.74	32.25	55.43	34.85	44.13	37.45	32.83	40.05	21.52	42.65	10.22		
24.50	89.13	27.10	77.82	29.70	66.52	32.30	55.22	34.90	43.91	37.50	32.61	40.10	21.30	42.70	10.00		
24.55	88.91	27.15	77.61	29.75	66.30	32.35	55.00	34.95	43.70	37.55	32.39	40.15	21.09	42.75	9.78		

APPENDIX C
MDOT SUPERPAVE
MIX DESIGN PROCEDURES

Procedures Manual

for

Submitted and Superpave

Mix Design Processing

MICHIGAN DEPARTMENT OF TRANSPORTATION
(MDOT)

PROCEDURES MANUAL FOR
SUBMITTED AND SUPERPAVE MIX DESIGN PROCESSING

Materials and Technology Division
Testing Laboratory Section
Mix Design
Bituminous Services Unit

MARCH, 1997

Table of Contents

1. SUBMITTED MIX DESIGN GUIDELINES

1. SUBMITTED MIX DESIGN GUIDELINES

For all projects, the contractor will supply the Michigan Department of Transportation (MDOT) a SUBMITTED MIX DESIGN (SMD). The SMD must be prepared by a private testing laboratory, either the contractor or consultant. SMD's must be prepared in accordance with MTM 322-97, Michigan Test Method for Bituminous Marshall Mix Design Procedure.

Qualifications of the contractor/consultant laboratory to submit Submitted Mix Designs to the MDOT: The laboratory must participate in MDOT's Round Robin Mix Design Testing Program and AASHTO Materials Reference Laboratory yearly laboratory inspection.

When a contractor uses a consulting laboratory to supply a mix design, the contractor must authorize in writing that the consultant acts as the contractor's agent on mix design issues for the project.

MDOT will only accept one passing design per course, per project. The maximum number of designs per course, per project, that any one contractor/consultant laboratory may submit is two.

Submittal of a submitted mix design shall be made to the MDOT, Materials and Technology Laboratory, Bituminous Mix Design Unit, 8885 Ricks Road, P.O. Box 30049, Lansing, Michigan, 48909. Acceptance for evaluation requires a person from the Bituminous Mix Design Unit to review the paperwork and submitted material. Upon acceptance, the MDOT will have 7 calendar days to evaluate the submitted mix design. SMD's received after 11.45 a.m. will start the 7 calendar day clock on the next scheduled work day.

The Project Engineer may require a new mix design from the contractor on materials at any time it is determined necessary.

2. SUBMITTED MIX DESIGN

2. SUBMITTED MIX DESIGN

The Bituminous Mix Design Unit's evaluation of the submitted mix design will be done as follows:

Review the submitted documentation and materials for compliance with project specifications.

Evaluate the design by entering and running the submitted mix design data with MDOT's Bituminous Mix Design Computer Program.

Evaluate Reclaimed Asphalt Pavement (RAP) to determine if the percent virgin to percent recycled conforms with MDOT procedures.

Test the following physical properties of the aggregate for compliance to Specification:

- Aggregate Wear Index (AWI)
- Angularity Index (AI)
- Soft Stone
- Percent Crush
- Current Los Angeles Abrasion Number

Prepare Marshall specimens for testing stability and flow (ASTM 1559), bulk specific gravity (ASTM 2726).

Prepare specimens for maximum theoretical specific gravity (ASTM 2041).

Perform a gradation and asphalt analysis on mixture submitted and compare results to the mix design and evaluation on:

- Aggregate gradation
- Percent crush
- Recovered asphalt cement penetration
- Percent of recovered asphalt cement

MATERIALS REQUIRED:

1. 3 - 5000 gram samples of mixture @ point closest to / at optimum asphalt content.
NOTE: At least 1 full test point (0.5 % asphalt) above or below optimum asphalt content is required. Identify on Form 1813 the asphalt content of submitted mix.

2. 1 - **6700** gram sample of mixture @ optimum asphalt content.

3. 2 - 1400 gram sample of blended aggregate.
NOTE: If Recycled Asphalt Pavement (RAP) is used in the mix design, these aggregate samples are not required.

4. 800 gram sample passing 2.36 mm (No. 8) sieve and retained 0.60 mm (No. 30) sieve for the final blend. This material will be used in determining the Angularity Index (AI). All material must be washed and dried.

5. Individual Aggregate Wear Index (AWI) samples for each aggregate requiring an AWI value.
NOTE: This should be submitted even if a nomograph exists for that aggregate.

DOCUMENTATION REQUIRED:

1. Form 1820 - Contractor Bituminous Mix Design Communication.

2. Form 1923 - Sample Identification.
NOTE: must be included in each sample package.

3. Form 1813 - Submitted Mix Design Summary Sheet.

4. Form 1822 - Marshall Mix Design Work Sheet.

5. Form 1806 - Theoretical Maximum Specific Gravity.

6. Form 1849 - Bituminous Mix Design Checklist.

7. Provide documentation of Quality Control Testing of RAP Stockpile.
NOTE: only if RAP is included in the mixture.

8. Mix Design Regression Analysis

TOLERANCE LIMITS* FOR MDOT VERIFICATION OF SUBMITTED MIX DESIGNS

1. Bulk specific gravity of mixture ± 0.026
2. Theoretical maximum specific gravity ± 0.019
3. Air voids ± 1.00
4. Asphalt content ± 0.3%
5. % crush must meet specification for project
6. Verification tolerance for crush particle content ± 15%
7. Angularity index must meet specification for project
8. Stability must meet specification for project
9. Flow must meet specification for project
10. Aggregate gradation must meet design master gradation specification
11. Sieve 25.0 mm thru 9.50 mm ± 3.0%
12. Sieve 4.75 mm thru 0.30 mm ± 2.0%
13. Sieve 0.15 mm thru 0.075 mm ± 1.0%
14. If the penetration results from the extracted mixture qualifies for a price adjustment per Table 501.04 of the Special Provision, the SMD will be considered a failing design.

*SMD's that meet all tolerance limits will be reported out as passing.

IV. MDOT FORMULAS AND CONSTANTS

EXAMPLE TO CALCULATE THE REGRESSION ANALYSIS EQUATION FOR STABILITY VS AC

TEST SAMPLE iTH	AC CONTENT IN % Xi	STABILITY LBS Yi	Xi SQUARED	Xi*Yi	Xi CUBED	Xi FOURTHED	Yi*Xi^2
1	4.8	1576	23.04	7564.8	110.592	530.8416	36311.04
2	5.3	1540	28.09	8162	148.877	789.0481	43258.6
3	5.8	1352	33.64	7841.6	195.112	1131.649	45481.28
4	6.3	1100	39.69	6930	250.047	1575.296	43659
SUMMATION	22.2	5568	124.46	30498.4	704.628	4026.835	168709.9

```
S(xx)=Sum(Xi^2)-(Sum(Xi))^2/n =                           1.25
S(xy)=Sum(Xi*Yi)-(Sum(Xi)*Sum(Yi))/n =                    -404
S(xx^2)=Sum(Xi^3)-(Sum(Xi)*Sum(Xi^2))/n =               13.875
S(x^2y)=Sum(Xi^2*Yi)-(Sum(Xi^2)*Sum(Yi))/n =           -4538.4
S(x^2x^2)=Sum(Xi^4)-((Sum(Xi^2))^2)/n =               154.2625

a = [S(x^2y)*S(xx)-S(xy)*S(xx^2)]/
    [S(xx)*S(x^2x^2)-(S(xx^2))^2] =                       -216
b = [S(xy)*S(x^2x^2)-S(x^2y)*S(xx^2)]/
    [S(xx)*S(x^2x^2)-(S(xx^2))^2] =                     2074.4
c = [Sum(Yi)-b*Sum(Xi)-a*Sum(Xi^2)]/n =               -3400.08

Y = a*X^2 + b*X + c =       1475.12 LBS OF MEASURED STABILITY
X =             5.5 % AC CONTENT
NOTE : ^ DESIGNATES THAT PRECEDING VARIABLE IS RAISED TO FOLLOW EXPONENT
```

3. MARSHALL VOLUMES

3. MARSHALL VOLUMES

The MS-2 Manual[1] recommends that the correct size of a compacted 4" Marshall is 63.5 ± 1.27 mm. This is equivalent to a volume of 515 ± 8. If the Marshall height or volume falls outside the limits, the amount of mixture used for the specimen may be adjusted using:

$$\text{Adjusted weight of mix} = \frac{515 * \text{weight of mix used}}{\text{volume measured}}$$

(1) Mix Design Methods for Asphalt Concrete (MS-2), Asphalt Institute, Research Park Drive, P.O. Box 14052, Lexington, Ky. 40512-4052

4. SUPERPAVE MIX DESIGN GUIDELINES

4. SUPERPAVE MIX DESIGN GUIDELINES

For all projects containing the Special Provision for Superpave Bituminous Mixtures, the contractor will supply the Michigan Department of Transportation (MDOT) a Superpave Mix Design. The Superpave Mix Design must be prepared by a private testing laboratory, either the contractor or consultant. Superpave Mix Designs must be prepared in accordance with the SUPERPAVE MIX DESIGN MANUAL (SP-2)*.

Qualifications of the contractor/consultant laboratory to submit Superpave Mix Designs to MDOT: the laboratory must participate in MDOT's Round Robin Mix Design Testing program and AASHTO Materials Reference Laboratory yearly laboratory inspection.

If a contractor uses a consulting laboratory to supply a mix design, the contractor must authorize in writing that the consultant acts as the contractor's agent on mix design issues for the project.. MDOT will only accept one passing design per course, per project. The maximum number of designs per course, per project, that any one contractor/consultant laboratory may submit is two.

Submittal of a Superpave Mix Design shall be made to:

MDOT, Materials and Technology Laboratory
Bituminous Mix Design Unit
8885 Ricks Road, P.O. Box 30049
Lansing, Michigan 48909

Acceptance for evaluation requires a person from the Bituminous Mix Design Unit to review the paperwork and the submitted material. Upon acceptance, MDOT will have 14 calendar days to evaluate the Superpave Mix Design. Superpave Mix Designs received after 11:45 a.m. will start the 14 day calendar clock on the next day.

The Project Engineer may require a new mix design from the contractor on materials at any time it is determined necessary.

* Superpave Mix Design, Superpave Series No. 2 (SP-2). Asphalt Institute, Research Park Drive, P.O. Box 14052, Lexington, Kentucky 40512-4052

5. SUPERPAVE MIX DESIGN

5. SUPERPAVE MIX DESIGN

The Bituminous Mix Design Unit's evaluation of the Superpave Mix Design will be done as follows:

Review the submitted documentation and materials for compliance with project specifications.

Evaluate the design by entering and running the Superpave Mix Design data with MDOT's Bituminous Mix Design Computer Program.

Test the following physical properties of the aggregate for compliance to specification:

- Aggregate Wear Index (AWI) - for top course material only
- Angularity Index (NAA Method A)
- Flat and elongated particles
- Soft stone
- Permanent crush (1/2 sides)
- Current Los Angeles Abrasion number
- Fine Aggregate Bulk - SSD - apparent specific gravities and % absorption
- Coarse Aggregate Bulk - SSD - apparent specific gravities and % absorption

Prepare gyratory specimens per Superpave Mix Design Manual (SP-2) for bulk specific gravity (ASTM 2726).

Prepare specimens for maximum theoretical specific gravity (ASTM 2041).

Perform a gradation and asphalt analysis on mixture submitted and compare results to the Superpave Mix Design and evaluation on:

- Aggregate gradation
- Percent crush
- Recovered asphalt cement penetration
- Percent of recovered asphalt cement

Perform Tensile Strength Ratio Test on the mixture at 7% air voids.

MATERIALS REQUIRED:

1. 2(*) - gram samples of mixture at optimum asphalt content.
NOTE: At least one full test point (0.5% asphalt) above or below optimum asphalt content is required. Identify on Form 1858 the asphalt content of submitted mix.

2. 1 - 2300 gram sample of mixture @ point closest to/at optimum asphalt content. (Theoretical Maximum Specific Gravity).

3. 1 - **6700** gram sample of mixture @ optimum asphalt content. (Asphalt Pavement Analyzer)

4. 2 - 1500 gram samples of mixture @ point closest to/at optimum asphalt content. (Extraction - Asphalt Ignition Furnace)

5. 2 - 1400 gram samples of blended aggregate. (Calibration of Asphalt Ignition Furnace)

6. 1 - 190 gram sample blended angularity index. (N.A.A. Method A)

7. 8 - TSR samples @ 7% air voids, 95 mm height, 150 mm mold.

8. Individual Aggregate Wear Index (AWI) samples for each aggregate which requires an AWI value.
NOTE: this should be submitted even if a nomograph exists for that aggregate or if previously submitted on another design.

9. 1 - 2000 gram sample of blended aggregate, plus 4.75 mm sieve. (Coarse Aggregate Specific Gravity)

10. 1 - 1400 gram sample of blended aggregate, 1.18 mm sieve minus. (Fine Aggregate Specific Gravity)

11. If the 2.36 mm sieve has 25% or greater retained, 1 - 2000 gram sample. Otherwise, the 2.36 mm sieve is not used for aggregate specific gravity.

12. 1 - 1400 gram sample of blended aggregate, passing 4.75 mm sieve. (Sand Equivalent Test)

RAP MIXES:

1. 1 - 2 - 3 - 6 - 7 - 8 - 9 - 10 - 11 and 12 above all apply.

2. 2 - 1900 gram samples of mixture @ point closest to/at optimum asphalt content.

* We want the weight of the mix to compact to 115 mm height at N max. See section later in this Procedures Manual on estimating the correct gyratory weight.

DOCUMENTATION REQUIRED:

1. Form 1855 - Superpave Bituminous Mix Design Communication

2. Form 1923 - Sample Identification
<u>NOTE: Must be included in each sample package.</u>

3. Form 1858 - Superpave Mix Design Summary Sheet

4. Form 1806 - Theoretical Maximum Specific Gravity work Sheet

5. Form 1851 - Gyratory Compacted Bulk Specific Gravity Work Sheet

6. Form 1862 - Superpave Mix Design Checklist

7. Provide documentation of Quality Control Testing of RAP Stockpiles. This includes a minimum of 10 Theoretical Maximum Specific Gravities performed on stockpile.
<u>NOTE: Only if RAP is included in the mixture.</u>

8. Combined gradation plotted on 0.45 power gradation chart.

9. Form 1859 - Coarse Aggregate Bulk Gravity

10. Form 1860 - Fine Aggregate Bulk Gravity

11. Mix Design regression Analysis

12. 3 1/2 disk containing gyratory data (Pine Pave)

TOLERANCE LIMITS FOR MDOT VERIFICATION OF SUPERPAVE MIX DESIGNS:

1. Compacted bulk specific gravity of mixture ± 0.020
2. Theoretical maximum specific gravity ± 0.013
3. Air voids ± 1.00
4. Asphalt content ± 0.3%
5. % crush must meet specification for project
6. Verification tolerance for crush particle content ± 15%
7. Angularity index must meet specification for project
8. Aggregate gradation must meet design master gradation specification
9. Sieve 25.0 mm through 9.50 mm ± 3.0%
10. Sieve 4.75 mm through 300 μm ± 2.0%
11. Sieve 150 μm through 75 μm ± 1.0%
12. If the penetration results from the extracted mixture qualifies for a price reduction per Table 501.04 of the Special Provision for Price Adjustment on Asphalt Binder, the Superpave Mix Design will be considered a failing design.
13. The tensile strength ratio must meet a minimum 80%
14. Fine aggregate bulk-SSD-apparent specific gravity ± 0.028
15. Coarse aggregate bulk-SSD-apparent specific gravity ± 0.028
16. MDOT gyratory test results must meet all project specifications

6. GYRATORY SAMPLE HEIGHTS

6. GYRATORY SAMPLE HEIGHTS

The correct height of a compacted gyratory sample at N max is 115 mm $\pm$ 2 mm. If the gyratory sample height falls outside the limits, the amount of mixture used for the sample may be adjusted, using:

$$\text{Adjusted weight of mix} = \frac{115 * \text{weight of mix used}}{\text{height measured}}$$

For the mixture samples submitted @ point closest to/at optimum asphalt content for gyratory compaction. Adjust the submittal weight so MDOT compacts to a 115 mm height at N max.

7. MIX DESIGN WITH RECLAIMED ASPHALT PAVEMENT (RAP)

7. MIX DESIGNS WITH RECLAIMED ASPHALT PAVEMENT (RAP)

The Contractor may substitute Reclaimed Asphalt Pavement (RAP) for a portion of the new materials required to produce bituminous mixture for a project. The mixture shall be produced in accordance with Section 501 of the 1996 Standard Specifications, or as modified herein.

Reclaimed Asphalt Pavement stockpiles shall be completely established at the plant site prior to submission of the mix design samples. There shall be sufficient RAP in the stockpile to meet the material requirements of each mixture that a recycled mix design is approved for, per project, or the contractor will provide a mixture with all virgin materials at the same unit price. RAP for bituminous mixtures shall be processed to a size compatible to the mixture specified. An Aggregate Wear Index (AWI) value of 240 will be assigned to all RAM. The contractor shall provide Quality Control testing of the RAP during the processing and stockpiling operation in accordance with the following schedule:

1. One complete mixture analysis every 1000 tons of RAP (minimum of 3).

2. One penetration test on the recovered asphalt cement every 3000 tons of RAP (minimum of 2).

3. A minimum of 10 theoretical maximum specific gravity tests showing TMDs and GSEs.

Documented evidence of testing and accumulated tonnage in the stockpile (tonnage may be estimated) must be provided to the MDOT Materials and Technology Laboratory before a mix design will be processed.

The contractor will be required to meet the minimum penetration values for recovered asphalt cement shown in Table 501.04 of the Special Provision for Price Adjustments on Asphalt Binder.

CALCULATION OF THE VIRGIN AGGREGATE COMBINED GRADATION FOR MIX DESIGNS WITH RAP

Combined Gradation With RAP

PIT NUMBER TYPE OF AGGREGATE	 RAP	95-5 3/8 CLEAR	41-117 3/8 - 4	41-117 #4 - 0	95-5 DOLOMITE SAND	COMBINED GRADATION
PERCENT OF	20.0	20.0	18.0	25.0	17.0	
19.0 mm	100.0	100.0	100.0	100.0	100.0	100.0
12.5 mm	99.0	98.8	100.0	100.0	100.0	99.6
9.5 mm	75.0	62.3	99.8	100.0	100.0	87.4
4.75 mm	56.0	7.1	11.9	89.5	93.4	53.0
2.36 mm	32.0	4.3	3.0	56.8	37.1	28.3
1.18 mm	21.0	3.5	2.1	34.9	22.5	17.8
600 µm	17.0	2.8	1.7	22.6	16.7	12.8
300 µm	14.0	2.3	1.5	13.3	13.0	9.1
150 µm	11.0	2.0	1.3	6.3	8.7	5.9
75 µm	7.6	1.5	1.1	4.0	5.0	3.9
Crush, Ret.#4	100.0	100.0	86.4	84.3	100.0	95

To obtain a combined gradation without the RAP, use the following formula to calculate each of the virgin aggregate adjusted percentages.

Virgin aggregate adjusted percentage = (mix design virgin aggregate percentage from mix design) / ((100-RAP percentage) / 100)

Example for 3/8-4 aggregate from Pit 41-117:
(18) / ((100-20) / 100)
18 / .80
22.5%

Using the individual virgin aggregate adjusted percentages, and the respective aggregate stockpile gradations, compute the blended combined gradation of the belt sample.

Combined Gradation of the Belt Sample

PIT NUMBER TYPE OF AGGREGATE	 RAP	95-5 3/8 CLEAR	41-117 3/8-4	41-117 #4-0	95-5 DOLOMITE SAND	COMBINED GRADATION
PERCENT OF		25.0	22.5	31.25	21.25	
19.0 mm	100.0	100.0	100.0	100.0	100.0	100.0
12.5 mm	99.0	98.8	100.0	100.0	100.0	99.7
9.5 mm	75.0	62.3	99.8	100.0	100.0	90.5
4.75 mm	56.0	7.1	11.9	89.5	93.4	52.3
2.36 mm	32.0	4.3	3.0	56.8	37.1	27.4
1.18 mm	21.0	3.5	2.1	34.9	22.5	17.0
600 µm	17.0	2.8	1.7	22.6	16.7	11.7
300 µm	14.0	2.3	1.5	13.3	13.0	7.8
150 µm	11.0	2.0	1.3	6.3	8.7	4.6
75 µm	7.6	1.5	1.1	4.0	5.0	2.9
Crush, Ret.#4	100.0	100.0	86.4	84.3	100.0	93

8. DESIGN TIME PERIOD

8. SUBMITTED MIX DESIGN TIME PERIOD (SEVEN CALENDAR DAYS)

MDOT will have 7 calendar days in which to review the submitted mix design.

The 7 calendar day time period begins when the mix design submittal forms and materials are deemed to be complete and correct by the Bituminous Mix Design Unit.

The mix design may be refused, or the review and the 7 calendar day time period stopped, for the following situations (but not limited to):

1. Evaluation of mix design results indicate a failing design.

2. Incorrect or insufficient material is submitted.

3. Aggregate(s) do not meet physical requirements specified for the project.

4. The contractor-requested combined gradation does not meet Table 501-2 Master Gradation Range in the 1996 Standard Specifications or Special Provision.

5. Incorrect calculation of ABR for mix designs incorporating RAP.

6. No project office review and signature.

7. Incomplete documentation.

8. Lacks a current Los Angeles Abrasion Number.

9. Contractor suspends interest in submitted material.

Restart of the seven calendar day clock will commence upon the timely response by the contractor in efforts to resolve any discrepancies in the submittal.

The contractor, Traveling Mix Inspector and/or the Project Engineer will be notified of situations that require cancellation of a Bituminous Mix Design submittal for reasons such as those listed above.

8. SUPERPAVE MIX DESIGN TIME PERIOD (FOURTEEN CALENDAR DAYS)

MDOT will have 14 calendar days to review the Superpave Mix Design.

The 14 calendar day time period begins when the Superpave Mix Design submittal forms and materials are deemed to be complete and correct by the Bituminous Mix Design Unit.

The Superpave Mix Design may be refused, or the review and the 14 calendar day time period stopped, for the following situations (but not limited to):

1. Evaluation of Superpave Mix Design results indicate a failing design

2. Incorrect or insufficient material is submitted

3. Incomplete documentation.

4. Aggregate(s) do not meet physical requirements specified for the project

5. The contractor requested combined gradation does not meet Table 10 Aggregate Gradation Requirements of the Special Provision for Superpave Bituminous Mixtures.

6. No project office review and signature.

7. Lacks a current Los Angeles Abrasion Number.

8. Contractor suspends interest in submitted material.

Re-start of the 14 calendar day clock will commence upon the timely response by the contractor in efforts to resolve any discrepancies in the submittal.

The Contractor/Consultant, Traveling Mix Inspector and/or the Project Engineer will be notified of situations requiring cancellation of a Superpave Mix Design submittal for reasons such as those listed above.

9. AGGREGATE REQUIREMENTS

9. AGGREGATE REQUIREMENT

NEW AGGREGATE SOURCE

If the aggregate source is new, the contractor must submit to the District Materials Unit a legal description for the new source and directions for driving to the location so a pit number may be assigned.

LOS ANGELES ABRASION NUMBER

Los Angeles Abrasions values are required on all new and existing aggregate sources. A Los Angeles Abrasion test is required if the percent retained on the 4.75 mm sieve is greater than 10 percent, or the percent retained on the 2.36 mm sieve is greater than 35 percent. An aggregate source with an L.A.Abrasion value lower than 35 is valid for 5 years, provided there are 3 L.A.s at 35 or under on record. If an aggregate source has an L.A.Abrasion value over 35, a minimum of one per year is required. If an L.A.Abrasion is required, contact your District Office to take the sample for submission to the Lab.

AWI SAMPLES

For each aggregate requiring an AWI number, the following procedure applies. Start with a 2500 gram sample and separate the retained 4.75 mm, 9.50 mm, and 12.5 mm aggregate by sieving. Wash each sieve size and dry. For each sieve size count out 300 particles and place in a small bag. <u>NOTE:Depending upon the gradation of the aggregate, a 300 particle count may not be possible. In both cases, count the particles and place in a small bag and write the count and sieve size on the outside of the bag. For each aggregate put all the individual sieve size bags into a larger bag and include Form 1923 and Form 1820 completely filled out..</u>

10% MINIMUM AGGREGATE REQUIREMENT

No less than 10% of any single aggregate is allowed in the mix design, excluding mineral filler or baghouse fines. With written permission from the Project Engineer or the Traveling Mix Inspector, less that 10% of single aggregate may be allowed. The written permission must be included with the mix design submittal.

SUPERPAVE FINE AGGREGATE ANGULARITY

Fine aggregate angularity will be tested per Test Method for Uncompacted Void Content of fine Aggregate, ASTM C 1252, Method A. All aggregates including RAP which have material retained on the 1.18 mm, 600 μm, 300 μm and 150 μm are to be used in the blend.
<u>NOTE: The RAP sample can be the result of either an extraction or asphalt ignition oven. For calculations, the GSE of the RAP is to be used. For virgin aggregates the bulk aggregate gravity will be used.</u>

10. NOMOGRAPHS

10. NOMOGRAPH

If a nomograph exists for an aggregate which requires an AWI value, the AWI number from the nomograph will be used for the mix design. An aggregate sample should still be submitted so the nomographs may be updated on a yearly basis.

APPENDIX B

Submitted Mix Design Forms

Michigan Department of Transportation
1820 (2/95)

CONTRACTOR'S BITUMINOUS MIX DESIGN COMMUNICATION

This information is required by the Michigan Department of Transportation for mix design. The CONTRACTOR is responsible for complete and accurate information on this form. Failure to supply this information will result in delay of Bituminous Pavin

Complete and return to Michigan Department of Transportation, Materials & Technology Division, P.O. Box 30049, Lansing, MI 48909.

CONTROL SECTION	JOB NUMBER
CONTRACTOR	ROUTE & LOCATION
PLANT NUMBER	PLANT LOCATION

BITUMINOUS MIXTURE (Circle One) 2C 2B 3C 3B 4C 4B 13A 13 11A OTHER

		AGG. A	AGG. B	AGG. C	AGG. D	AGG. E	AGG. F	MASTER GRADATION RANGE	COMBINED GRADATION
PIT NUMBER									
AGGREGATE TYPE									
BLEND % (10% Minimum)									
AVERAGE GRADATION	P 37.5 mm								
	P 25.0 mm								
	P 19.0 mm								
	P 12.5 mm								
	P 9.50 mm								
	P 4.75 mm								
	P 2.36 mm								
	P 1.18 mm								
	P 0.60 mm								
	P 0.30 mm								
	P 0.1 5mm								
	TOTAL P 0.075 mm								
CRUSH COUNT									
L.A. ABRASION	Value/Year								
ANGULARITY INDEX									
AWI NOMOGRAPH									

ASPHALT CEMENT SUPPLIER		GRADE	
SUBMITTED BY:	NAME (Print or Type)	DATE	PHONE NUMBER
	SIGNATURE		( )
DATE REC'D BY LAB	PROJECT OFFICE NOTIFICATION (Signature)		DATE

Michigan Department
of Transportation
1813 (3/96)

SUBMITTED MIX DESIGN SUMMARY SHEET

CONTRACTOR		CONSULTANT
CONTROL SECTION I.D.	JOB NO.	TYPE OF MIXTURE

MARSHALL MIX PROPERTIES AT TESTED & OPTIMUM ASPHALT CONTENT

ITEM	TEST POINTS Actual Test Data					RECOMMENDED OPTIMUM Regression Value at Optimum Asphalt Content
ASPHALT CONTENT (%)						
BULK SPECIFIC GRAVITY (Compacted)						
THEORETICAL MAXIMUM (S.G.)						
AIR VOIDS (%)						
VOIDS IN MINERAL AGGREGATE % (VMA)						
DS FILLED WITH ASPHALT % (VFA)						
TABILITY (LBS.)						
LOW (0.01 IN.)						
COMPACTIVE EFFORT (BLOWS)						

NOTES

ASPHALT CONTENT OF SUBMITTED MIX DESIGN ______________________________

The submitted mix design shall have a minimum of 4 test points at 0.5 percent asphalt content increments. At least one full asphalt content (0.5%) above and below optimum asphalt content is required.

Michigan Department
of Transportation
1822 (12/90)

MARSHALL MIX DESIGN WORKSHEET

PROJECT NUMBER	DATE	MIX DESIGN NUMBER
CONTRACTOR		TYPE SAMPLE

SAMPLE	A WEIGHT IN AIR	B SSD WEIGHT	C WEIGHT IN WATER	D VOLUME OF SAMPLE (B - C)	E ACTUAL SPG. GR. (A / D)	UNIT WEIGHT (LB./CU. FT.)	MARSHALL STABILITY (LBS. ACTUAL)	FLOW (.01")
				AVERAGE				
				AVERAGE				
				AVERAGE				
				AVERAGE				

TESTER	CHECKED BY

chigan Department
of Transportation
1806 (1/97)

THEORETICAL MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS PAVING MIXTURES MODIFIED ASTM D 2041 (RICE METHOD)

M·DOT METRIC

ROJECT NUMBER | MIX DESIGN NUMBER

ONTRACTOR

% ASPHALT BINDER			
ASPHALT SPECIFIC GRAVITY			
SAMPLE and BOWL WEIGHT in AIR, g	A		
BOWL WEIGHT in AIR, g	B		
SAMPLE WEIGHT in AIR, g	C=A-B		
SAMPLE and BOWL in WATER, g	D		
BOWL in WATER, g	E		
SAMPLE in WATER, g	F=D-E		
VOLUME, cc	G=C-F		
G_{mm}	C/G		
G_{se}			

% ASPHALT BINDER			
ASPHALT SPECIFIC GRAVITY			
SAMPLE and BOWL WEIGHT in AIR, g	A		
BOWL WEIGHT in AIR, g	B		
SAMPLE WEIGHT in AIR, g	C=A-B		
SAMPLE and BOWL in WATER, g	D		
BOWL in WATER, g	E		
SAMPLE in WATER, g	F=D-E		
VOLUME, cc	G=C-F		
G_{mm}	C/G		
G_{se}			
AVERAGE G_{se}			

URCE AND GRADE OF ASPHALT CEMENT USED | DATE TESTED

STER | CHECKED BY

Michigan Department
of Transportation
1828 (N2/92)

ANGULARITY INDEX OF FINE AGGREGATES

MIX DESIGN NO.	MIX TYPE	CONTRACTOR

AGG. LAB #	AGGREGATE TYPE	PIT #	% OF MIX	BLEND WT. gram

Ws WEIGHT OF SAMPLE	Vt TOTAL VOLUME	Vsa SAMPLE VOLUME	Vs VOLUME SOLIDS Vt-100ml	Vv VOLUME VOIDS Vsa-Vs	e ANGULARITY VOID RATIO Vv/Vs	
						e, AVERAGE

ANGULARITY INDEX = 10*(e,avg-0.6) =

AGG. LAB #	AGGREGATE TYPE	PIT #	% OF MIX	BLEND WT. gram

Ws WEIGHT OF SAMPLE	Vt TOTAL VOLUME	Vsa SAMPLE VOLUME	Vs VOLUME SOLIDS Vt-100ml	Vv VOLUME VOIDS Vsa-Vs	e ANGULARITY VOID RATIO Vv/Vs	
						e, AVERAGE

ANGULARITY INDEX = 10*(e,avg-0.6) =

AGG. LAB #	AGGREGATE TYPE	PIT #	% OF MIX	BLEND WT. grams

Ws WEIGHT OF SAMPLE	Vt TOTAL VOLUME	Vsa SAMPLE VOLUME	Vs VOLUME SOLIDS Vt-100ml	Vv VOLUME VOIDS Vsa-Vs	e ANGULARITY VOID RATIO Vv/Vs	
						e, AVERAGE

ANGULARITY INDEX = 10*(e,avg-0.6) =

Michigan Department of Transportation
1923 (1/88)

FILE 300

SAMPLE IDENTIFICATION

Send samples to MDOT, M&T Laboratory, 8885 Ricks Rd., Lansing, Michigan 48909

SEE INSTRUCTIONS BELOW

CONTROL SECTION(S)	
JOB NO./P.O. NO.	DATE SAMPLED
LAB. NO.	DATE RECEIVED

NAME OF MATERIAL

SOURCE	ADDRESS/PIT NO.
MANUFACTURER	ADDRESS

SAMPLED FROM:

QUANTITY OF MATERIAL REPRESENTED BY SAMPLE

CONSIGNED TO:

SAMPLED BY:	TITLE
SUBMITTED BY:	TITLE

INTENDED USE

SPECIFICATION	SENDER'S SAMPLE I.D.

REMARKS:

INSTRUCTIONS

NOTE: **The ID is the sole basis for identification and distribution of the report.**

PLEASE BE ACCURATE

CONTROL SECTION NO. — Or General, Tested Stock or name of other Agency
JOB NO. — As given or PURCHASE ORDER NO. — If applicable
NAME OF MATERIAL — As shown in Standard Specifications; for Soils Testing use Soil or Granular Material as appropriate
SOURCE — Contractor, supplier, or producer (and pit name for aggregates); location for naturally occurring materials
ADDRESS — Address of source (city & state or county), include pit number for aggregates
MANUFACTURER — If appropriate
ADDRESS — Address of manufacturer if appropriate
SAMPLED FROM — Indentifiable lot or batch number, car or tank number, and/or specific location, project site, source, etc.
QUANTITY REPRESENTED — Number of gallons, tons, pieces, etc.
CONSIGNED TO — If sampled at source other than project, state to whom and where the material is to be shipped
SAMPLED BY — Name & Title if different from submitter
INTENDED USE — State material's use in general terms
SPECIFICATION — As called for. For Example:

Grade 35S, 19_____ Std Spec (for concrete test specimen) or
Class II, 19_____ Std Spec (for granular material) or
22A, 19_____ Std Spec (for aggregates) or
19_____ Std Spec (for block, steel bars, fencing, etc.)
Indicate if specification is a supplemental and if gradation or other property requirements have been modified

SENDERS SAMPLE ID — Sample number, test hole, etc., to identify sample (Not sender's name)
REMARKS — State special tests to be run, if sample is rush or resample, and if results are to be phoned, state to whom & phone number
INDICATE PURPOSE OF SAMPLE — Acceptance, Certification Verification, Independent Assurance, Information, etc.

Michigan Department
of Transportation
1849 (2/97)

BITUMINOUS MIX DESIGN CHECKLIST

ALL ITEMS MUST BE CHECKED OR FILLED IN AND VALID, OR THE REVIEW PROCESS WILL STOP.

COMPANY NAME	SUBMITTED BY	DATE	TIME

CONTROL SECTION	JOB NO.	MIX TYPE

PAPERWORK REVIEW

	YES	NO
Resubmittal	☐	☐
Blend % adds up to 100%	☐	☐
Pit numbers filled in	☐	☐
Pit numbers on the communication sheet correlate with the pit numbers on the sample identification sheets	☐	☐
Aggregate types filled in	☐	☐
Aggregate types on the communication sheet correlate with the aggregate types on the sample identification sheets	☐	☐
Master gradation range filled in	☐	☐
Combined gradation filled in	☐	☐
Crush count filled in	☐	☐
Angularity index filled in	☐	☐
Combined gradation meets specification	☐	☐
Crush count meets specification	☐	☐
Angularity index meets specification	☐	☐
Current L.A. Abrasion number and year filled in for each aggregate source	☐	☐
If this is a 11A - 13 - 13A mixture, does the sand ratio pass?	☐	☐
Does the mix pass fines/asphalt ratio?	☐	☐
For top course mixtures, are the AWI values from the nomographs?	☐	☐
Does the combined AWI value meet specification?	☐	☐
Is each sample submitted accompanied by a Sample Identification form (form 1923)?	☐	☐

SAMPLE SUBMITTAL

	YES	NO
3 - 5000 gram mixture samples at point closest to/or at optimum asphalt content Identify on form 1813 the asphalt content of the submitted mix.	☐	☐
2 - 1400 gram samples of blended aggregate NOTE: If RAP is used in the mix design, these aggregate samples are not required.	☐	☐
1 - 800 gram blended angularity index sample	☐	☐
Individual AWI samples	☐	☐
1 - 6700 gram mixture sample at optimum asphalt content	☐	☐

PAPERWORK

	YES	NO
Contractor's Bituminous Mix Design Communication (form 1820)	☐	☐
Contractor's Furnished Bituminous Mix Design Summary (form 1813)	☐	☐
Marshall Mix Design Worksheet (form 1822)	☐	☐
Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures (form 1806)	☐	☐
Contractor Furnished Mixed Design Data (form 1814)	☐	☐
Sample Identification (form 1923)	☐	☐
Documentation of Quality Control Testing of RAP Stockpiles	☐	☐

Project office review and signature	☐	☐

Asphalt cement grade used in the mixture ______________________________

Asphalt cement grade required for the project ______________________________

APPENDIX C

Superpave Mix Design Forms

CONTRACTOR'S SUPERPAVE BITUMINOUS MIX DESIGN COMMUNICATION

This information is required by the Michigan Department of Transportation for mix design. The CONTRACTOR is responsible for complete and accurate information on this form. Failure to supply this information will result in delay of Bituminous Paving.

Complete and return to Michigan Department of Transportation, Materials & Technology Division, P.O. Box 30049, Lansing, MI 48909.

MDOT 1855 N(2/97)

CONTROL SECTION	JOB NUMBER
CONTRACTOR	ROUTE & LOCATION
PLANT NUMBER	PLANT LOCATION
BITUMINOUS MIXTURE	

		AGG. A	AGG. B	AGG. C	AGG. D	AGG. E	AGG. F	CONTROL POINTS		RESTRICTED ZONE		COMBINED GRADATIO
PIT NUMBER												
AGGREGATE TYPE												
BLEND % (10% Minimum)												
AVERAGE GRADATION	P 37.5 mm											
	P 25.0 mm											
	P 19.0 mm											
	P 12.5 mm											
	P 9.50 mm											
	P 4.75 mm											
	P 2.36 mm											
	P 1.18 mm											
	P 0.60 mm											
	P 0.30 mm											
	P 0.15 mm											
	TOTAL P 0.075 mm											
CRUSH COUNT ½ SIDE												
L.A. ABRASION Value/Year												
NAA ANGULARITY INDEX (METHOD A)												
AWI NOMOGRAPH												
COARSE AGGREGATE BULK SPECIFIC GRAVITY												
FINE AGGREGATE BULK SPECIFIC GRAVITY												
FLAT & ELONGATED												

ASPHALT CEMENT SUPPLIER		GRADE	SPECIFIC GRAVITY
SUBMITTED BY:	NAME (Print or Type)	DATE	PHONE NUMBER
	SIGNATURE		( )

DATE REC'D BY LAB	PROJECT OFFICE NOTIFICATION (Signature)	DATE

Michigan Department of Transportation
1858 N(2/97)

SUBMITTED SUPERPAVE MIX DESIGN SUMMARY SHEET

CONTRACTOR		CONSULTANT
CONTROL SECTION I.D.	JOB NO.	TYPE OF MIXTURE
INITIAL GYRATIONS	DESIGN GYRATIONS	MAXIMUM GYRATIONS
DESIGN TEMPERATURE	MIXING TEMPERATURE	COMPACTOR TEMPERATURE

SUPERPAVE MIX PROPERTIES AT TESTED & OPTIMUM ASPHALT CONTENT

ITEM	TEST POINTS							RECOMMENDED OPTIMUM Regression Value at Optimum Asphalt Content
	TRIAL BLEND			4 POINT DESIGN				
	#1	#2	#3	FINAL		BLEND		
ASPHALT CONTENT (%)								
BULK SPECIFIC GRAVITY (Compacted)								
THEORETICAL MAXIMUM (S.G.)								
AIR VOIDS (%)								
VOIDS IN MINERAL AGGREGATE % (VMA)								
VOIDS FILLED WITH ASPHALT % (VFA)								
% G_{mm} @ N INITIAL								
% G_{mm} @ N DESIGN								
SPECIFIC GRAVITY OF COMBINED AGGREGATE G_{sb}								
FINES/EFF ASPHALT RATIO								

The submitted superpave mix design shall have a minimum of 3 trial blends and the final blend have 4 test points at 0.5 percent asphalt content increments. At least one full asphalt content (0.5%) above and below optimum asphalt content is required.

ASPHALT CONTENT OF SUBMITTED SUPERPAVE MIX DESIGN ______________________

ASPHALT SPECIFIC GRAVITY ______________________

Michigan Department
of Transportation
1851 N(1/97)

GYRATORY COMPACTED BULK SPECIFIC GRAVITY WORKSHEET

M·DOT METRIC

PROJECT NUMBER	DATE	MIX DESIGN NUMBER
CONTRACTOR		TYPE SAMPLE

ASPHALT %	SAMPLE	A WEIGHT IN AIR	B SSD WEIGHT	C WEIGHT IN WATER	D VOLUME OF SAMPLE (B-C)	E ACTUAL SPEC. GRAVITY (A/D)
					AVERAGE	

ASPHALT %						
					AVERAGE	

ASPHALT %						
					AVERAGE	

ASPHALT %						
					AVERAGE	

TESTER	CHECKED BY

ichigan Department
of Transportation
1806 (1/97)

THEORETICAL MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS PAVING MIXTURES MODIFIED ASTM D 2041 (RICE METHOD)

M·DOT METRIC

'ROJECT NUMBER	MIX DESIGN NUMBER

:ONTRACTOR

% ASPHALT BINDER			
ASPHALT SPECIFIC GRAVITY			
SAMPLE and BOWL WEIGHT in AIR, g	A		
BOWL WEIGHT in AIR, g	B		
SAMPLE WEIGHT in AIR, g	C=A-B		
SAMPLE and BOWL in WATER, g	D		
BOWL in WATER, g	E		
SAMPLE in WATER, g	F=D-E		
VOLUME, cc	G=C-F		
G_{mm}	C/G		
G_{se}			

% ASPHALT BINDER			
ASPHALT SPECIFIC GRAVITY			
SAMPLE and BOWL WEIGHT in AIR, g	A		
BOWL WEIGHT in AIR, g	B		
SAMPLE WEIGHT in AIR, g	C=A-B		
SAMPLE and BOWL in WATER, g	D		
BOWL in WATER, g	E		
SAMPLE in WATER, g	F=D-E		
VOLUME, cc	G=C-F		
G_{mm}	C/G		
G_{se}			

AVERAGE G_{se}

)URCE AND GRADE OF ASPHALT CEMENT USED	DATE TESTED
:STER	CHECKED BY

Michigan Department
of Transportation
1850 N(1/97)

FINE AGGREGATE ANGULARITY
NAA PROCEDURE (METHOD A)
ASTM C 1252

PROJECT NUMBER	DATE	MIX DESIGN NUMBER

CONTRACTOR	TESTER
AGGREGATE TYPE	**PIT NUMBER**

MASS OF SAMPLE (grams)	NET MASS OF FINE AGG. IN CYLINDER F (grams)	VOLUME OF CYLINDER V (mL)	BULK SPEC. GRAVITY OF FINE AGGREGATE G
190		100	
190		100	
190		100	

AVERAGE F =

UNCOMPACTED VOIDS
U =

$$U = [V-(F/G)]*[100/V]$$

STANDARD GRADATION

Retained	Mass (grams)
1.18mm sieve	44
600μm sieve	57
300μm sieve	72
150μm sieve	17
TOTAL	190

Michigan Department
of Transportation
1852 N(2/97)

COARSE AGGREGATE CRUSH CONTENT
ONE & TWO FACE CRUSH

M·DOT METRIC

PROJECT NUMBER	SAMPLE NUMBER
CONTRACTOR	SAMPLE DESCRIPTION
TESTER	DATE

SIEVE SIZES	ONE FACE CRUSH WEIGHT	TWO FACE CRUSH WEIGHT	UNCRUSHED WEIGHT	TOTAL WEIGHT
RETAINED ON 4.75mm				
9.5mm & ABOVE				
TOTAL FOR COLUMNS				
	A	B	C	T=A+B+C

% ONE FACE CRUSH	(A+B)/T		MINIMUM	
% TWO FACE CRUSH	B/T		MINIMUM	

FLAT & ELONGATED CONTENT

SIEVE SIZES	FLAT & ELONG. WEIGHT	NON FLAT & ELONGATED	
MATERIAL RETAINED ON 9.50mm & ABOVE SIEVES			
	F	G	H=F+G

% FLAT & ELONGATED	F/H		MAXIMUM	

REMARKS

Michigan Department
of Transportation
1860 N(2/97)

FINE AGGREGATE GRAVITY

CONTROL SECTION I.D.	JOB NO.	LAB NUMBER

AGGREGATE TYPE	SOURCE OF AGGREGATE	DATE

TEST NUMBER					
FLASK NUMBER					
PAN NUMBER					
A. Weight of Flask + SSD Agg.					
B. Weight of Flask					
C. = Weight of SSD Aggregate (A - B)					
D. Weight of Flask + SSD Agg. + H^2O					
E. Weight of Flask + H^2O					
F. = Weight of SSD Agg. in H^2O (D - E)					
G. Weight of Pan + Oven Dry Aggregate					
H. Weight of Pan					
J. = Weight of Oven Dry Aggregate (G - H)					
C - F (SSD Volume)					
J - F (Dry Agg. - Dry Weight)					
C - J (SSD - Dry Weight)					
Bulk Dry S.G. = J/(C - F)					AVERAGE
Bulk SSD S.G. = C/(C - F)					
Apparent S.G. = J/(J - F)					
Absorption, % = [(C - J)/J] x 100					

REMARKS:

TEST PERFORMED BY: ______________________

ichigan Department
of Transportation
1859 N(2/97)

COARSE AGGREGATE GRAVITY

ONTROL SECTION I.D.	JOB NO.	LAB NUMBER

GGREGATE TYPE	SOURCE OF AGGREGATE	DATE

TEST NUMBER					
BUCKET ID					
PAN ID					
. SSD Agg. + Bucket					
. Weight of Bucket					
. = Weight of SSD Aggregate (A - B)					
. Weight of SSD Agg. + Bucket in H^2O					
Weight of Bucket in H^2O					
= Weight of SSD Agg. in H^2O (D - E)					
Weight of Pan + Oven Dry Aggregate					
Weight of Pan					
= Weight of Oven Dry Aggregate (G - H)					
C - F (SSD Volume)					
J - F (Dry Agg. - Dry Weight)					
C - J (SSD - Dry Weight)					
Bulk Dry S.G. = J/(C - F)					AVERAGE
Bulk SSD S.G. = C/(C - F)					
Apparent S.G. = J/(J - F)					
Absorption, % = [(C - J) /J] x 100					

MARKS:

TEST PERFORMED BY: ______________________

Michigan Department of Transportation
1923 (1/88)

SAMPLE IDENTIFICATION

Send samples to MDOT, M&T Laboratory, 8885 Ricks Rd., Lansing, Michigan 48909
SEE INSTRUCTIONS BELOW

FILE 300

CONTROL SECTION(S)	
JOB NO./P.O. NO.	DATE SAMPLED
LAB. NO.	DATE RECEIVED

NAME OF MATERIAL	
SOURCE	ADDRESS/PIT NO.
MANUFACTURER	ADDRESS
SAMPLED FROM:	
QUANTITY OF MATERIAL REPRESENTED BY SAMPLE	
CONSIGNED TO:	
SAMPLED BY:	TITLE
SUBMITTED BY:	TITLE
INTENDED USE	
SPECIFICATION	SENDER'S SAMPLE I.D.

REMARKS:

INSTRUCTIONS

NOTE: The ID is the sole basis for identification and distribution of the report.
PLEASE BE ACCURATE

CONTROL SECTION NO. — Or General, Tested Stock or name of other Agency
JOB NO. — As given or PURCHASE ORDER NO. — If applicable
NAME OF MATERIAL — As shown in Standard Specifications; for Soils Testing use Soil or Granular Material as appropriate
SOURCE — Contractor, supplier, or producer (and pit name for aggregates); location for naturally occurring materials
ADDRESS — Address of source (city & state or county), include pit number for aggregates
MANUFACTURER — If appropriate
ADDRESS — Address of manufacturer if appropriate
SAMPLED FROM — Indentifiable lot or batch number, car or tank number, and/or specific location, project site, source, etc.
QUANTITY REPRESENTED — Number of gallons, tons, pieces, etc.
CONSIGNED TO — If sampled at source other than project, state to whom and where the material is to be shipped
SAMPLED BY — Name & Title if different from submitter
INTENDED USE — State material's use in general terms
SPECIFICATION — As called for. For Example:

Grade 35S, 19_____ Std Spec (for concrete test specimen) or
Class II, 19_____ Std Spec (for granular material) or
22A, 19_____ Std Spec (for aggregates) or
19_____ Std Spec (for block, steel bars, fencing, etc.)
Indicate if specification is a supplemental and if gradation or other property requirements have been modified

SENDERS SAMPLE ID — Sample number, test hole, etc., to identify sample (Not sender's name)
REMARKS — State special tests to be run, if sample is rush or resample, and if results are to be phoned, state to whom & phone number
INDICATE PURPOSE OF SAMPLE — Acceptance, Certification Verification, Independent Assurance, Information, etc.

en Department
ansportation
52 N(3/97)

SUPERPAVE MIX DESIGN CHECKLIST

ALL ITEMS MUST BE CHECKED OR FILLED IN AND VALID, OR THE REVIEW PROCESS WILL STOP.

PANY NAME	SUBMITTED BY	DATE	TIME

TROL SECTION	JOB NO.	MIX TYPE

PERWORK REVIEW

	YES	NO
submittal	☐	☐
nd % adds up to 100%	☐	☐
numbers filled in	☐	☐
numbers on the communication sheet relate with the pit numbers on the sample ntification sheets	☐	☐
gregate types filled in	☐	☐
gregate types on the communication sheet relate with the aggregate types on the sample ntification sheets	☐	☐
ster gradation range filled in	☐	☐
mbined gradation filled in	☐	☐
& 2 sided crush counts filled in & blend meets specification	☐	☐
mbined gradation meets specification	☐	☐
arity index filled in & meets specification	☐	☐
rrent L.A. Abrasion number and year filled in each aggregate source	☐	☐
es the mix pass fines/effective asphalt ratio?	☐	☐
es the combined AWI value meet specification?	☐	☐
each sample accompanied by a Sample ntification form (form 1923)?	☐	☐

MPLE SUBMITTAL

RGIN MIXES

	YES	NO
(*) gram samples of mixture @ point closest to/at optimum asphalt content MDOT wants the weight of the mix to compact to 115mm height at N max.)	☐	☐
2300 gram sample of mixture @ point closest to/at optimum asphalt content	☐	☐
1500 gram samples of mixture @ point closest to/at optimum asphalt content	☐	☐
5700 gram sample of mixture <u>@ optimum sphalt content</u>	☐	☐
1400 gram samples of blended aggregate	☐	☐

VIRGIN MIXES (cont.)

	YES	NO
1 - 190 gram blended angularity index sample (NAA Method A)	☐	☐
8 - TSR samples @ optimum asphalt content at 7% air voids	☐	☐
Individual Aggregate Wear Index (AWI) samples for each aggregate which requires an AWI value	☐	☐
1 - 2000 gram sample of blended virgin aggregate, 4.75mm sieve plus	☐	☐
1 - 1400 gram sample of blended virgin aggregate, 1.18 sieve minus	☐	☐
1 - 2000 gram sample of blended virgin aggregate on 2.36mm sieve NOTE: Only if this sieve has 25% or greater retained	☐	☐
1 - 1400 gram sample of blended aggregate, passing 4.75mm sieve	☐	☐

RAP MIXES

	YES	NO
1 - 2 - 4 - 6 (includes extracted RAP) - 7 - 8 - 9 - 10 - 11 & 12 for virgin mixes apply	☐	☐
2 - 1900 gram samples of mixture @ point closest to/at optimum asphalt content	☐	☐

DOCUMENTATION

	YES	NO
Form 1855 - Superpave Bituminous Mix Design Communication	☐	☐
Form 1923 - Sample Identification NOTE: Must be included in each sample package	☐	☐
Form 1858 - Superpave Mix Design Summary Sheet	☐	☐
Form 1806 - Theoretical Maximum Specific Gravity Worksheet	☐	☐
Form 1851 - Gyratory Compacted Bulk Specific Gravity Worksheet	☐	☐
Provide documentation of Quality Control Testing of RAP Stockpiles. This includes a minimum of 10 Theoretical Maximum Specific Gravities performed on stockpile. NOTE: Only if RAP is included in the mixture	☐	☐
Combined gradation plotted on 0.45 power gradation chart	☐	☐
Form 1859 - Coarse Aggregate Bulk Gravity	☐	☐
Form 1860 - Fine Aggregate Bulk Gravity	☐	☐
Mix Design Regression Analysis	☐	☐
3½ disk containing gyratory data (Pine Pave)	☐	☐

	YES	NO
ject office review and signature	☐	☐

phalt cement grade used in the mixture ______________________

phalt cement grade required for the project ______________________

APPENDIX D
PROJECT TEST DATA

Appendix D1

QC/QA Test Data
US-2 Dickinson Co.
<1 Million ESAL
3E1 and 4E1 Mixtures

FILE 300 ______

REPORT OF TEST

BITUMINOUS MIX DESIGN

1931 (N9/91)

Control Section: NH 22023
Job Number: 32295A
Mix Design No.: 97MD-166
Date: JULY 30, 1997

Sample Of: BITUMINOUS MIXTURE NO. 3E1
Date Tested: JULY 24, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	KOCH		1.025
1	COARSE	7/8X5/16	PIT # 22-08	43.0%	
2	COARSE	31A	PIT # 75-05	23.0%	
3	DENSE	3/8-SAND	PIT # 22-08	16.0%	
4	FINE	MAN SAND	PIT # 22-08	17.0%	
5	B.H. FINES		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 4.8 Air Voids = 4.0
Density lb/cu.ft = 153.0*
(kg/cu.m) =(2451.1) V.M.A. = 13.4
Theo.Max. Density= 159.4
(kg/cu.m) =(2553.1) V.F.A. = 70.2

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
1 IN (25.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100
3/4 IN (19.0mm)	96.7	100.0	100.0	100.0	100.0	98.6	90-100
1/2 IN (12.5mm)	60.3	100.0	99.9	100.0	100.0	82.9	90 MAX
3/8 IN (9.5mm)	39.4	99.0	95.9	99.8	100.0	73.0	
No. 4 (4.75mm)	10.8	39.0	79.4	94.6	100.0	43.4	
No. 8 (2.36mm)	4.5	2.0	64.6	59.2	100.0	23.8	23-49
No. 16 (1.18mm)	3.6	0.4	51.3	36.8	100.0	17.1	
No. 30 (600µm)	3.2	0.4	37.7	24.0	100.0	12.6	
No. 50 (300µm)	2.9	0.4	18.8	15.0	100.0	7.9	
No. 100 (150µm)	2.3	0.2	8.0	7.8	100.0	4.6	
No. 200 (75µm)	2.3	0.1	4.7	4.5	100.0	3.5	2-8
CRUSH RET.#4	82.1	100.0	34.7	94.2	0.0	84.0	65 Min.

Materials submitted by: BACCO CONSTRUCTION COMPANY Plant # 050-02 --(Contractor Furnished)

ANGULARITY INDEX = 45.5

* RECOMMENDED FIELD CONTROL DENSITY
EFFECTIVE SPECIFIC GRAVITY = 2.762

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: ROBERTS, N. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
KEN LAMBERT (2)
D. ANDREWS (4)

____
Bituminous Unit - Supervising Engineer

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/E ASPHA RATIO
@ OPTIMUM								
4.8	2.452	153	2.554	159.4	4.0	13.4	70.2	0.89
REGRESSION EVERY 0.1%								
4.2	2.430	151.6	2.578	160.9	5.7	13.7	57.9	1.05
4.3	2.434	151.9	2.574	160.6	5.4	13.6	60.0	1.02
4.4	2.438	152.1	2.570	160.4	5.1	13.5	62.1	0.99
4.5	2.442	152.4	2.566	160.1	4.8	13.5	64.2	0.96
4.6	2.446	152.6	2.562	159.9	4.5	13.4	66.3	0.94
4.7	2.449	152.8	2.558	159.6	4.3	13.4	68.3	0.91
4.8	2.452	153.0	2.554	159.4	4.0	13.4	70.2	0.89
4.9	2.455	153.2	2.550	159.1	3.7	13.4	72.2	0.87
5.0	2.458	153.4	2.546	158.9	3.5	13.4	74.2	0.85
5.1	2.460	153.5	2.542	158.6	3.2	13.4	75.9	0.83
5.2	2.462	153.6	2.538	158.4	3.0	13.4	77.7	0.81
5.3	2.464	153.8	2.534	158.1	2.8	13.4	79.5	0.79
5.4	2.466	153.9	2.530	157.9	2.5	13.5	81.2	0.77
5.5	2.468	154.0	2.527	157.7	2.3	13.5	82.7	0.75
5.6	2.469	154.1	2.523	157.4	2.1	13.5	84.2	0.74
5.7	2.470	154.1	2.519	157.2	1.9	13.6	85.7	0.72
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2

- (PG 58-28 – KOCH OIL) SP. GR. = 1.025

- EFFECTIVE SPECIFIC GRAVITY = 2.762

BULK AGGREGATE SPECIFIC GRAVITY = 2.696

DESIGN ESAL'S = <1.0

DESIGN TEMPERATURE = 39 degrees C

MIXING TEMPERATURE = 143 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 7 %Gmm = 85.8 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 76

MAXIMUM GYRATIONS = 117 %Gmm = 97.3 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

C

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION: NH 22023	JOB NO.: 32295A	PROJECT ENGINEER: Nancy Roberts	DATE EFFECTIVE: 8-29-97
CONTRACTOR: Bacco Cons'T Co.		PLANT LOCATION: Norway	PLANT NO.: 50-01

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3E1	97MD 166	13.4	4.0	153.0 ~~kg/m³~~	159.4 ~~kg~~/m³

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IV	2.762	N/A	☐ YES ☐ NO N/A

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	4.8	Coarse, 7/8 x 5/16	22-08	43.0
P 37.5 mm	JMF / Belt	coarse, 31A	75-05	23.0
P 25.0 mm	100.0 / 100.0	Dense, 3/8-Sand	22-08	17.0
P 19.0 mm	98.6 / 98.6	Fine, Man Sand	22-08	17.0
P 12.5 mm	82.9 / 82.9			
P 9.5 mm	73.0 / 73.0			
P 4.75 mm	43.4 / 43.2			
P 2.36 mm	23.8 / 23.4			
P 1.18 mm	17.1 / 16.6	RECLAIMED		
P 600 μm	12.6 / 12.0	FILLER		
P 300 μm	7.9 / 7.1	ASPHALT	Koch - Green Bay PG 58-28	4.8
P 150 μm	4.6 / 3.8	AWI (Spec.) N/A	AWI (Actual) N/A	ANGULARITY INDEX 45.5
P 75 μm	3.5 / 3.4	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	84.0	☐ BATCH PLANT ☒ DRUM PLANT		DUST. CORRECTION –

REMARKS:
Proposal original called for 3B in Pay Items. However Special Provision for Super Pave Plant Mixed Bituminous Mixtures on Page 59 Change this to a 3E1 Mixture

TRAVELLING MIX INSPECTOR (TMI) - Signature: [signature]

DATE: 8-29-97

Michigan Department
of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M•DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 22023	32295A	Nancy Roberts	9-16-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
Bacco	Loretto *	50-2 *

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3E1	97MD166	13.4	4.0	153.0 ~~kg/m³~~	159.4 ~~kg/m³~~

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER ☐ YES ☐ NO
IV	2.762	N/A	N/A

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	4.8	Coarse, 7/8 x 5/16	22-08	43.0
P 37.5 mm	JMF/Belt	Coarse, 31A	75-05	23.0
P 25.0 mm	100.0/100.0	Dense, 3/8 - SAND	22-08	17.0
P 19.0 mm	98.6/98.6	Fine, Man. Sand	22-08	17.0
P 12.5 mm	82.9/82.9			
P 9.5 mm	73.0/73.0			
P 4.75 mm	43.4/43.2			
P 2.36 mm	23.8/23.4			
P 1.18 mm	17.1/16.6	RECLAIMED		
P 600 μm	12.6/12.0	FILLER		
P 300 μm	7.9/7.1	ASPHALT	Koch-Green Bay PG 58-28	4.8
P 150 μm	4.6/3.8	AWI (Spec.) N/A	AWI (Actual) N/A	ANGULARITY INDEX 45.5
P 75 μm	3.5/3.4	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	84.0	☐ BATCH PLANT ☒ DRUM PLANT		DUST. CORRECTION

REMARKS:

This 1911 Reflects only the Change in Plant and Location as shown on the Previous 1911 date 8-29-97.

Compare Gradation Results to Belt Gradation

TRAVELLING MIX INSPECTOR (TMI) - Signature: Kenneth C [signature]

DATE: 9-16-97

US-2 Dickinson Co.

Contractors Quality Control Test Data 3E1 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1	4.35	86.61	98.27	78.5		
2	4.47	86.6	98.22	85.9		
3	4.27	86.23	98	82.2		
4	4.89	88.3	97.92	82.9		
5	5.37	85.81	97.43	83.8		
6	3.29	87.3	98.51	83		
7	5.78	86.04	97.38	82.9		
8	6.2	85.45	96.95	78.1		
9	4.64	86.6	97.89	82.7		
10	4.83	86.41	97.64	81.2		
11	4.73	89.72	97.98	86.4		
12	4.73	86.44	97.89	85		
13	4.86	88.05	97.14	81.1		
14	5.3	86.21	97.81	85		
15		85.44	97.19	83.3		
16		85.17	96.73	84.6		
17	4.93	87.2	97.95	86.7		
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
Average	4.84	86.68	97.70	83.14		
STD	0.6764	1.1582	0.4918	2.4558		

US-2 Dickinson Co.

Contractors Quality Control Test Data 3E1 Mixture

Sublot	75um	150mm	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	3.8	5.5	8.5	12.1	15.9	21.8	40	68.5	78.7	98.4	100
2	3.4	4.8	8.3	12.1	16	22.1	41.1	69.1	78.3	98.3	100
3	3.9	5.6	8.6	12.4	16.6	23	41.6	70.4	83.4	100	100
4	3.7	5.3	8.4	12.2	16.2	22.4	41.2	70.8	81.4	100	100
5	3.5	5.1	8.1	11.9	16.1	22.3	40.3	67.6	77.6	100	100
6	3.7	5.3	8.1	11.5	15.1	20.6	37.1	67.7	78.1	100	100
7	3.7	5.3	8.2	11.9	16.2	23.2	44.5	73.4	82.9	100	100
8	3.5	5	7.7	10.9	14.6	20.7	39.9	70.1	81.1	100	100
9	3.7	5.4	8.6	12.4	16.4	22.6	41.9	70.7	81.5	100	100
10	3.5	5.1	8.3	12.2	16.2	22.1	39.6	68.1	78.9	100	100
11	3.5	5.1	7.9	11.3	15.1	21.4	40.6	66.7	77	100	100
12	3.6	5.3	8.6	12.8	16	24.4	43.2	73	77.8	100	100
13	3.6	5.2	8.3	12.1	16.3	22.9	43.1	74.9	84.1	100	100
14	3.4	4.9	7.6	10.8	14.8	21.5	42.4	73	81.9	100	100
15	3.2	4.7	7.5	11	14.9	20.8	39.4	69.6	79.4	100	100
16	3.4	5	8	11.7	15.6	21.5	39.2	71.3	81.3	98.5	100
17	3.2	4.6	7.7	11.8	15.8	21	39.5	72.6	81.5	100	100
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											
Average	3.55	5.13	8.14	11.83	15.75	22.02	40.86	70.44	80.29	99.72	100.00
STD	0.194	0.2756	0.3606	0.5654	0.6195	1.0193	1.8100	2.3555	2.2036	0.6297	0

US-2 Dickinson Co.

Contractors Quality Control Test Data 3E1 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1	4.35	86.61	98.27	78.5		
2	4.47	86.6	98.22	85.9		
3	4.27	86.23	98	82.2		
4	4.89	88.3	97.92	82.9		
5	5.37	85.81	97.43	83.8		
6	3.29	87.3	98.51	83		
7	5.78	86.04	97.38	82.9		
8	6.2	85.45	96.95	78.1		
9	4.64	86.6	97.89	82.7		
10	4.83	86.41	97.64	81.2		
11	4.73	89.72	97.98	86.4		
12	4.73	86.44	97.89	85		
13	4.86	88.05	97.14	81.1		
14	5.3	86.21	97.81	85		
15		85.44	97.19	83.3		
16		85.17	96.73	84.6		
17	4.93	87.2	97.95	86.7		
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
Average	4.84	86.68	97.70	83.14		
STD	0.6764	1.1582	0.4918	2.4558		

US-2 Dickinson Co.

Contractors In Place Density Results 3E1 Mixture

sublot	core #1	core #2	core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	93.7	93.1	93.3	93.367						
2	91.9	91.3	91.5	91.567						
3	90.8	91.9	91	91.233						
4	92.6	92.6	91.5	92.233						
5	89.8	88.3	91.6	89.900	91.66	33.33	20.00	6.67	10.00	10.00
6	90	88.2	89.9	89.367	90.86					
7	89.2	86.3	87.2	87.567	90.06					
8	91.7	90.6	91.1	91.133	90.04					
9	92.3	92.7	93.2	92.733	90.14					
10	92.3	93.6	91	92.300	90.62	20.00	13.33	6.67	10.00	10.00
11	92.3	92	92.3	92.200	91.19					
12	92.7	91.1	90.4	91.400	91.95					
13	92.1	92.6	92.6	92.433	92.21					
14	94.2	92	93.5	93.233	92.31					
15	93.8	90.7	91.7	92.067	92.27					
16	90.3	91	92.9	91.400	92.11					
17	91.5	91.4	92.4	91.767	92.18	40.00	20.00	13.33	6.00	6.00
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
Average			91.5235							
STD			1.6381							
Bonus Lots						0	0	0		
Deduct Lots									0	3

US-2 Dickinson Co.
Contractors Mixture Price Adjustment Table 3E1 Mixture

	TMD				VMA				Voids			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
sublot	159.4	Avg.	Dev.	Dev.	13.4	Avg.	Dev.	Dev.	4.0	Avg.	Dev.	Dev.
1	1.34				0.26				0.6			
2	0.44				0.06				0.5			
3	0.22				0.16				0.38			
4	0.03				0.17				0.22			
5	0.71	159.37	0.548	0.028	0.48	13.09	0.226	0.31	0.21	3.64	0.382	0.36
6	0.16				0.68				0.91			
7	0.48				0.19				0.27			
8	0.03				0.69				0.81			
9	0.59				0.2				0.36			
10	0.08	159.41	0.268	-0.018	0.05	13.41	0.362	-0.01	0.13	4.032	0.496	-0.032
11	0.25				0.6				0.43			
12	0.09				0.36				0.3			
13	0.15				0.6				0.51			
14	0.16				0.06				0.23			
15	0.09	159.59			0.68	13.648			0.81	4.454		
16	0.78				0.26				1.02			
17	0.78	159.46	0.392	-0.062	0.4	13.75	0.4	-0.35	0.34	4.43	0.582	-0.43
SPEC			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			3				3				2	
Deduct Lots				0				0				0

US-2 Dickinson Co.

Contractors Mixture Price Adjustment Table 3E1 Mixture

	% A.C.				75um				% Crushed			
sublot	JMF 4.8	Lot Avg.	Abs. Dev.	Dev.	JMF 3.4	Lot Avg.	Abs Dev.	Dev.	JMF 84	Lot Avg.	Abs. Dev.	Dev.
1	0.04				0.4				5.5			
2	0.16				0				1.9			
3	0.07				0.5				1.8			
4	0				0.3				1.1			
5	0.31	4.792	0.116	0.008	0.1	3.66	0.26	-0.26	0.2	82.66	2.1	1.34
6	0.05				0.3				1			
7	0.19				0.3				1.1			
8	0.03				0.1				5.9			
9	0.22				0.3				1.3			
10	0.03	4.816	0.104	-0.016	0.1	3.62	0.22	-0.22	2.8	81.58	2.42	2.42
11	0.09				0.1				2.4			
12	0.05				0.2				1			
13	0.06				0.2				2.9			
14	0.57				0				1			
15	0	4.67			0.2	3.46			0.7	84.16		
16	0.27				0				0.6			
17	0.3	4.704	0.24	0.096	0.2	3.36	0.12	0.04	2.7	84.14	1.58	-0.14
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			3				3				3	
Deduct Lots				0				0				0

US-2 Dickinson Co.

MDOT Verification Test Data 3E1 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff AC	Fines/AC	VFA
3	160.1	154.06	3.75	12.58	4.53	3.66	1.392	70.191
8	159.31	149.18	4.8	14.2	4.83	3.97	1.160	66.197
15	159.93	149.88	5.3	14.11	4.6	3.73	0.696	62.438
Average	159.78	151.04	4.617	13.63	4.65	3.79	1.08	66.28
STD	0.4158	2.6387	0.7911	0.9104	0.1570	0.1584	0.3543	3.8770

MDOT Central Lab Test Data 3E1 Mixture

			AC Used	PG58-28	
LAB	Fines/AC	Eff. AC	%AC	Orig. Pen	Rec. Pen
7/2/1997	1.115	4.04	4.9	129	75
8/29/1997	1.487	3.43	4.3	145	68
9/6/1997	1.399	3.43	4.3	145	71
9/12/1997				133	
9/16/1997				130	
9/17/1997				137	
9/19/1997	1.631	3.13	4	134	100
9/27/1997	1.682	3.33	4.2		48
10/4/1997				136	
10/7/1997	1.457	3.43	4.3	138	76
Average	1.46	3.46	4.33	136.33	73.00
STD	0.2008	0.3038	0.3011	5.7445	16.7092

US-2 Dickinson Co.

MDOT Verification Test Data 3E1 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
3	3.6	5.2	8	12.1	16.7	24.5	44.1	71.3	81.4	99.3	100
8	3.1	4.8	7.4	11.2	15.3	22.4	42.8	71.4	79.7	100	100
15	1.1	2.8	5.6	9.7	13.8	20.1	38.4	64.3	77.4	98	100
Avg.	2.60	4.27	7.00	11.00	15.27	22.33	41.77	69.00	79.50	99.10	100.00
STD	1.322	1.2858	1.2490	1.2124	1.4503	2.2008	2.9872	4.0706	2.0075	1.0149	0.0000

MDOT Central Lab Test Data 3E1 Mixture

LAB	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
7/2/97	4.5	6.7	14.8	24	31.2	39.3	53.9	70.9	83.4	100	100
8/29/97	5.1	6.9	10.2	13.8	17.8	23.8	41.9	71.5	82.3	98.2	100
9/6/97	4.8	6.8	10.1	13.9	17.9	24	43.7	72.9	82.7	98.5	100
9/19/97	5.1	7.1	10	12.9	16.2	22.4	43	74.1	83.7	98.1	100
9/27/97	5.6	7.8	10.6	13.9	17.6	25	44.8	72.3	83.3	96.9	100
10/7/97	5	6.9	9.7	12.5	15.8	21.6	43	72.3	83.5	100	100
Avg.	5.02	7.03	10.90	15.17	19.42	26.02	45.05	72.33	83.15	98.62	100.00
STD	0.365	0.3983	1.9328	4.3669	5.8393	6.6188	4.4392	1.1129	0.5357	1.2023	0

US-2 Dickinson Co.

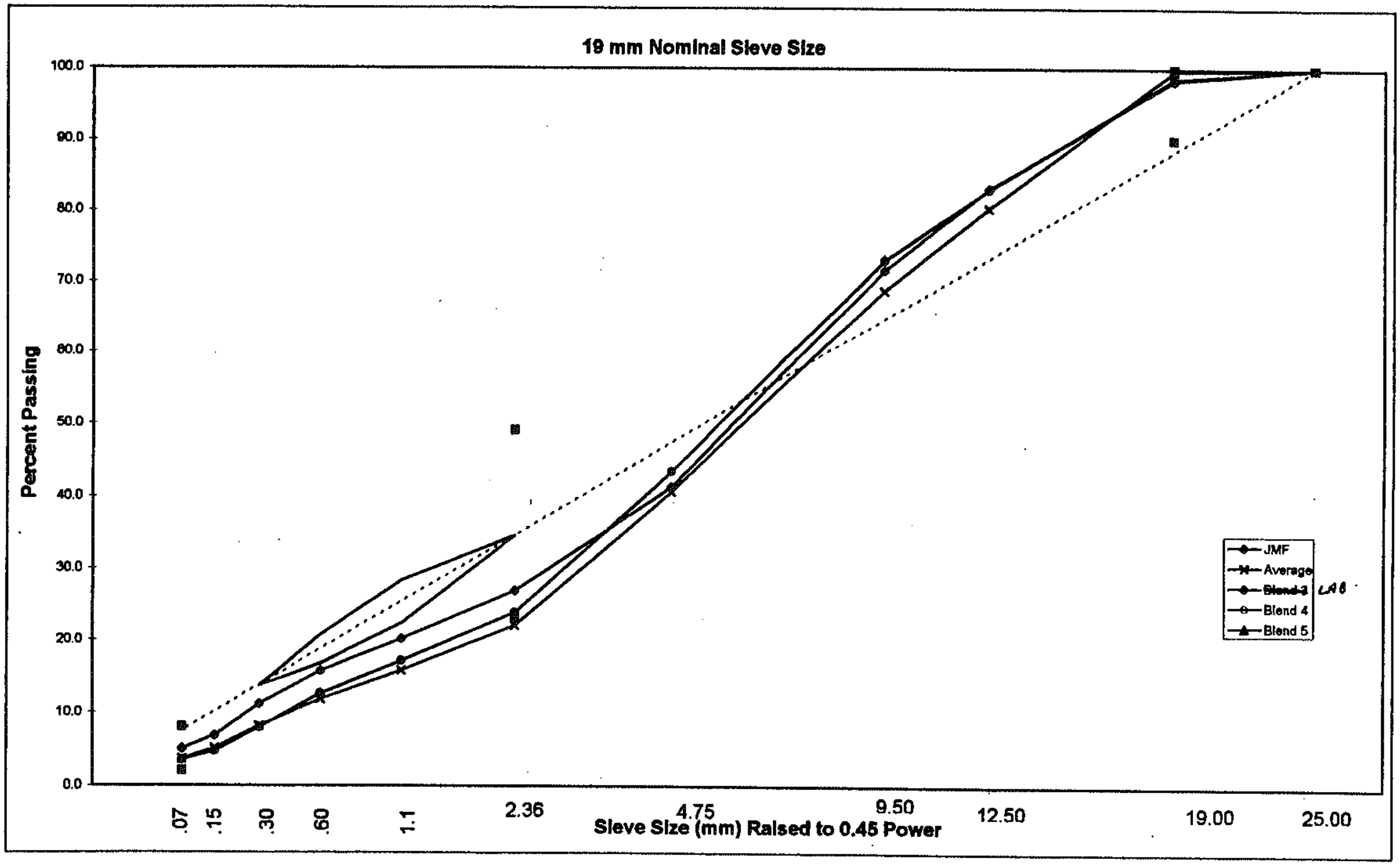
Film Thickness Table 3E1 Mixture

Gradation	DESIGN % Pass	PLANT % Pass	MDOT LAB % Pass
37.5	100	100	100
25	100	100	100
19	98.6	99.7	98.6
12.5	82.9	80.3	83.2
9.5	73	70.4	72.3
4.75	43.4	40.9	45.1
2.36	23.8	22	26
1.18	17.1	15.8	19.4
0.6	12.6	11.8	15.2
0.3	7.9	8.1	10.9
0.15	4.6	5.1	7
0.075	3.5	3.6	5
% AC	4.8	4.77	4.3
Film Thick.	0.00122	0.00118	0.00079

Aggregate Gradation Trials

Project Name: US-2 Bacco
Technician: Doug
Date: 1/0/00

Filename: US2B-3E1.XLS
Description: JMF/prod
Nominal Sieve Size: 19 mm



FAIL: Compacted Specific Gravity fails the tolerance limits established by MDOT on the Submitted Mix Design.

FILE 300 ______

MICHIGAN DEPARTMENT OF TRANSPORTATION

REPORT OF TEST

1931 (N9/91)

BITUMINOUS MIX DESIGN

Control Section: NH 22023
Job Number: 32295A
Mix Design No.: 97MD-241
Date: OCTOBER 7, 1997

Sample Of: BITUMINOUS MIXTURE NO. 4E1
Date Tested: OCTOBER 1, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	KOCH		1.025
1	COARSE GRADED	11/16 X 5/16	PIT # 22-08	27.0%	
2	COARSE GRADED	31 A	PIT # 75-05	20.0%	
3	FINE GRADED	MAN. SAND	PIT # 22-08	33.0%	
4	FINE GRADED	3/8 - SAND	PIT # 22-08	7.0%	
5	COARSE GRADED	5/8 - CHIP	PIT # 22-53	12.0%	
6	BH FINES		PLANT	1.0%	

NOTE: If the crush count falls below 94%, the AWI will fail.

MIX DESIGN

FAILED

Asphalt @ Optimum= 5.5 Air Voids = 4.0
Density lb/cu.ft = 151.6*
(kg/cu.m) =(2428.7) V.M.A. = 14.8
Theo.Max. Density= 157.9
(kg/cu.m) =(252[illegible]3) V.F.A. = [illegible]3

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	[illegible].0	100
1/2 IN (12.5mm)	80.9	100.0	100.0	99.9	9[illegible].2	100.0	[illegible].8	90-100
3/8 IN (9.5mm)	56.2	99.0	99.8	95.9	63.5	100.0	[illegible]3.2	90 MAX
No. 4 (4.75mm)	16.3	39.0	94.6	83.2	14.3	100.0	52.0	
No. 8 (2.36mm)	7.3	2.0	59.2	64.6	11.3	100.0	28.8	28-58
No. 16 (1.18mm)	4.3	0.4	36.8	51.3	8.1	100.0	18.9	
No. 30 (600µm)	3.8	0.4	24.0	37.7	6.6	100.0	13.5	
No. 50 (300µm)	3.4	0.4	15.0	18.8	4.4	100.0	8.8	
No. 100 (150µm)	2.8	0.2	7.8	8.0	3.7	100.0	5.4	
No. 200 (75µm)	2.0	0.1	4.5	4.7	3.4	100.0	3.8	2-10
CRUSH RET.#4	93.0	100.0	94.2	34.7	100.0	100.0	94.9	65 Min.
A.W.I.	263.6	170.0	266.3	232.2	365.0		260.9	260 Min.

Materials submitted by: BACCO CONSTRUCTION COMPANY Plant # 050-02 --(Contractor Furnished)
NOTE: THE 2.36MM SIEVE IS NEAR MINIMUM SPECIFICATION.

* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 46.1
EFFECTIVE SPECIFIC GRAVITY = 2.767

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC:

BIT. FILE

D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

MICHIGAN DEPARTMENT OF TRANSPORTATION

REPORT OF TEST

1931A (N9/91) BITUMINOUS MIX DESIGN

Control Section: NH 22023
Job Number: 32295A
Mix Design No.: 97MD-241
Mix Type: 4E1

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
5.5	2.43	151.6	2.53	157.9	4.0	14.8	73.3	0.83
REGRESSION EVERY 0.1%								
4.5	2.390	149.1	2.570	160.4	7.0	15.3	54.2	1.07
4.6	2.396	149.5	2.566	160.1	6.6	15.2	56.4	1.04
4.7	2.401	149.8	2.562	159.9	6.3	15.1	58.4	1.01
4.8	2.406	150.1	2.558	159.6	5.9	15.0	60.4	0.99
4.9	2.411	150.4	2.554	159.4	5.6	14.9	62.5	0.96
5.0	2.415	150.7	2.550	159.1	5.3	14.9	64.4	0.94
5.1	2.419	150.9	2.546	158.9	5.0	14.8	66.3	0.91
5.2	2.422	151.1	2.542	158.6	4.7	14.8	68.1	0.89
5.3	2.425	151.3	2.538	158.4	4.5	14.8	69.9	0.87
5.4	2.428	151.5	2.534	158.1	4.2	14.8	71.7	0.85
5.5	2.430	151.6	2.530	157.9	4.0	14.8	73.3	0.83
5.6	2.432	151.8	2.527	157.7	3.8	14.8	74.6	0.81
5.7	2.433	151.8	2.523	157.4	3.6	14.9	76.0	0.80
5.8	2.434	151.9	2.519	157.2	3.4	14.9	77.4	0.78
5.9	2.435	151.9	2.515	156.9	3.2	15.0	78.8	0.76
6.0	2.435	151.9	2.511	156.7	3.0	15.1	79.9	0.75
SPECIFICATIONS =					4%	14.0	65-78	0.6-1.2

- (PG 52-28 – KOCH OIL) SP. GR. = 1.025

- EFFECTIVE SPECIFIC GRAVITY = 2.767

BULK AGGREGATE SPECIFIC GRAVITY = 2.695

DESIGN ESAL'S = <1.0

DESIGN TEMPERATURE = 38 degrees C

MIXING TEMPERATURE = 143 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 7 %Gmm = 86.1 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 76

MAXIMUM GYRATIONS = 117 %Gmm = 97.8 SPECIFICATION = 98% MAX.

US-2 Dickinson Co.

Contractors Quality Control Test Data 4E1

G_b =1.025		G_{se} =2.767		G_{sb} =2.695		Absorb. =0.99		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	158.75	152.17	4.15	70.88	14.25	5.16	4.22	0.92
2	158.37	152.73	3.56	74.70	14.07	5.31	4.37	0.94
3	157.68	152.98	2.98	78.98	14.18	5.59	4.66	0.92
4	158.31	152.39	3.74	73.83	14.29	5.34	4.40	0.91
5	158.37	152.55	3.67	74.10	14.17	5.37	4.43	0.92
6	158.37	152.12	3.94	72.66	14.41	5.31	4.37	0.91
7	158.5	153.02	3.46	75.07	13.88	5.26	4.32	1.04
8	157.81	152.27	3.51	75.84	14.53	5.54	4.61	0.83
9	158.32	152.58	3.64	74.31	14.17	5.32	4.38	0.80
10	158.43	151.46	4.4	70.17	14.75	5.29	4.35	0.78
11	158.18	152.18	3.79	73.75	14.44	5.39	4.45	0.81
12	157.93	152.13	3.67	74.79	14.56	5.49	4.55	0.77
13	158.06	151.16	4.36	71.05	15.06	5.44	4.50	0.73
14	157.93	152.1	3.69	74.69	14.58	5.49	4.55	0.70
15	158.12	151.3	4.31	71.21	14.97	5.41	4.47	0.76
16	158	151.9	3.86	73.71	14.68	5.47	4.53	0.71
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
Average	158.20	152.19	3.80	73.73	14.44	5.39	4.45	0.84
STD	0.2820	0.5428	0.3727	2.2039	0.3249	0.1131	0.1142	0.0992

US-2 Dickinson Co.

Contractors Quality Control Test Data 4E1 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	3.9	5.7	8.8	12.5	17.1	24.9	48.2	80.4	92	100
2	4.1	6	9.6	14.1	19.5	28.1	50.3	80.3	91	100
3	4.3	6.3	10.2	14.8	20.2	28.8	52	84	94.7	100
4	4	5.9	9.4	13.6	19	28	51.6	81.9	93.1	100
5	4.1	6.1	10.1	14.9	21.1	31	54.1	81.2	91.3	100
6	4	5.9	9.5	14.3	20.2	29.4	51.9	81.6	92.3	100
7	4.5	6.4	9.8	14	19.2	27.6	49.8	79.4	92	100
8	3.8	5.9	10.9	17.7	23.6	30.4	49.2	82	93	100
9	3.5	5.3	9.8	15.4	20.4	26.4	44.8	80	92.8	100
10	3.4	5	9	14.6	19.7	25.9	43.6	76.4	91.1	100
11	3.6	5.3	9.5	15.5	21	27.5	46.7	80.1	92.7	100
12	3.5	5.2	9.1	14.5	19.5	27.4	45.6	77.3	90.8	100
13	3.3	4.8	8.4	13.8	18.9	27.6	45.9	80.1	91.2	100
14	3.2	4.7	8.3	13.8	18.7	26.4	46.8	78.3	90.4	100
15	3.4	5.1	9.3	15.4	21.1	27.9	46.7	80.8	92.7	100
16	3.2	4.8	8.7	14.3	19.3	25.2	43.3	76.7	90	100
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
Average	3.74	5.53	9.40	14.58	19.91	27.66	48.16	80.03	91.94	100.00
STD	0.4047	0.5639	0.6870	1.1346	1.4261	1.7009	3.2422	2.0476	1.2137	0

US-2 Dickinson Co.

Contractors Quality Control Test Data 4E1 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1	5.54	86.27	97.44	93.8		
2	4.96	86.81	97.91	95.3		
3	4.51	87.45	98.62	98.2		
4		86.66	97.75	91.7		
5		88.4	98.11	92		
6		86.13	97.84	91.9		
7		86.53	98.15	91		
8		87.33	98.1	91.9		
9		87.19	97.63	91.1		
10		86.83	97.4	88.9		
11		87.22	97.52	90.1		
12	4.66	87.37	97.63	88.6		
13	5.65	86.89	97.24	89.3		
14	5.34	87.16	97.79	88.2		
15	5.64	88.91	97.28	88.5		
16		87.4	97.59	89.5		
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
Average	5.19	87.16	97.76	91.25		
STD	0.4752	0.7129	0.3652	2.7141		

US-2 Dickinson Co.

Contractors In Place Density Results 4E1 Mixture

Sublot	core #1	core #2	core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	89.9	93	89.9	90.933						
2	90.5	90.9	89.5	90.300						
3	91.4	90.7	92.5	91.533						
4	92.1	93.7	91.4	92.400						
5	92.7	90.5	89.1	90.767	91.19	20.00	6.67	6.67	10.00	8.00
6	92.4	90.7	91.6	91.567	91.31					
7	90.3	90.2	91.5	90.667	91.39					
8	89.8	92.2	91.2	91.067	91.29					
9	91	93.1	95.4	93.167	91.45					
10	92.1	94.6	92.4	93.033	91.90	20.00	20.00	13.33	8.00	4.00
11	93.5	92.1	92.1	92.567	92.10					
12	93.4	93.3	93.6	93.433	92.65					
13	93.8	92	94.4	93.400	93.12					
14	95.2	92.1	93.4	93.567	93.20					
15	92.3	93.2	93	92.833	93.16	66.67	60.00	26.67	0.00	0.00
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
Average			92.0822							
STD			1.5282							
Bonus Lots						0	0	0	0	
Deduct Lots										2

US-2 Dickinson Co.
Contractors Mixture Price Reduction Table 4E1 Mixture

	TMD				VMA				Voids			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	157.9	Avg.	Dev.	Dev.	14.8	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.
1	0.85				0.55				0.15			
2	0.47				0.73				0.44			
3	0.22				0.62				1.02			
4	0.41				0.51				0.26			
5	0.47	158.29	0.484	0.396	0.63	14.192	0.608	0.608	0.33	3.62	0.44	0.38
6	0.47				0.39				0.06			
7	0.6				0.92				0.54			
8	0.09				0.27				0.49			
9	0.42				0.63				0.36			
10	0.53	158.28	0.422	0.386	0.05	14.348	0.452	0.452	0.4	3.79	0.37	0.21
11	0.28				0.36				0.21			
12	0.03				0.24				0.33			
13	0.16				0.26				0.36			
14	0.03				0.22				0.31			
15	0.22	158.04			0.17	14.722			0.31	3.964		
16	0.1	158.00	0.108	0.108	0.12	14.77	0.202	0.03	0.14	3.978	0.29	0.022
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			3				2				3	
Deduct Lots				0				1				0

US-2 Dickinson Co.

Contractors Mixture Price Adjustment Table 4E1 Mixture

	% A.C.				75um				% Crushed			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
sublot	4.8	Avg.	Dev.	Dev.	3.4	Avg.	Dev.	Dev.	84	Avg.	Dev.	Dev.
1	0.04				0.4				5.5			
2	0.16				0				1.9			
3	0.07				0.5				1.8			
4	0				0.3				1.1			
5	0.31	4.792	0.116	0.008	0.1	3.66	0.26	-0.26	0.2	82.66	2.1	1.34
6	0.05				0.3				1			
7	0.19				0.3				1.1			
8	0.03				0.1				5.9			
9	0.22				0.3				1.3			
10	0.03	4.816	0.104	-0.016	0.1	3.62	0.22	-0.22	2.8	81.58	2.42	2.42
11	0.09				0.1				2.4			
12	0.05				0.2				1			
13	0.06				0.2				2.9			
14	0.57				0				1			
15	0	4.67			0.2	3.46			0.7	84.16		
16	0.27				0				0.6			
17	0.3	4.704	0.24	0.096	0.2	3.36	0.12	0.04	2.7	84.14	1.58	-0.14
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			3				3				3	
Deduct Lots				0				0				0

US-2 Dickinson Co.

MDOT Verification Test Data 4E1 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	Fines/AC	VFA
1	158.87	151.68	4.6	14.48	5.11	4.17	0.911	68.23
7	157.93	153.07	3.1	13.99	5.49	4.55	0.944	77.84
Average	158.4	152.38	3.85	14.24	5.30	4.36	0.93	73.04
STD	0.6647	0.9829	1.0607	0.3465	0.2687	0.2714	0.0233	6.7948

MDOT Central Lab Test Data

			AC Used	PG58-28	Koch
LAB	Fines/AC	Eff. AC	%AC	Orig. Pen	Rec. Pen
Average					
STD					

US-2 Dickinson Co.

MDOT Verification Test Data 4E1 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
1	3.8	5.8	8.7	12.8	17.7	26.7	51.4	81.1	92	100
7	4.3	6.5	9.8	14.8	20.5	30.4	54.8	82.9	93.6	100
Average	4.05	6.15	9.25	13.80	19.10	28.55	53.10	82.00	92.80	100.00
STD	0.3536	0.4950	0.7778	1.4142	1.9799	2.6163	2.4042	1.2728	1.1314	0.0000

MDOT Central Lab Test Data

LAB	75umm	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
Average										
STD										

US-2 Dickinson Co.
Film Thickness Table 4E1

Gradation	DESIGN % Pass	PLANT % Pass	MDOT LAB % Pass
37.5	100	100	
25	100	100	
19	100	100	
12.5	93.8	91.9	
9.5	83.2	80	
4.75	52	48.2	
2.36	28.8	27.7	
1.18	18.9	19.9	
0.6	13.5	14.6	
0.3	8.8	9.4	
0.15	5.4	5.5	
0.075	3.8	3.7	
% AC	5.5	5.39	
Film Thick.	0.00128	0.00123	

FILE 300 ______

1931 (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: NH 21024
Job Number: 31059A
Mix Design No.: 97MD-172
Date: AUGUST 5, 1997

Sample Of: BITUMINOUS MIXTURE NO. 3E3
Date Tested: JULY 31, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 52-28	PAYNE AND DOLAN		1.019
1	COARSE	6A	PIT # 75-05	15.0%	
2	COARSE	5/8 CHIP	PIT # 21-78	40.0%	
3	FINE	3/8 MINUS	PIT # 21-78	15.0%	
4	FINE	MAN SAND	PIT # 75-05	24.0%	
5	FINE	REJECT SAND	PIT # 21-89	5.0%	
6	DEG		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 4.9 Air Voids = 3.8
Density lb/cu.ft = 150.4*
(kg/cu.m) =(2409.1) V.M.A. = 13.5
Theo.Max. Density= 156.4
(kg/cu.m) =(2505.9) V.F.A. = 71.4

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
1 IN (25.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
3/4 IN (19.0mm)	81.5	100.0	100.0	100.0	100.0	100.0	97.2	90-100
1/2 IN (12.5mm)	36.7	76.5	100.0	100.0	98.6	100.0	81.0	90 MAX
3/8 IN (9.5mm)	14.0	42.2	100.0	100.0	91.8	100.0	63.6	
No. 4 (4.75mm)	3.6	4.5	79.0	98.4	79.6	100.0	42.8	
No. 8 (2.36mm)	2.2	2.1	49.4	66.6	67.4	100.0	28.9	23-49
No. 16 (1.18mm)	1.8	1.8	31.7	37.9	57.0	100.0	18.7	
No. 30 (600µm)	1.6	1.8	21.3	21.7	45.5	100.0	12.6	
No. 50 (300µm)	1.4	1.7	15.6	12.4	28.1	99.0	8.6	
No. 100 (150µm)	1.3	1.7	11.1	6.5	10.9	98.0	5.6	
No. 200 (75µm)	1.2	1.1	9.9	3.7	6.1	75.0	4.0	2-8
CRUSH RET.#4	100.0	100.0	100.0	100.0	53.6		99.2	75 Min.

Materials submitted by: PAYNE & DOLAN, INC. Plant # 350-05 --(Contractor Furnished)
NOTE TO TMI: ELIMINATE THE DEG & INCREASE THE REJECT SAND TO 6%.

* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 42.5
EFFECTIVE SPECIFIC GRAVITY = 2.711
The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: BEDARD, J. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
KEN LAMBERT (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

wt

FILE 300 ____

1931 (N9/91)

REPORT OF TEST

BITUMINOUS MIX DESIGN

Control Section: NH 21024
Job Number: 31059A
Mix Design No.: 97MD-172
Date: AUGUST 5, 1997

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
4.9	2.41	150.4	2.507	156.4	4.0	13.5	71.4	0.98
REGRESSION EVERY 0.1%								
4.4	2.390	149.1	2.526	157.6	5.4	13.8	60.9	1.12
4.5	2.395	149.4	2.523	157.4	5.1	13.7	62.9	1.09
4.6	2.400	149.8	2.519	157.2	4.7	13.6	65.3	1.06
4.7	2.404	150.0	2.515	156.9	4.4	13.5	67.4	1.03
4.8	2.407	150.2	2.511	156.7	4.1	13.5	69.4	1.01
4.9	2.410	150.4	2.507	156.4	3.9	13.5	71.4	0.98
5.0	2.412	150.5	2.503	156.2	3.6	13.5	73.1	0.96
5.1	2.414	150.6	2.499	155.9	3.4	13.6	74.9	0.93
5.2	2.415	150.7	2.496	155.8	3.2	13.6	76.2	0.91
5.3	2.416	150.8	2.792	174.2	13.5	13.7	1.4	0.89
5.4	2.416	150.8	2.788	174.0	13.3	13.8	3.0	0.87
5.5	2.415	150.7	2.484	155.0	2.8	13.9	80.0	0.85
5.6	2.414	150.6	2.480	154.8	2.7	14.0	81.0	0.84
5.7	2.412	150.5	2.477	154.6	2.6	14.2	81.5	0.82
5.8	2.410	150.4	2.473	154.3	2.5	14.3	82.2	0.80
5.9	2.407	150.2	2.469	154.1	2.5	14.5	82.7	0.79
SPECIFICATIONS =					4.0%	13.0	65-78	0.6-1.2

- (PG 52-28 – PAYNE&DOLAN) SP. GR. = 1.019

- EFFECTIVE SPECIFIC GRAVITY = 2.711

BULK AGGREGATE SPECIFIC GRAVITY = 2.650

DESIGN ESAL'S = <3.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 132 degrees C

COMPACTION TEMPERATURE = 124 degrees C

INITIAL GYRATIONS = 7 %Gmm = 85.4 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 86

MAXIMUM GYRATIONS = 134 %Gmm = 97.6 SPECIFICATION = 98% MAX.

ichigan Department
of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

ONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
IH 21024 ETC	31059A ETC	Jack Bedard	9-8-97

ONTRACTOR	PLANT LOCATION	PLANT NO.
Payne & Dolan	Gladstone	350-05

YPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3E3	97MD172	13.5	3.8	150.4 ~~kg/m³~~	156.4 ~~kg/m³~~

ESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IV	2.711		☐ YES ☐ NO

MIX/AGG. GRADATION, %

ITEM	PERCENT
ASPHALT, %	4.9
P 37.5 mm	
P 25.0 mm	100.0
P 19.0 mm	97.2
P 12.5 mm	81.0
P 9.5 mm	63.6
4.75 mm	42.8
P 2.36 mm	28.9
P 1.18 mm	18.7
P 600 μm	12.6
P 300 μm	8.6
P 150 μm	5.6
P 75 μm	4.0
CRUSHED	99.2

MIX/AGG. BLEND PROPORTION, %

MATERIAL/PRODUCER	PIT NO.	PERCENT
Coarse, 6A	75-05	15.0
Coarse, 5/8 Chip	21-78	40.0
Fine, 3/8 Minus	21-78	15.0
Fine, Man. Sand	75-05	24.0
Fine, Reject Sand	21-89	6.0
RECLAIMED		
FILLER -		
ASPHALT	PED Gladstone P.G. 52-28	4.9

AWI (Spec.)	AWI (Actual)	ANGULARITY INDEX
N/A	N/A	42.5

TYPE OF TESTING: ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING

☒ BATCH PLANT ☐ DRUM PLANT

DUST. CORRECTION:

MARKS:

VELLING MIX INSPECTOR (TMI) - Signature: Glenn [signature]

DATE: 9-8-97

US-2 Delta Co.

Contractors Quality Control Test Data — 3E3 Mixture

G_b =1.019		G_{se} =2.711		G_{sb} =2.65		Absorb =0.87		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	156.56	153.44	3.55	72.92	13.11	4.85	4.03	1.01
2	156.12	153.5	3.32	75.06	13.31	5.03	4.21	0.74
3	156.36	153.13	3.69	72.50	13.42	4.93	4.11	0.95
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
Average	156.35	153.36	3.52	73.49	13.28	4.94	4.11	0.90
STD	0.2203	0.1986	0.1868	1.3692	0.1572	0.0902	0.0910	0.1393

US-2 Delta Co.

Contractors Quality Control Test Data 3E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	4.06	5.6	9.06	13.43	19.28	29.72	42.8	64.67	77.36	93.74	100
2	3.13	4.51	7.72	11.88	17.2	25.87	38.13	59.19	76.6	96.15	100
3	3.91	5.28	8.77	13.1	18.49	27.97	42.78	65.07	81.67	96.51	100
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											
Ave.	3.70	5.13	8.52	12.80	18.32	27.85	41.24	62.98	78.54	95.47	100.00
STD	0.499	0.5602	0.7050	0.8164	1.0499	1.9276	2.6904	3.2854	2.7343	1.5061	0

US-2 Delta Co.

Contractors Quality Control Test Data 3E3 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1				98.1		
2				99.4		
3				98.7		
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
average				98.73		
STD				0.650640		

US-2 Delta Co.

Contractors In Place Density Results 3E3 Mixture

sublot	Core #1	Core #2	Core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1				#DIV/0!						
2				#DIV/0!						
3				#DIV/0!						
4				#DIV/0!						
5				#DIV/0!	#DIV/0!	0.00	0.00	0.00		
6				#DIV/0!	#DIV/0!					
7				#DIV/0!	#DIV/0!					
8				#DIV/0!	#DIV/0!					
9				#DIV/0!	#DIV/0!					
10				#DIV/0!	#DIV/0!	0.00	0.00	0.00		
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
Average										
STD										
Bonus Lots										
Deduct Lots										

US-2 Delta Co.

Contractors Mixture Price Adjustment Table 3E3 Mixture

	TMD				VMA				VOIDS			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	156.4	Avg.	Dev.	Dev.	13.5	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.
1	0.16				0.39				0.45			
2	0.28				0.19				0.68			
3	0.04	156.34	0.16	0.053	0.08	13.28	0.22	0.22	0.31	3.52	0.48	0.48
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots												
Deduct Lots												

US-2 Delta Co.

Contractors Mixture Price Adjustment Table — 3E3 Mixture

	% A.C				75um				% Crushed			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	4.9	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.	99.2	Avg.	Dev.	Dev.
1	0.05				0.06				1.1			
2	0.13				0.87				0.2			
3	0.03	4.93	0.07	0.03	0.09	3.7	0.34	0.3	0.5	98.73	0.6	0.46
4												
5												
6												
7												
8												
9												
10												
11												
12												
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots												
Deduct Lots												

US-2 Delta Co.

MDOT Verification Test Data 3E3 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff AC	Fines/AC	VFA
1	156.48	153.55	3.57	13.19	4.88	4.06	1.181	72.934
average	156.48	153.55	3.57	13.19	4.88	4.06	1.18	72.93
STD								

MDOT Central Lab Test Data 3E3 Mixture

		AC Used	PG52-28		
LAB	%AC	Eff AC	Orig. Pen	Rec. Pen	Fines/AC
9/13/97	4.7	3.88	202	105	1.16
Average	4.70	3.88	202.00	105.00	1.16
STD					

US-2 Delta Co.

MDOT Verification Test Data 3E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	4.79	6.32	10.03	14.56	20.73	32.76	51.78	73.39	85	97.31	100
Avg.	4.79	6.32	10.03	14.56	20.73	32.76	51.78	73.39	85.00	97.31	100.00
STD											

MDOT Central Lab Test Data 3E3 Mixture

LAB	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
9/13/97	4.5	6.2	9.9	14.3	20.2	30.6	47.9	70.2	85.9	97.1	100
Avg.	4.50	6.20	9.90	14.30	20.20	30.60	47.90	70.20	85.90	97.10	100.00
STD											

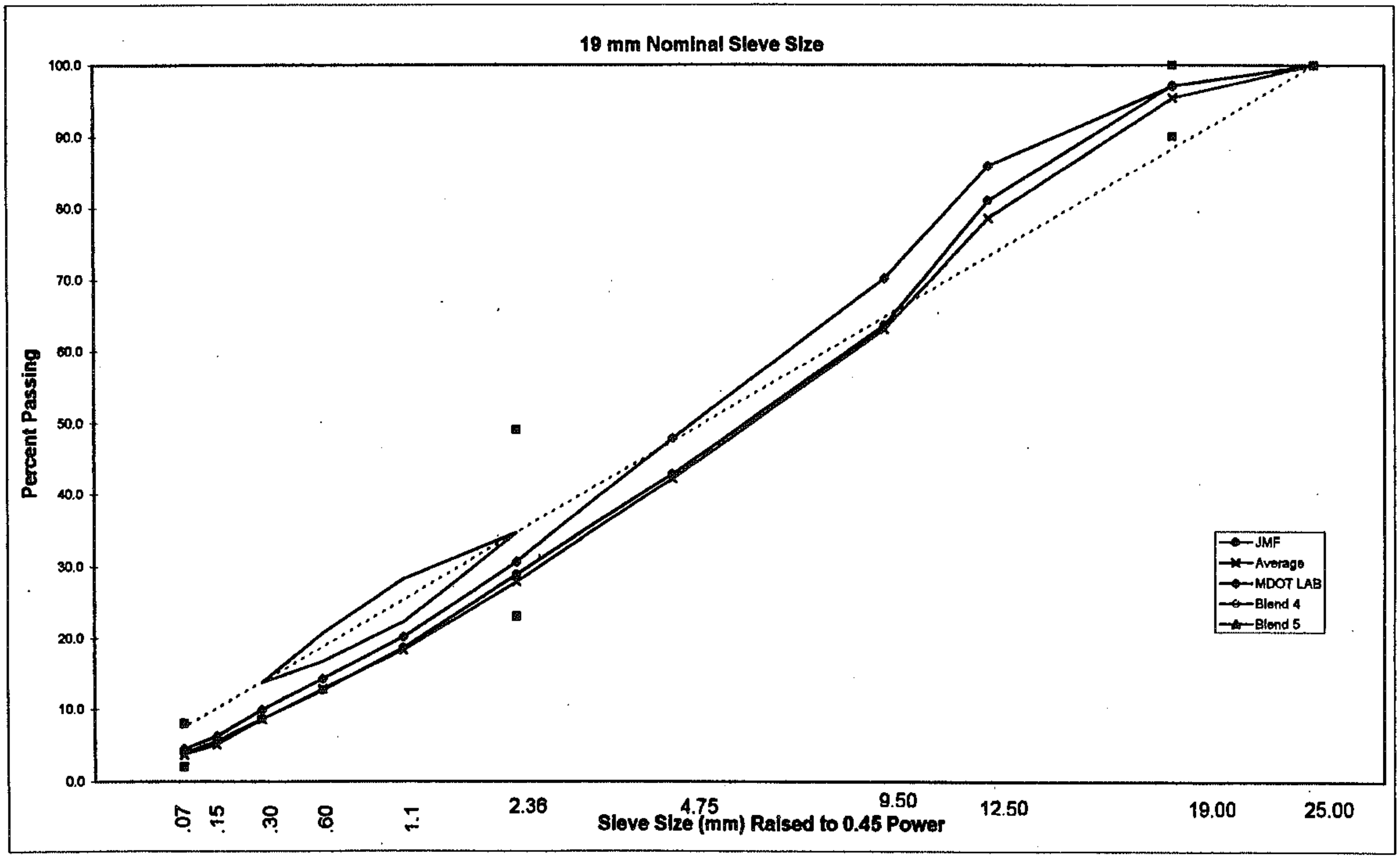
US-2 Delta Co.

Film Thickness Table 3E3 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	97.2	95.5	97.1
12.5	81	78.5	85.9
9.5	63.6	63	70.2
4.75	42.8	41.2	47.9
2.36	28.9	27.9	30.6
1.18	18.7	18.3	20.2
0.6	12.6	12.8	14.3
0.3	8.6	8.5	9.9
0.15	5.6	5.1	6.2
0.075	4	3.7	4.5
% AC	4.9	4.94	4.7
Film Thick.	0.00112	0.00118	0.00095

Project Name: US-2 P&D
Technician: Doug
Date: 1/0/00

Filename: US2P-3E1.XLS
Description: JMF/prod
Nominal Sieve Size: 19 mm



FILE 300 ____

REPORT OF TEST

BITUMINOUS MIX DESIGN

1931 (N9/91)

Control Section: NH 21024
Job Number: 31059A
Mix Design No.: 97MD-164
Date: JULY 30, 1997

Sample Of: BITUMINOUS MIXTURE NO. 4E3
Date Tested: JULY 24, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 52-28	PAYNE & DOLAN		1.019
1	COARSE	5/8 CHIP	PIT # 21-78	20.0%	
2	COARSE	5/8 CHIP	PIT # 52-36	25.0%	
3	FINE	3/8 MINUS	PIT # 21-78	10.0%	
4	FINE	MAN SAND	PIT # 75-05	39.0%	
5	DENSE	REJECT SAND	PIT # 21-89	5.0%	
6	DEG		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 5.5 Air Voids = 4.0
Density lb/cu.ft = 148.9*
(kg/cu.m) =(2385.7) V.M.A. = 14.8
Theo.Max. Density= 155.3
(kg/cu.m) =(2487.0) V.F.A. = 72.5

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
1/2 IN (12.5mm)	76.5	85.3	100.0	100.0	98.6	100.0	91.6	90-100
3/8 IN (9.5mm)	42.2	65.3	100.0	100.0	91.8	100.0	79.4	90 MAX
No. 4 (4.75mm)	4.5	6.4	79.0	98.4	79.6	100.0	53.8	
No. 8 (2.36mm)	2.1	2.5	49.4	66.6	67.4	100.0	36.3	28-58
No. 16 (1.18mm)	1.8	2.0	31.7	37.9	57.0	100.0	22.7	
No. 30 (600µm)	1.8	1.7	21.3	21.7	45.5	100.0	14.7	
No. 50 (300µm)	1.7	1.7	15.6	12.4	28.1	100.0	9.6	
No. 100 (150µm)	1.7	1.3	11.1	6.5	10.9	99.0	5.8	
No. 200 (75µm)	1.1	0.8	9.9	3.7	6.1	90.0	4.1	2-8
CRUSH RET.#4	100.0	100.0	100.0	100.0	53.6	0.0	99.0	75 Min.
A.W.I.	228.7	318.0	228.7	170.0	236.0	0.0	273.3	260 Min.

Materials submitted by: PAYNE & DOLAN, INC. Plant # 350-05 --(Contractor Furnished)
NOTE TO TMI: ELIMINATE THE DEG & INCREASE THE MAN SAND TO 40%.

* RECOMMENDED FIELD CONTROL DENSITY ANGULARITY INDEX = 43.3
EFFECTIVE SPECIFIC GRAVITY = 2.716
The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: BEDARD, J. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
KEN LAMBERT (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF ASPHALT RATIO
@ OPTIMUM 5.5	2.387	148.9	2.488	155.3	4.0	14.8	72.5	0.9
REGRESSION EVERY 0.1%								
4.4	2.349	146.6	2.531	157.9	7.2	15.2	52.6	1.18
4.5	2.353	146.8	2.527	157.7	6.9	15.1	54.4	1.15
4.6	2.356	147.0	2.523	157.4	6.6	15.1	56.1	1.12
4.7	2.359	147.2	2.519	157.2	6.4	15.1	57.8	1.09
4.8	2.363	147.5	2.515	156.9	6.0	15.0	59.7	1.06
4.9	2.366	147.6	2.511	156.7	5.8	15.0	61.5	1.03
5.0	2.370	147.9	2.507	156.4	5.5	14.9	63.4	1.01
5.1	2.373	148.1	2.503	156.2	5.2	14.9	65.2	0.98
5.2	2.376	148.3	2.500	156.0	5.0	14.9	66.7	0.96
5.3	2.380	148.5	2.496	155.8	4.6	14.9	68.7	0.94
5.4	2.383	148.7	2.492	155.5	4.4	14.8	70.5	0.92
5.5	2.387	148.9	2.488	155.3	4.1	14.8	72.5	0.90
5.6	2.390	149.1	2.484	155.0	3.8	14.8	74.4	0.88
5.7	2.394	149.4	2.481	154.8	3.5	14.7	76.2	0.86
5.8	2.397	149.6	2.477	154.6	3.2	14.7	78.0	0.84
5.9	2.401	149.8	2.473	154.3	2.9	14.6	80.1	0.82
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2

- (PG 52-28 – PAYNE & DOLAN) SP. GR. = 1.019

- EFFECTIVE SPECIFIC GRAVITY = 2.716

BULK AGGREGATE SPECIFIC GRAVITY = 2.647

DESIGN ESAL'S = <3.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 132 degrees C

COMPACTION TEMPERATURE = 124 degrees C

INITIAL GYRATIONS = 7 %Gmm = 85.4 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 86

MAXIMUM GYRATIONS = 134 %Gmm = 97.0 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 21024 et	31059A	J. Bedard	9-8-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
Payne & Dolan	Gladstone	350-05

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY ~~kg/m³~~	THEORETICAL MAX. DENSITY ~~kg/m³~~
4E3	97MO164	14.8	4.0	148.9	155.3

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IV	2.716		☐ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	5.5	Coarse, 5/8 Chip	21-78	20.0
P 37.5 mm		Coarse, 5/8 Chip	52-36	25.0
P 25.0 mm		Fine, 3/8 Minus	21-78	10.0
P 19.0 mm	100.0	Fine, Man-Sand	75-05	40.0
P 12.5 mm	91.6	Dense, Reject Sand	21-89	5.0
P 9.5 mm	79.4			
P 4.75 mm	53.8			
P 2.36 mm	36.3			
P 1.18 mm	22.7	RECLAIMED		
P 600 μm	14.7	FILLER		
P 300 μm	9.6	ASPHALT	P&D Gladstone, P.G. 52-28	5.5
P 150 μm	5.8	AWI (Spec.) 260	AWI (Actual) 273.3	ANGULARITY INDEX 43.3
P 75 μm	4.1	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	99.0	☒ BATCH PLANT ☐ DRUM PLANT	DUST. CORRECTION	

REMARKS:

TRAVELLING MIX INSPECTOR (TMI) - Signature: Kenneth Fink

DATE: 9-8-97

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M·DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 21024	31059A	J. Bedard	9-12-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
Payne & Dolan	Gladstone	350-05

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
4E3	97MD164Mod	14.2 *	4.0	149.1* kg/m³	155.6 kg/m³ *

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
II	2.716	9-6-97	☑ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	5.3 *	Coarse, 5/8 Chip	21-78	20.0
P 37.5 mm		Coarse, 5/8 Chip	52-36	25.0
P 25.0 mm		Fine, 3/8 Minus	21-78	10.0
P 19.0 mm	100.0	Fine, Mfg Sand	75-05	40.0
P 12.5 mm	91.6	Dense, Reject Sand	21-89	5.0
P 9.5 mm	79.4			
P 4.75 mm	54.0 *			
P 2.36 mm	36.3			
P 1.18 mm	22.7	RECLAIMED		
P 600 µm	14.7	FILLER		
P 300 µm	9.6	ASPHALT	PFO Gladstone ~~PG~~ 52-28	5.3 *
P 150 µm	5.8	AWI (Spec.) 260	AWI (Actual) 273.3	ANGULARITY INDEX
P 75 µm	4.1	TYPE OF TESTING ☑ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		DUST. CORRECTION
CRUSHED	99.0	☐ BATCH PLANT ☑ DRUM PLANT		

REMARKS:

* Denote Changes to JMF As Approved by P.E.

TRAVELLING MIX INSPECTOR (TMI) - Signature: [signature]

DATE: 10-14-97

US-2 Delta Co.

Contractors Quality Control Test Data 4E3 Mixture

G_b =1.019		G_{se} =2.716		G_{sb} =2.647		Absorb. =0.98		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	155.24	153	3.03	78.43	14.05	5.5	4.58	0.96
2	155.72	152.07	4	72.03	14.3	5.29	4.36	0.89
3	155	152.57	3.13	77.96	14.2	5.61	4.69	0.92
4	155.8	152.57	3.67	73.64	13.92	5.27	4.34	1.05
5	155.8	152.44	3.72	73.35	13.96	5.27	4.34	0.96
6	155.25	152.6	3.26	76.83	14.07	5.5	4.58	0.80
7	155.91	152.13	3.79	73.40	14.25	5.37	4.44	0.78
8	155.5	152.19	3.72	73.91	14.26	5.4	4.47	0.83
9	155.5	152.51	3.51	75.25	14.18	5.45	4.53	1.02
10	155.99	152.38	3.82	72.46	13.87	5.19	4.26	1.13
11	155.94	151.8	4.16	70.77	14.23	5.21	4.28	1.18
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
Average	155.60	152.39	3.62	74.37	14.12	5.37	4.44	0.96
STD	0.3302	0.3250	0.3546	2.4710	0.1505	0.1353	0.1366	0.1303

US-2 Delta Co.

Contractors Quality Control Test Data 4E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	4.38	5.95	10.21	15.73	23.18	36.48	54.38	75.22	89.6	100
2	3.87	5.24	8.97	14.45	21.93	35.93	55.82	78.67	92.32	100
3	4.29	5.81	9.81	15.38	22.83	36.98	56.67	78.49	92.48	100
4	4.55	6.09	10.02	15.49	23.09	37.21	57.62	80.19	91.99	100
5	4.17	5.68	9.59	15	22.41	36.14	54.67	75.35	87.8	100
6	3.65	5.11	9.03	14.44	21.95	35.54	54.23	78.19	93.65	100
7	3.48	4.89	8.6	13.63	20.6	32.83	49.29	72.39	88.91	100
8	3.72	5.11	8.94	14.58	22.28	36.82	56.07	78.41	89.83	100
9	4.62	6.04	9.6	14.86	22.45	35.76	52.79	75.61	89.23	100
10	4.83	6.2	9.64	15.19	22.95	36.95	54.89	78.99	92.69	100
11	5.04	6.75	10.14	16.66	25.89	40.39	56.73	81	92.57	100
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
Average	4.24	5.72	9.50	15.04	22.69	36.46	54.83	77.50	91.01	100.00
STD	0.5087	0.5706	0.5425	0.7989	1.2854	1.7760	2.2965	2.5468	1.9576	0

US-2 Delta Co.

Contractors Quality Control Test Data 4E3 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1				99.4		
2				98.2		
3				98.4		
4				99.4		
5				99.2		
6				98.2		
7				99.4		
8				99.1		
9				99.5		
10				99.4		
11				99.5		
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
average				99.06		
STD				0.5277		

US-2 Delta Co.

Contractors In Place Density Results — 4E3 Mixture

Sublot	Core #1	Core #2	Core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	93.1	93.1	93.1	93.100						
2	91.7	91.7	91.7	91.700						
3	94.4	94.4	94.4	94.400						
4	92.4	92.4	92.4	92.400						
5	92.2	92.2	92.2	92.200	92.76	40.00	40.00	20.00	3.00	0.00
6	93.8	93.8	93.8	93.800	92.90					
7	92.6	92.6	92.6	92.600	93.08					
8	92.5	92.5	92.5	92.500	92.70					
9	93.4	93.4	93.4	93.400	92.90					
10	92.9	92.9	92.9	92.900	93.04	80.00	40.00	20.00	0.00	0.00
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
Average			92.9							
STD			0.7732							
Bonus Lots						1	0	0		
Deduct Lots									0	0

US-2 Delta Co.

Contractors Mixture Price Adjustment Table 4E3 Mixture

	TMD				VMA				VOIDS			
Sublot	JMF 155.6	Lot Avg.	Abs Dev	Dev	JMF 14.2	Lot Avg.	Abs Dev	Dev	JMF 4	Lot Avg.	Abs Dev	Dev
1	0.36				0.15				0.97			
2	0.12				0.1				0			
3	0.6				0				0.87			
4	0.2				0.28				0.33			
5	0.2	155.51	0.296	0.088	0.24	14.086	0.154	0.114	0.28	3.51	0.49	0.49
6	0.35				0.13				0.74			
7	0.31				0.05				0.21			
8	0.1				0.06				0.28			
9	0.1				0.02				0.49			
10	0.39				0.33				0.18			
11	0.34	155.76	0.248	0.168	0.03	14.158	0.098	0.042	0.16	3.8	0.264	0.2
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			2				2				2	
Deduct Lots				0				0				0

US-2 Delta Co.

Contractors Mixture Price Adjustment Table 4E3 Mixture

	% AC				75um				Crushed			
Sublot	JMF 5.3	Lot Avg.	Abs. Dev.	Dev.	JMF 4.1	Lot Avg.	Abs. Dev.	Dev.	JMF 99	Lot Avg.	Abs. Dev.	Dev.
1	0.2				0.28				0.4			
2	0.01				0.23				0.8			
3	0.31				0.19				0.6			
4	0.03				0.45				0.4			
5	0.03	5.388	0.116	0.088	0.07	4.252	0.244	0.152	0.2	98.92	0.48	0.08
6	0.2				0.45				0.8			
7	0.07				0.62				0.4			
8	0.1				0.38				0.1			
9	0.15				0.52				0.5			
10	0.11				0.73				0.4			
11	0.09	5.324	0.104	0.024	0.94	4.338	0.638	0.238	0.5	99.38	0.38	0.38
12												
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			2				2				2	
Deduct Lots				0				0				0

US-2 Delta Co.

MDOT Verification Test Data 4E3 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	Fines/AC	VFA
2	155.69	151.32	4.4	14.7	5.32	4.39	0.915	70.07
8	155.35	152.82	3.23	13.93	5.45	4.53	0.871	76.81
11	155.86	152.7	3.46	13.67	5.24	4.31	1.122	74.69
average	155.6333	152.28	3.696666	14.10	5.34	4.41	0.97	73.86
STD	0.2597	0.8335	0.6199	0.5356	0.1060	0.1070	0.1343	3.4485

MDOT Central Lab Test Data

				PG52-28	
LAB	Fines/AC	Eff AC	%AC	Orig. Pen	Rec. Pen
9/8/97	1.100	4.27	5.2	213	112
9/10/97				205	
9/11/97	1.111	3.87	4.8	200	76
9/12/97	1.111	3.87	4.8		
9/12/97	0.982	3.97	4.9	189	103
9/15/97				202	
9/16/97				201	
Average	1.08	4.00	4.93	201.67	97.00
STD	0.062837	0.191148	0.189296	7.788880	18.73499

US-2 Delta Co.

MDOT Verification Test Data 4E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
2	4.02	5.44	9.19	14.7	22.11	35.74	54.6	79.52	91.75	100
8	3.94	5.49	9.33	14.78	22.22	36.79	56.96	79.25	92.83	100
11	4.84	6.07	9.52	15.98	24.74	39.26	55.72	77.59	90.35	100
Average	4.27	5.67	9.35	15.15	23.02	37.26	55.76	78.79	91.64	100.00
STD	0.4981	0.3502	0.1656	0.7170	1.4877	1.8071	1.1805	1.0451	1.2434	0.0000

MDOT Central Lab Test Data

LAB	75umm	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
9/8/97	4.7	6.3	10.5	15.8	22.5	36.3	55.8	79	92.3	100
9/11/97	4.3	5.8	9.9	14.9	22.5	36.6	54.1	74.8	92.2	100
9/12/97	4.3	6	9.9	14.9	25	35	54	76.6	92.8	100
9/12/97	3.9	5.4	8.9	13.5	21	34.8	53.8	75.7	93.4	100
Average	4.30	5.88	9.80	14.78	22.75	35.68	54.43	76.53	92.68	100.00
STD	0.3265	0.3774	0.6633	0.95	1.6583	0.9069	0.9251	1.8062	0.55	0

US-2 Delta Co.

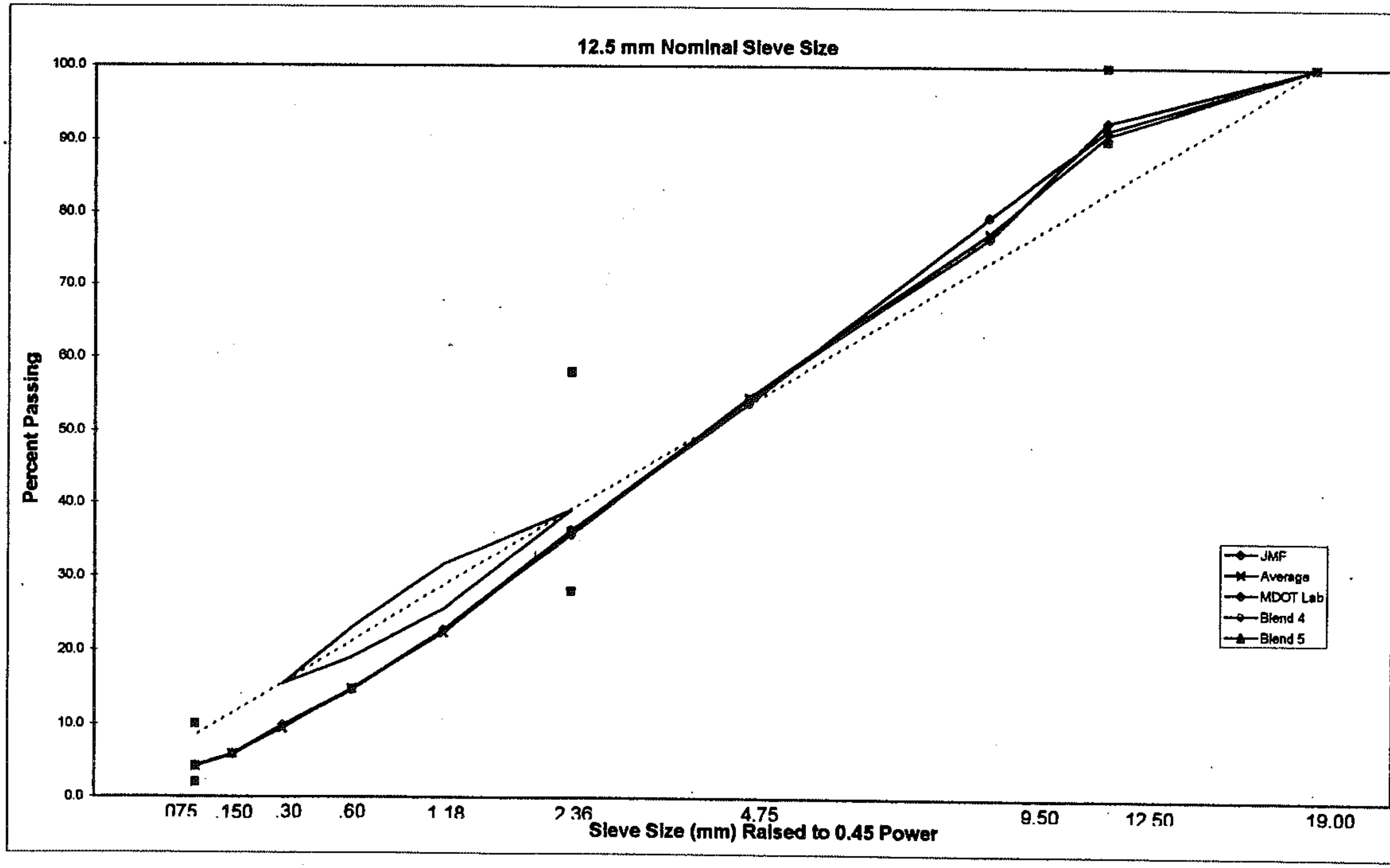
Film Thickness Table 4E3 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	100	100	100
12.5	91.6	91	92.7
9.5	79.4	77.5	76.5
4.75	53.8	54.8	54.4
2.36	36.3	36.5	35.7
1.18	22.7	22.7	22.8
0.6	14.7	15	14.8
0.3	9.6	9.5	9.8
0.15	5.8	5.7	5.9
0.075	4.1	4.2	4.3
% AC	5.5	5.37	4.9
Film Thick.	0.00117	0.00111	0.00098

Aggregate Gradation Trials

Project Name: US-2 P&D
Technician: Doug
Date: 11/11/97

Filename: US2P-4E.XLS
Description: 4E3
Nominal Sieve Size: 12.5 mm



Appendix D3

QC/QA Test Data
I-75 Cheboygan Co.
<3 Million ESAL
3E3 and 4E3 Mixtures

FILE 300

1931 (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: IM 16093
Job Number: 32510A
Mix Design No.: 97MD-131
Date: JUNE 25, 1997

Sample Of: BITUMINOUS MIXTURE NO. 3E3 --Recycled
Date Tested: JUNE 19, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 46-34	AMOCO	-	1.021
1	COARSE	3/4" - STONE	PIT # 16-52	20.0%	
2	COARSE	1/2" - STONE	PIT # 16-52	35.0%	
3	FINE	3/8" - SAND	PIT # 16-52	10.0%	
4	DENSE	1/2" - DENSE GR	PIT # 16-52	10.0%	
5	RAP		YARD	25.0%	

MIX DESIGN

Asphalt @ Optimum= 4.7 Air Voids = 4.0
Density lb/cu.ft = 149.1*
(kg/cu.m) =(2388.3) V.M.A. = 13.7
Theo.Max. Density= 155.4
(kg/cu.m) =(2488.7) V.F.A. = 70.5

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	90-100
1/2 IN (12.5mm)	32.5	100.0	100.0	96.5	100.0	86.2	90 MAX
3/8 IN (9.5mm)	5.5	82.5	100.0	86.5	83.0	69.4	
No. 4 (4.75mm)	2.5	24.0	93.0	65.5	53.0	38.0	
No. 8 (2.36mm)	2.0	6.0	78.0	54.0	35.0	24.4	23-49
No. 16 (1.18mm)	1.9	5.0	62.0	45.5	30.0	20.4	
No. 30 (600µm)	1.8	4.2	38.0	33.0	23.0	14.7	
No. 50 (300µm)	1.7	3.6	10.0	12.0	12.5	6.9	
No. 100 (150µm)	1.6	3.3	3.5	6.5	7.5	4.3	
No. 200 (75µm)	1.5	2.8	3.0	5.5	6.5	3.8	2-8
Crush Count Ret. 4.75mm ½ Side	97/92	99/94	10/2	65/55	99/95	95.4/90.3	75 MIN

Materials submitted by: H & D, INC. Plant # 210-03 --(Contractor Furnished)

RAP CONTAINS 4.6% ASPHALT - 3.6% NEW ASPHALT ADDED TO THE MIXTURE

PG 52-28 GRADE ASPHALT REQUIRED FOR THE PROJECT

* RECOMMENDED FIELD CONTROL DENSITY

ANGULARITY INDEX NUMBER = 42.8

EFFECTIVE SPECIFIC GRAVITY = 2.680

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: HILBERG, T (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
JOHN LIJEWSKI (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

FILE 300 _

MICHIGAN DEPARTMENT OF TRANSPORTATION

REPORT OF TEST

1931 (N9/91)

BITUMINOUS MIX DESIGN

Control Section: IM 16093
Job Number: 32510A
Mix Design No.: 97MD-131
Date: JUNE 25, 1997

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO	% ABSORBED ASPHALT	% EFFECTIVE ASPHALT CONTENT
@ OPTIMUM 4.7	2.389	149.1	2.49	155.4	4	13.7	70.5	0.92		
									Pba	Pbe
REGRESSION EVERY 0.1%										
4.0	1.273	79.4	2.516	157.6	49.4	53.7	8.0	1.11	0.592	3.4
4.1	2.377	148.3	2.513	156.8	5.4	13.6	60.3	1.08	0.592	3.5
4.2	2.380	148.5	2.509	156.6	5.1	13.6	62.2	1.05	0.592	3.6
4.3	2.382	148.6	2.505	156.3	4.9	13.6	63.9	1.02	0.592	3.7
4.4	2.385	148.8	2.501	156.1	4.6	13.6	65.9	0.99	0.592	3.8
4.5	2.387	148.9	2.497	155.8	4.4	13.6	67.7	0.97	0.592	3.9
4.6	2.388	149.0	2.494	155.6	4.3	13.7	68.9	0.94	0.592	4.0
4.7	2.389	149.1	2.490	155.4	4.1	13.7	70.5	0.92	0.592	4.1
4.8	2.390	149.1	2.486	155.1	3.9	13.8	72.0	0.90	0.592	4.2
4.9	2.391	149.2	2.482	154.9	3.7	13.8	73.5	0.88	0.592	4.3
5.0	2.391	149.2	2.479	154.7	3.5	13.9	74.5	0.86	0.592	4.4
5.1	2.391	149.2	2.475	154.4	3.4	14.0	76.8	0.84	0.592	4.5
5.2	2.390	149.1	2.471	154.2	3.3	14.1	76.8	0.82	0.592	4.6
5.3	2.389	149.1	2.468	154.0	3.2	14.3	77.6	0.80	0.592	4.7
5.4	2.388	149.0	2.464	153.8	3.1	14.4	78.6	0.79	0.592	4.8
5.5	2.386	148.9	2.460	153.5	3.0	14.6	79.3	0.77	0.592	4.9
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2		

- (PG 46-34 -- AMOCO OIL) SP. GR. = 1.021

- EFFECTIVE SPECIFIC GRAVITY = 2.680

BULK AGGREGATE SPECIFIC GRAVITY = 2.639

DESIGN ESAL'S = <3.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 143 degrees C 290°F

COMPACTION TEMPERATURE = 143 degrees C

INITIAL GYRATIONS = 7 %Gmm = 86.8 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 86

MAXIMUM GYRATIONS = 134 %Gmm = 97.6 SPECIFICATION = 98% MAX.

Absorpsion = 0.6%

$\frac{3.8}{x} = .92$

$x = \frac{3.8}{.92}$

4.1 Eff AC
4.7 Add
.6 Absorp

Michigan Department of Transportation 1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
IM 16093	32510A	T. Hilberg	6-26-97
CONTRACTOR		PLANT LOCATION	PLANT NO.
H+D INC		Indian River (Ronad Pit)	210-3

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY kg/m³	THEORETICAL MAX. DENSITY kg/m³
E3 + Rap	97MO 131	13.7 ±1.20	4.0 ±1.00	1491 ±1.60	1554 ±1.20

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IV		—	☐ YES ☐ NO

ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	4.7 ±0.50 EXTRACTED	3/4" Stone H+D Inc	16-52	20.0
P 37.5 mm		1/2" Stone "	16-52	35.0
P 25.0 mm		3/8" Sand "	16-52	10.0
P 19.0 mm	100.0	1/2" Dense Gr "	16-52	10.0
P 12.5 mm	86.2			
P 9.5 mm	69.4			
P 4.75 mm	38.0			
P 2.36 mm	24.4			
P 1.18 mm	20.4	RECLAIMED	RAP. Screened I75 millings	25.0
P 600 µm	14.7	FILLER		
P 300 µm	6.9	ASPHALT	P.G 46-34 Amoco Oil Co Elbenta	3.6
P 150 µm	4.3	AWI (Spec.) N/A	AWI (Actual) N/A	ANGULARITY INDEX 42.8
P 75 µm	3.8	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	95.4 / 90.3 ±15.0	☐ BATCH PLANT ☒ DRUM PLANT		DUST. CORRECTION N/A

REMARKS:

Contractor Began Production For This Project This Date

Option IV To Be Used with Belt Samples For Agg Gradation.

Personell From Lansing Mix Design Section At Plantsite Today.

TRAVELLING MIX INSPECTOR (TMI) - Signature: John [signature]

DATE: 6-26-97

I-75 Cheboygan Co.

Contractors Quality Control Test Data — 3E3 Mixture

G_b =1.021 G_{se} =2.68 G_{sb} =2.639 % Absorb. =0.6

SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	155.13	151.10	2.60	79.3	12.7	4.8	4.24	0.590
2	155.25	150.90	2.80	77.9	12.7	4.8	4.24	0.519
3	155.75	150.92	3.10	75.2	12.5	4.5	3.93	0.610
4	155.44	150.93	2.90	76.8	12.7	4.7	4.14	0.629
5	155.70	148.07	4.90	65.3	14.3	4.6	4.04	0.669
6	155.48	148.64	4.40	69.2	14.2	4.8	4.24	0.637
7	154.75	149.33	3.50	74.7	13.9	5	4.44	0.608
8	155.26	149.36	3.80	72	13.7	4.8	4.24	0.614
9	155.35	149.60	3.70	72.5	13.4	4.7	4.14	0.653
10	155.38	149.16	4.00	70.5	13.7	4.7	4.14	0.701
11	155.70	149.16	4.20	68.9	13.6	4.6	4.04	0.694
12	155.11	149.22	3.80	72.2	13.7	4.8	4.24	0.685
13	155.05	150.09	3.20	75.7	13.2	4.8	4.24	0.614
14	155.41	149.35	3.90	71.2	13.6	4.7	4.14	0.604
15	155.68	148.99	4.30	68.6	13.7	4.6	4.04	0.644
16	155.44	149.22	4.00	70.9	13.6	4.7	4.14	0.701
17	155.13	149.39	3.70	72.8	13.6	4.8	4.24	0.685
18	155.34	149.59	3.70	72.2	13.5	4.7	4.14	0.629
19	155.71	149.01	4.30	68.7	13.8	4.7	4.14	0.629
20	155.4	149.03	4.10	70.3	13.8	4.7	4.14	0.677
21	155.24	149.03	4.00	71.2	13.8	4.8	4.24	0.637
22	155.48	148.79	4.30	68.6	13.8	4.6	4.04	0.595
23	155.24	149.50	3.70	72.8	13.6	4.8	4.24	0.567
24	155.24	149.03	4.00	71	13.8	4.8	4.24	0.614
25	155.51	148.98	4.20	69.5	13.7	4.6	4.04	0.620
26	155.65	148.96	4.30	68.7	13.7	4.6	4.04	0.743
27	155.01	149.74	3.40	75	13.5	4.9	4.34	0.692
28	155.48	149.42	3.90	71.1	13.5	4.7	4.14	0.677
29	155.52	149.92	3.60	72.8	13.1	4.6	4.04	0.669
30	155.57	149.97	3.60	72.4	13.2	4.6	4.04	0.694
31	155.77	148.92	4.40	68	13.6	4.5	3.93	0.813
32	155.83	149.13	4.30	68.4	13.5	4.5	3.93	0.737
33	155.42	149.98	3.50	73.2	13.2	4.7	4.14	0.750
34	155.82	149.74	3.90	70.2	13.2	4.5	3.93	0.813
35	154.94	148.90	3.90	72.1	14	4.9	4.34	0.715
36	155.69	148.84	4.40	68.1	13.7	4.5	3.93	0.813
37	155.58	149.67	3.80	71.5	13.3	4.6	4.04	0.793
38	155.3	149.86	3.50	73.5	13.3	4.7	4.14	0.798
39	155.56	149.03	4.20	69.3	13.7	4.6	4.04	0.719
40	155.72	149.02	4.30	68.4	13.5	4.5	3.93	0.737
41	155.24	149.19	3.90	71.4	13.7	4.7	4.14	0.701
42	155.36	148.83	4.20	69.7	13.9	4.7	4.14	0.677
43	155.32	149.42	3.80	71.9	13.5	4.7	4.14	0.822
44	155.29	149.08	4.00	70.8	13.7	4.7	4.14	0.750
45	155.33	149.12	4.00	70.7	13.7	4.7	4.14	0.798
46	155.73	149.03	4.30	68.5	13.6	4.5	3.93	0.788
47	155.79	148.78	4.50	67.3	13.7	4.5	3.93	0.737
48	155.28	149.69	3.60	73.5	13.4	4.8	4.24	0.685
49	155.56	149.96	3.60	72.5	13.1	4.6	4.04	0.644
Average	155.43	149.40	3.88	71.37	13.53	4.68	4.12	0.69
STD	0.2479	0.6198	0.4561	2.7926	0.3640	0.1202	0.1209	0.0727

I-75 Cheboygan Co.

Contractors Quality Control Test Data 3E3 Mixture

Sublot	75um	150mm	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	2.50	3.10	5.80	14.10	18.30	21.20	29.50	65.20	84.60	100.00
2	2.20	2.80	5.40	12.90	16.40	18.90	26.30	62.50	83.80	100.00
3	2.40	2.90	5.30	13.10	16.50	19.20	26.10	62.20	84.10	100.00
4	2.60	3.20	6.30	15.20	19.80	22.30	30.90	64.30	83.40	100.00
5	2.70	3.80	5.40	10.50	14.20	17.10	27.80	65.10	80.70	100.00
6	2.70	3.40	5.30	11.70	14.90	17.80	27.60	64.30	80.20	100.00
7	2.70	3.30	4.50	9.20	12.40	15.30	27.30	66.20	82.10	100.00
8	2.60	3.30	5.20	10.90	14.50	17.40	29.50	66.20	81.90	100.00
9	2.70	3.60	6.10	10.80	13.70	16.20	27.90	65.40	82.20	100.00
10	2.90	3.40	5.80	11.00	14.20	16.70	29.40	64.40	81.40	100.00
11	2.80	3.40	5.50	13.00	17.60	20.50	29.30	65.90	84.30	100.00
12	2.90	3.70	6.20	13.90	18.60	21.90	30.30	66.60	84.50	100.00
13	2.60	3.30	5.00	12.40	17.30	20.40	28.80	65.10	83.70	100.00
14	2.50	2.90	4.60	10.70	14.70	17.80	27.00	62.00	81.50	100.00
15	2.60	2.90	4.60	10.20	15.50	19.80	29.40	62.30	82.10	100.00
16	2.90	3.40	5.30	12.20	16.90	20.60	31.50	67.70	83.90	100.00
17	2.90	3.50	5.50	11.80	16.50	20.00	30.30	66.30	83.20	100.00
18	2.60	3.10	4.90	12.30	17.10	20.30	28.70	63.10	82.90	100.00
19	2.60	3.10	4.70	12.40	17.30	20.50	28.80	62.70	82.50	100.00
20	2.80	3.30	4.80	9.50	12.70	16.00	27.90	62.90	80.80	100.00
21	2.70	3.30	4.90	10.40	13.70	16.60	29.60	63.50	81.40	100.00
22	2.40	3.10	5.40	12.30	17.40	19.80	29.40	62.70	82.70	100.00
23	2.40	3.00	5.30	11.90	16.80	21.00	30.60	63.50	84.50	100.00
24	2.60	3.20	5.50	12.80	17.50	20.80	31.50	68.00	84.10	100.00
25	2.50	3.00	4.30	10.90	16.80	18.90	29.30	65.40	83.30	100.00
26	3.00	3.60	6.10	14.00	19.40	23.20	34.10	68.40	85.60	100.00
27	3.00	3.50	5.70	9.10	16.70	20.10	30.80	66.90	85.40	100.00
28	2.80	3.40	5.70	9.30	16.30	19.50	30.50	66.10	84.50	100.00
29	2.70	3.20	5.10	10.70	14.70	18.50	29.80	60.60	80.10	100.00
30	2.80	3.40	5.20	11.30	16.70	20.70	32.70	63.30	82.20	100.00
31	3.20	3.20	5.90	12.70	17.00	20.60	33.70	66.60	85.40	100.00
32	2.90	3.50	5.60	12.00	16.20	19.50	30.20	64.20	79.20	100.00
33	3.10	3.70	5.60	10.90	14.00	17.00	30.20	65.10	83.20	100.00
34	3.20	3.70	5.60	11.10	14.40	17.40	30.80	66.40	82.60	100.00
35	3.10	3.70	5.50	10.90	13.90	16.80	30.00	65.90	82.40	100.00
36	3.20	3.80	5.80	11.60	15.00	18.10	28.80	64.90	84.30	100.00
37	3.20	3.80	5.90	12.80	17.50	21.20	33.10	68.70	84.10	100.00
38	3.30	4.00	6.30	13.50	18.10	22.00	34.80	70.70	86.50	100.00
39	2.90	3.50	5.40	11.00	14.80	18.10	29.10	64.60	82.80	100.00
40	2.90	3.50	5.60	11.50	14.60	17.50	28.40	63.60	82.10	100.00
41	2.90	3.50	5.60	11.50	15.30	18.70	29.70	64.70	82.80	100.00
42	2.80	3.40	5.60	11.60	15.40	18.40	28.90	63.70	81.90	100.00
43	3.40	4.10	6.50	13.10	17.20	20.80	33.30	69.70	87.10	100.00
44	3.10	3.80	6.10	10.70	14.10	18.00	30.00	63.30	84.00	100.00
45	3.30	3.90	5.90	12.40	16.30	19.50	29.80	63.10	80.20	100.00
46	3.10	3.50	5.50	12.30	16.20	19.40	29.90	62.80	80.50	100.00
47	2.90	3.40	5.60	12.40	16.80	20.00	29.90	63.10	79.70	100.00
48	2.90	3.50	5.80	12.20	15.90	19.10	31.60	67.20	85.10	100.00
49	2.60	3.30	5.50	10.60	15.10	18.00	31.70	64.40	84.10	100.00
Average	2.82	3.41	5.48	11.74	15.98	19.17	29.93	64.93	82.97	100.00
STD	0.2705	0.2981	0.4900	1.3198	1.6568	1.7969	1.8935	2.1219	1.7839	0

I-75 Cheboygan Co.

Contractors Quality Control Test Data — 3E3 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed
1	4.83	87.4	98.8	93.4	91.1
2	4.78	87.4	98.6	92.2	90
3	5.05	87	98.3	92.7	90.3
4	5.58	87.1	98.5	92.3	89.9
5	6.6	83.5	96.9	92.5	90.4
6	6.6	84.3	97.4	94.1	92
7	4.72	85.4	98.1	94.9	90
8	5.27	85.3	97.8	93.7	90.3
9	5.38	85.6	97.9	93.8	88.5
10	5.38	85.2	97.6	94.9	91.2
11	5.21	84.9	97.5	95.6	92
12	5.15	85.3	97.8	94.7	88.9
13	4.95	86.7	98.3	94.9	91.6
14	5.42	85.5	97.7	95.1	91.1
15	5.73	85.1	97.3	93.7	89.4
16	5.46	85	97.7	93.8	89.6
17	4.59	85.4	97.9	94.1	90
18	4.9	85.4	97.9	93.4	88.9
19	5.7	84.7	97.3	92.4	89.1
20	5.2	84.8	97.6	93	86.9
21	5	85.4	97.6	93.1	89.7
22	5.5	85	97.4	93.9	88.1
23	5.2	85.9	97.9	93.9	89.5
24	5.2	85.2	97.6	92.9	89
25	5.3	85.1	97.5	93.2	90.1
26	5.6	84.8	97.4	95.1	91.5
27	4.91	86.2	98.2	91.4	84.3
28		85.1	97.8	93.7	88.8
29	4.9	86	97.92	91.4	88.3
30	5.13	85.9	98	93.1	88.9
31	5.7	84.6	97.4	95.1	91.2
32	5.6	85	97.4	93.3	89.9
33	4.94	85.9	98.1	95	89.4
34	5.48	85.2	97.7	93.8	88.7
35	5.07	85.4	97.8	92.8	90.1
36	5.77	84.9	97.3	94.2	90
37	5.33	85.6	97.8	96.4	91.5
38		85.8	98.1	94.2	90.3
39	5.58	84.8	97.5	93.1	91.4
40	5.37	85.1	97.4	94.8	90.1
41	5.14	85	97.7	93.2	90
42	5.5	84.9	97.5	94.1	90
43	5.38	85.7	97.8	94.4	90.2
44	5.38	85.3	97.6	92.9	89.3
45	5.46	85.1	97.6	91	88.9
46	6.09	85.1	97.3	92.8	88.7
47	5.53	85	97.2	91.3	85.4
48	5.18	85.7	97.9	95.6	90.7
49	5.33	86.2	97.9	94	90.1
Average	5.34	85.43	97.74	93.65	89.70
STD	0.4075	0.7527	0.3753	1.1853	1.4728

I-75 Cheboygan Co.

Contractors In Place Density Results

3E3 Mixture

Sublot	core #1	core #2	core #3	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	93.8	94.6	95.2						
2	94.8	96.8	95.1						
3	96	95.9	96						
4	94.4	95.1	94.4						
5	91.3	94.7	92	94.67	86.67	86.67	86.67	1.00	0.00
6	93.5	92.6	93.8	94.43					
7	93.2	91.1	94.6	93.91					
8	91.4	92.1	92.4	93.11					
9	94.3	91.9	94.6	92.90					
10	94.4	95.4	96.6	93.46	66.67	60.00	46.67	3.00	0.00
11	93.3	93.5	91.9	93.38					
12	90.8	91.8	94.8	93.28					
13	92.6	93	92.6	93.43					
14	93.7	95	93.5	93.53					
15	94	94.4	94.3	93.28	80.00	60.00	40.00	3.00	1.00
16	93.1	93	93.8	93.36					
17	93.9	94.2	93.2	93.62					
18	93.2	93.9	93.8	93.80					
19	93.3	92.7	92.3	93.54					
20	93.3	94.4	93.9	93.47	93.33	80.00	46.67	0.00	0.00
21	92	93.9	95.2	93.55					
22	92.9	94.1	91.8	93.38					
23	93.1	94	92.8	93.31					
24	92.5	93.2	94.5	93.44					
25	93.5	94.2	93.3	93.40	80.00	66.67	40.00	1.00	0.00
26	93.2	93.5	94.6	93.41					
27	93.8	94.1	95.9	93.75					
28	94.4	95.7	94.1	94.03					
29	96.2	94.2	94.1	94.32					
30	92.8	93.3	93	94.19	100.00	86.67	66.67	0.00	0.00
31	93.1	93.3	95.3	94.22					
32	92.7	94.1	94.8	94.07					
33	94.9	96.2	92.9	94.06					
34	94.1	94.2	93.4	93.87					
35	92.4	93.7	92.2	93.82	86.67	73.33	53.33	0.00	0.00
36	94.9	95	95.4	94.06					
37	93.8	93.3	94.7	94.07					
38	92.2	91.8	93.6	93.65					
39	94.3	92.5	94.2	93.60					
40	92.7	93.9	95.2	93.83	80.00	73.33	66.67	1.00	0.00
41	92.5	93.4	94.9	93.53					
42	92.4	93.3	93.9	93.39					
43	95.1	93.5	93.5	93.69					
44	95.9	94.6	94.3	93.94					
45	93	94.9	95.1	94.02	86.67	80.00	53.33	0.00	0.00
46	93.8	92.3	92.5	93.87					
47	95	94.4	93.3	94.08					
48	90.4	94.4	93.6	93.83					
49	93.9	95.5	93.4	93.70	80.00	73.33	60.00	1.00	1.00
Average			93.77						
STD			1.2052						
Bonus Lots					9	4	1		

I-75 Cheboygan Co.

Contractors Mixture Price Adjustment Table 3E3 Mixture

	TMD				VMA				Voids			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	155.40	Avg.	Dev.	Dev.	13.70	Avg.	Dev.	Dev.	4.00	Avg.	Dev.	Dev.
1	0.27				1.00				1.40			
2	0.15				1.00				1.20			
3	0.35				1.20				0.90			
4	0.04				1.00				1.10			
5	0.30	155.45	0.22	-0.05	0.60	12.98	0.96	0.72	0.90	3.26	1.10	0.74
6	0.08				0.50				0.40			
7	0.65				0.20				0.50			
8	0.14				0.00				0.20			
9	0.05				0.30				0.30			
10	0.02	155.24	0.19	0.16	0.00	13.78	0.20	-0.08	0.00	3.88	0.28	0.12
11	0.30				0.10				0.20			
12	0.29				0.00				0.20			
13	0.35				0.50				0.80			
14	0.01				0.10				0.10			
15	0.28	155.39	0.25	0.01	0.00	13.56	0.14	0.14	0.30	3.88	0.32	0.12
16	0.04				0.10				0.00			
17	0.27				0.10				0.30			
18	0.06				0.20				0.30			
19	0.31				0.10				0.30			
20	0.00	155.40	0.14	-0.00	0.10	13.66	0.12	0.04	0.10	3.96	0.20	0.04
21	0.16				0.10				0.00			
22	0.08				0.10				0.30			
23	0.16				0.10				0.30			
24	0.16				0.10				0.00			
25	0.11	155.34	0.13	0.06	0.00	13.74	0.08	-0.04	0.20	4.04	0.16	-0.04
26	0.25				0.00				0.30			
27	0.39				0.20				0.60			
28	0.08				0.20				0.10			
29	0.12				0.60				0.40			
30	0.17	155.45	0.20	-0.05	0.50	13.40	0.30	0.30	0.40	3.76	0.36	0.24
31	0.37				0.10				0.40			
32	0.43				0.20				0.30			
33	0.02				0.50				0.50			
34	0.42				0.50				0.10			
35	0.46	155.56	0.34	-0.16	0.30	13.50	0.32	0.20	0.10	4.00	0.28	0.00
36	0.29				0.00				0.40			
37	0.18				0.40				0.20			
38	0.10				0.40				0.50			
39	0.16				0.00				0.20			
40	0.32	155.57	0.21	-0.17	0.20	13.50	0.20	0.20	0.30	4.04	0.32	-0.04
41	0.16				0.00				0.10			
42	0.04				0.20				0.20			
43	0.08				0.20				0.20			
44	0.11				0.00				0.00			
45	0.07	155.31	0.09	0.09	0.00	13.70	0.08	0.00	0.00	3.98	0.10	0.02
46	0.33				0.10				0.30			
47	0.39				0.00				0.50			
48	0.12				0.30				0.40			
49	0.16	155.54	0.21	-0.14	0.60	13.50	0.20	0.20	0.40	4.00	0.32	0.00
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			10				9				9	
Deduct Lots				0				1				1

I-75 Cheboygan Co.

Contractors Mixture Price Adjustment Table — 3E3 Mixture

	% A.C,				75um				Crushed			
Sublot	JMF 4.70	Lot Avg.	Abs Dev.	Dev	JMF 2.80	Lot Avg.	Abs Dev.	Dev	JMF 90.30	Lot Avg.	Abs Dev.	Dev
1	0.10				0.30				3.10			
2	0.10				0.60				1.90			
3	0.20				0.40				2.40			
4	0.00				0.20				2.00			
5	0.10	4.68	0.10	0.02	0.10	2.48	0.32	0.32	2.20	92.62	2.32	-2.32
6	0.10				0.10				3.80			
7	0.30				0.10				4.60			
8	0.10				0.20				3.40			
9	0.00				0.10				3.50			
10	0.00	4.80	0.10	-0.10	0.10	2.72	0.12	0.08	4.60	94.28	3.98	-3.98
11	0.10				0.00				5.30			
12	0.10				0.10				4.40			
13	0.10				0.20				4.60			
14	0.00				0.30				4.80			
15	0.10	4.70	0.08	0.00	0.20	2.68	0.16	0.12	3.40	94.80	4.50	-4.50
16	0.00				0.10				3.50			
17	0.10				0.10				3.80			
18	0.00				0.20				3.10			
19	0.00				0.20				2.10			
20	0.00	4.72	0.02	-0.02	0.00	2.76	0.12	0.04	2.70	93.34	3.04	-3.04
21	0.10				0.10				2.80			
22	0.10				0.40				3.60			
23	0.10				0.40				3.60			
24	0.10				0.20				2.60			
25	0.10	4.72	0.10	-0.02	0.30	2.52	0.28	0.28	2.90	93.40	3.10	-3.10
26	0.10				0.20				4.80			
27	0.20				0.20				1.10			
28	0.00				0.00				3.40			
29	0.10				0.10				1.10			
30	0.10	4.68	0.10	0.02	0.00	2.86	0.10	-0.06	2.80	92.94	2.64	-2.64
31	0.20				0.40				4.80			
32	0.20				0.10				3.00			
33	0.00				0.30				4.70			
34	0.20				0.40				3.50			
35	0.20	4.62	0.16	0.08	0.30	3.10	0.30	-0.30	2.50	94.00	3.70	-3.70
36	0.20				0.40				3.90			
37	0.10				0.40				6.10			
38	0.00				0.50				3.90			
39	0.10				0.10				2.80			
40	0.20	4.58	0.12	0.12	0.10	3.10	0.30	-0.30	4.50	94.54	4.24	-4.24
41	0.00				0.10				2.90			
42	0.00				0.00				3.80			
43	0.00				0.60				4.10			
44	0.00				0.30				2.60			
45	0.00	4.70	0.00	0.00	0.50	3.10	0.30	-0.30	0.70	93.12	2.82	-2.82
46	0.20				0.30				2.50			
47	0.20				0.10				1.00			
48	0.10				0.10				5.30			
49	0.10	4.62	0.12	0.08	0.20	2.96	0.24	-0.16	3.70	92.94	2.64	-2.64
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			10				10				10	
DeductLots				0				0				0

I-75 Cheboygan Co.

MDOT Verification Test Data 3E3 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	Fines/AC	VFA
2	155.88	151.20	3	12.3	4.48	3.91	0.639	75.610
9	155.94	150.01	3.8	13	4.46	3.89	0.822	70.769
15	155	148.34	4.3	14.3	4.86	4.30	0.628	69.930
19	155.44	148.29	4.6	14.1	4.67	4.11	0.609	67.376
23	155.38	148.85	4.2	13.9	4.7	4.14	0.895	69.784
28	156.25	148.91	4.7	13.5	4.33	3.76	0.664	65.185
34	156.19	149.01	4.6	13.5	4.36	3.79	0.817	65.926
40	155.94	148.77	4.6	13.6	4.44	3.87	0.826	66.176
41	155.42	148.74	4.3	13.9	4.65	4.09	0.685	69.065
46	156	149.7	4	13.2	4.4	3.83	0.782	69.697
Average	155.7155	149.1235	4.2333	13.5666	4.55	3.9850	0.7316	68.8690
STD	0.4222	0.9251	0.5408	0.6103	0.1776	0.1787	0.1071	3.2163

MDOT Central Lab Test Data

	Specification AC	PG52-34	AC used PG46-34		+30% RAP	Amoco
LAB		%AC	Eff. AC	Orig. Pen	Rec. Pen	Fines/AC
6/26/97		4.4	3.83	260	94	1.304
7/9/97				301		
7/10/97		4.2	3.63	323	105	1.376
7/16/97		4.1	3.53	315	122	1.444
7/19/97		4.1	3.53	330	120	1.359
7/23/97				325		
7/26/97		3.9	3.33	340	121	1.261
7/30/97				336		
7/31/97		3.8	3.23	335	116	1.362
8/1/97				336		
8/7/97				382		
8/8/97		4	3.43		112	1.224
8/21/97		4.2	3.63	367	134	1.404
8/22/97		4.1	3.53	361	129	1.387
8/23/97				364		
8/27/97		4.1	3.53	370	129	1.274
8/28/97				360		
9/5/97		4.2	3.63		131	1.294
9/6/97		4.2	3.63		133	1.184
9/12/97				351		
Average		4.11	3.54	338.59	120.50	1.32
STD		0.1564	0.1573	29.7007	12.1767	0.0784

I-75 Cheboygan Co.

MDOT Verification Test Data 3E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
2	2.5	3.2	6.4	14.4	18.5	21.6	30.3	63.9	82	100
9	3.2	4	5.6	10.5	14.1	17.5	31	68	83.8	100
15	2.7	3.2	5.4	12	16.5	19.9	29.7	63.6	80.8	100
19	2.5	3.2	5.6	12.7	17.2	20.2	28.5	63.2	85.2	100
23	3.7	4.8	7.5	11.9	16.7	21.2	31.5	65.8	84.6	100
28	2.5	2.9	5	10.9	15.1	19	30.3	66.5	83.3	100
34	3.1	3.7	5.7	10.6	13.7	16.9	29.7	66.2	85.4	100
40	3.2	3.9	6.3	12.7	17.1	20.8	32.5	68.4	84.6	100
41	2.8	3.5	6	12.2	16.4	20.2	31.8	66.2	85.9	100
46	3	3.2	5.6	11.1	14.5	17.3	27.8	60.4	79.6	100
Average	2.92	3.56	5.91	11.90	15.98	19.46	30.31	65.22	83.52	100.00
STD	0.3938	0.5602	0.6951	1.1981	1.5548	1.6985	1.4617	2.4362	2.0965	0.0000

MDOT Central Lab Test Data

LAB	75umm	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
6/26/97	5	6.1	9.5	18.2	24.6	28.1	40.4	72.6	90.5	100
7/10/97	5	5.7	8	13.7	17.6	21.2	32.3	66.1	83	98.4
7/16/97	5.1	6	8.8	15.6	19.8	23.7	36.1	71.5	88	100
7/19/97	4.8	5.8	8.6	15.4	19.8	23.7	35.7	69.6	86.4	100
7/26/97	4.2	5	7.7	13.1	16.7	20.1	31.3	67	84.1	99.5
7/31/97	4.4	5.3	8.2	14	17.8	20.9	30.8	65.3	86.4	99.1
8/8/97	4.2	5.1	8	13.2	16.9	20.4	34.1	67	84.6	99
8/21/97	5.1	6.1	9.3	15.3	19.3	23	36.6	69.6	88.6	100
8/22/97	4.9	5.9	8.7	15	18.9	22.4	34.9	67.2	85.2	100
8/27/97	4.5	5.7	8.6	14.6	18.8	21.3	32.5	65.6	84.8	100
9/5/97	4.7	5.7	8.7	15.4	19.6	23.3	36.7	70.3	86.4	100
9/6/97	4.3	5.2	8.2	14.8	18.7	22.4	34	68.9	84.2	100
Average	4.68	5.63	8.53	14.86	19.04	22.54	34.62	68.39	86.02	99.67
STD	0.3485	0.3892	0.5344	1.3654	2.0518	2.1529	2.7175	2.3758	2.1611	0.5466

I-75 Cheboygan Co.

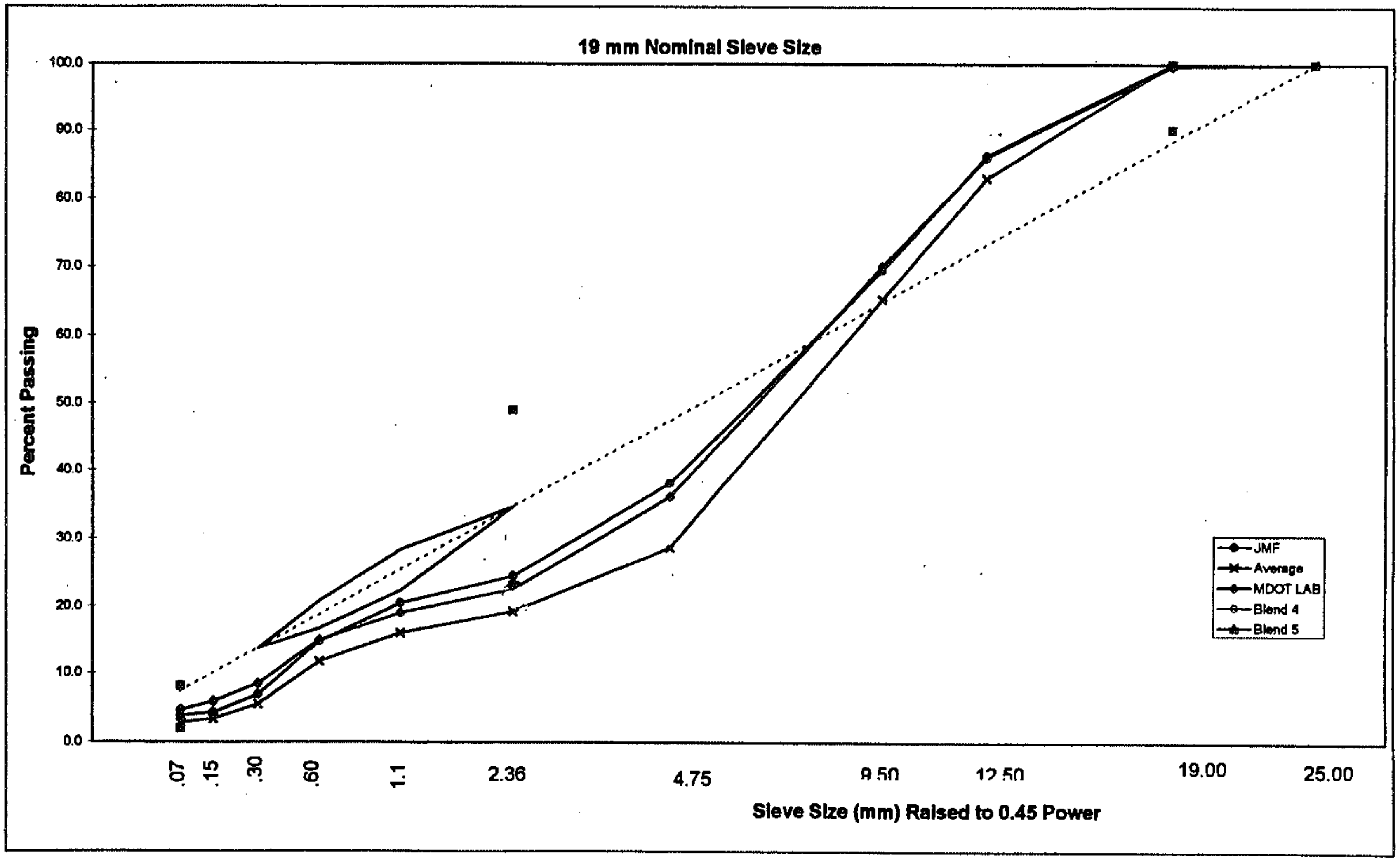
Film Thickness Table 3E3 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	100	100	99.7
12.5	86.2	83	86
9.5	69.4	64.9	68.4
4.75	38	29.9	34.6
2.36	24.4	19.2	22.5
1.18	20.4	16	19
0.6	14.7	11.7	14.9
0.3	6.9	5.5	8.5
0.15	4.3	3.4	5.6
0.075	3.8	2.8	4.7
% AC	4.7	4.68	4.1
Film Thick.	0.00121	0.00153	0.00089

Aggregate Gradation Trials

Project Name: I-75
Technician: Doug
Date: 1/0/00

Filename: I75-3E.XLS
Description: JMF/PROD
Nominal Sieve Size: 19 mm



FILE 300 __

Control Section: IM 16093
Job Number: 32510A
Mix Design No.: 97MD-228
Date: SEPTEMBER 17, 1997

REPORT OF TEST

1931 (N9/91)

BITUMINOUS MIX DESIGN

Sample Of: BITUMINOUS MIXTURE NO. 4E3 --Recycled
Date Tested: SEPTEMBER 17, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 46-34	AMOCO		1.018
1	COARSE	5/8" - STONE	PIT # 16-52	45.0%	
2	FINE	3/8" - SAND	PIT # 16-52	10.0%	
3	FINE	SCREENED FINES	PIT # 16-52	15.0%	
4	RAP		YARD	30.0%	

MIX DESIGN

Asphalt @ Optimum= 5.2 Air Voids = 4.0
Density lb/cu.ft = 148.1*
(kg/cu.m) =(2372.6) V.M.A. = 14.6
Theo.Max. Density= 154.4
(kg/cu.m) =(2473.2) V.F.A. = 72.3

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100
1/2 IN (12.5mm)	88.0	100.0	100.0	94.5	92.9	90-100
3/8 IN (9.5mm)	67.5	100.0	100.0	83.0	80.3	90 MAX
No. 4 (4.75mm)	24.5	94.0	97.0	56.5	51.9	
No. 8 (2.36mm)	8.0	85.0	39.0	40.0	30.0	28-58
No. 16 (1.18mm)	6.0	74.0	11.5	31.5	21.3	
No. 30 (600µm)	5.0	53.0	8.5	24.0	16.0	
No. 50 (300µm)	4.0	17.0	7.5	12.8	8.5	
No. 100 (150µm)	3.7	4.0	6.5	7.8	5.4	
No. 200 (75µm)	3.2	3.3	5.5	6.5	4.5	2-10
CRUSH RET.#4	93.5	10.0	100.0	91.4	91.9	75 Min.
A.W.I.	268.0	215.0	273.0	272.0	268.5	260 Min.

Materials submitted by: H & D, INC. Plant # 210-03 --(Contractor Furnished)
RAP CONTAINS 4.6% ASPHALT - 3.9% NEW ASPHALT ADDED TO THE MIXTURE
PG 52-28 GRADE ASPHALT REQUIRED FOR THE PROJECT
* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 42.9
EFFECTIVE SPECIFIC GRAVITY = 2.685

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratio indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: HILBERG, T. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
JOHN LIJEWSKI (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

wt

1931A (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: IM 16093
Job Number: 32510A
Mix Design No.: 97MD-228
Mix Type: 4E3 RP

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM 5.2	2.374	148.1	2.474	154.4	4.0	14.6	72.3	1.00
REGRESSION EVERY 0.1%								
4.5	2.347	146.5	2.501	156.1	6.2	14.9	58.8	1.18
4.6	2.351	146.7	2.497	155.8	5.8	14.9	60.7	1.15
4.7	2.356	147.0	2.493	155.6	5.5	14.8	62.8	1.12
4.8	2.360	147.3	2.489	155.3	5.2	14.7	64.8	1.09
4.9	2.364	147.5	2.486	155.1	4.9	14.7	66.6	1.07
5.0	2.367	147.7	2.482	154.9	4.6	14.7	68.4	1.04
5.1	2.371	148.0	2.478	154.6	4.3	14.6	70.4	1.02
5.2	2.374	148.1	2.474	154.4	4.0	14.6	72.3	1.00
5.3	2.376	148.3	2.471	154.2	3.8	14.6	73.7	0.97
5.4	2.379	148.4	2.467	153.9	3.6	14.6	75.6	0.95
5.5	2.381	148.6	2.463	153.7	3.3	14.6	77.2	0.93
5.6	2.382	148.6	2.459	153.4	3.1	14.7	78.6	0.91
5.7	2.384	148.8	2.456	153.3	2.9	14.7	80.0	0.90
5.8	2.385	148.8	2.452	153.0	2.7	14.7	81.5	0.88
5.9	2.386	148.9	2.448	152.8	2.5	14.8	82.9	0.86
6.0	2.386	148.9	2.445	152.6	2.4	14.9	83.8	0.85
SPECIFICATIONS =					4%	14.0	65-78	0.6-1.2

- (PG 46-34 -- AMOCO OIL) SP. GR. = 1.018

- EFFECTIVE SPECIFIC GRAVITY = 2.685

BULK AGGREGATE SPECIFIC GRAVITY = 2.635

Pbs = 0.7

DESIGN ESAL'S = <3.0

DESIGN TEMPERATURE = 38 degrees C

MIXING TEMPERATURE = ~~143~~ 135 degrees C

COMPACTION TEMPERATURE = ~~143~~ 124 degrees C

INITIAL GYRATIONS = 7 %Gmm = 85.7 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 86

MAXIMUM GYRATIONS = 134 %Gmm = 97.7 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M·DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
IM 16093	32510A	T. HILBERG	10-1-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
H+D INC	INDIAN RIVER	210-3

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
4E3 HMA	97MO228	14.6	4.0	148.1 kg/m³	154.4 kg/m³

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IV	2.685	9-5-97	☐ YES ☒ NO

MIX/AGG. GRADATION, %			MIX/AGG. BLEND PROPORTION, %		
ITEM	Extract	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %		5.2 ±0.50	5/8" H+D INC	16-52	45.0
P 37.5 mm			3/8" "	16-52	10.0
P 25.0 mm			SCREENED FINES "	16-52	15.0
P 19.0 mm	100.0	100.0			
P 12.5 mm	92.3	92.9			
P 9.5 mm	79.1	80.3			
P 4.75 mm	50.0	51.9			
P 2.36 mm	25.6	30.0			
P 1.18 mm	16.9	21.3	RECLAIMED	SCREENED RAP Y/ARD	30.0
P 600 µm	12.6	16.0	FILLER		
P 300 µm	6.6	8.5	ASPHALT	PG 46-34 AMOCO OIL CO ELBERTA	3.7
P 150 µm	4.3	5.4	AWI (Spec.) 260	AWI (Actual) 268.5	ANGULARITY INDEX 42.9
P 75 µm	3.7	4.5	TYPE OF TESTING	☒ QUALITY ASSURANCE TESTING	☐ REGULAR TESTING
CRUSHED	92.0	91.9 ±15	☐ BATCH PLANT	☒ DRUM PLANT	DUST. CORRECTION N/A

REMARKS: CONTRACTOR BEGAN PRODUCTION OF THIS MIX TODAY
800 TON INITIAL SUBLOT SIZE AS PER P.E
OPTION IV USING BELT SAMPLES, FOR AGG. GRADATION.

TRAVELLING MIX INSPECTOR (TMI) - Signature	DATE
John Lysaught	10-1-97

I-75 Cheboygan Co.

Contractors Quality Control Test Data 4E3 Mixture

G_b =1.018		G_{se} =2.685		G_{sb} =2.635		Absorb. =0.72		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	154.2	148.1	3.9	73.29	14.6	5.3	4.62	0.82
2	154.4	148.2	3.7	74.13	14.3	5.2	4.52	0.82
3	154.47	147.67	4.40	70.27	14.8	5.18	4.50	0.84
4	154.5	147.86	4.3	70.75	14.7	5.15	4.47	0.83
5	154.26	147.78	4.2	71.81	14.9	5.26	4.58	0.85
6	154.64	147.68	4.5	69.59	14.8	5.1	4.42	0.86
7	154.4	147.76	4.3	70.95	14.8	5.21	4.53	0.80
8	154.69	148.19	4.2	70.83	14.4	5.07	4.39	0.80
9	154.2	148.49	3.7	74.48	14.5	5.29	4.61	0.78
10	154.26	148.71	3.6	74.83	14.3	5.26	4.58	0.81
11	154.55	148.37	4	72.22	14.4	5.13	4.45	0.85
12	154.37	148.04	4.1	71.92	14.6	5.21	4.53	0.82
13	154.44	147.80	4.3	70.95	14.8	5.18	4.50	0.84
14	154.36	147.72	4.3	70.95	14.8	5.21	4.53	0.84
15	154.24	148.22	3.9	73.29	14.6	5.26	4.58	0.83
16	154.17	148.16	3.9	73.29	14.6	5.29	4.61	0.85
17	154.31	148.60	3.7	74.13	14.3	5.24	4.56	0.81
18	154.53	148.66	3.8	73.43	14.3	5.15	4.47	0.87
19	154.32	148.30	3.9	73.10	14.5	5.24	4.56	0.63
20	154.52	148.34	4	72.41	14.5	5.15	4.47	0.85
21	154.51	148.18	4.1	71.72	14.5	5.15	4.47	0.85
22	154.6	148.57	3.9	72.73	14.3	5.1	4.42	0.93
23	154.38	148.36	3.9	73.10	14.5	5.21	4.53	0.88
24	154.21	148.20	3.9	73.29	14.6	5.29	4.61	0.91
25	154.31	148.60	3.7	74.31	14.4	5.24	4.56	0.88
26	154.33	148.47	3.8	73.79	14.5	5.24	4.56	0.88
27	154.49	148.16	4.1	71.72	14.5	5.15	4.47	0.98
28	154.31	147.98	4.1	72.11	14.7	5.24	4.56	0.94
29	154.24	148.69	3.6	74.83	14.3	5.26	4.58	0.85
30	154.32	148.30	3.9	73.29	14.6	5.24	4.56	0.92
31	154.52	148.34	4	72.41	14.5	5.15	4.47	0.85
32	154.5	148.47	3.9	72.73	14.3	5.15	4.47	0.85
33	154.4	148.22	3.7	74.13	14.3	5.21	4.53	0.86
34	154.5	148.32	4.2	71.23	14.6	5.15	4.47	0.87
35	154.31	148.14	3.5	75.18	14.1	5.24	4.56	0.86
36								
37								
38								
39								
40								
Average	154.39	148.22	3.97	72.66	14.52	5.20	4.52	0.86
STD	0.134749	0.298181	0.248017	1.424787	0.192200	0.060076	0.060509	0.042955

I-75 Cheboygan Co.

Contractors Quality Control Test Data 4E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	3.8	4.5	9.1	15	19.2	25.8	49.3	81	94.9	100
2	3.7	4.4	6.1	10.7	14	21.2	49	80	92.6	100
3	3.8	4.3	6.1	11.7	16.5	23.2	48.7	80	92.8	100
4	3.7	4.3	5.9	10.2	13.2	20.1	46.1	78.7	92.1	100
5	3.9	4.8	7.3	14	19.8	27.2	48.7	79.1	91	100
6	3.8	4.6	6.8	12.8	17.9	24.2	47.4	78.3	90.7	100
7	3.6	4.3	6.5	11.6	16.6	23.5	47.3	78.5	90.9	100
8	3.5	4.1	5.9	11.4	15.5	23	47.3	74.7	91.3	100
9	3.6	4.1	6.2	11.7	15.3	24.2	47.7	79.1	91.8	100
10	3.7	4.5	6.7	12.7	17.6	25.8	47.3	77.8	91.4	100
11	3.8	4.5	6.4	12.6	17.3	26.1	47.3	78.2	91.6	100
12	3.7	4.5	6.7	12.7	16.7	24	48.1	77.1	90.9	100
13	3.8	4.4	6.5	12.8	16.8	23.7	48.5	77.3	90.7	100
14	3.8	4.5	6.5	12.1	16.3	23.9	47.4	77.1	91.9	100
15	3.8	4.6	6.9	12.9	17.1	24.6	49	79.3	93.2	100
16	3.9	4.5	6.9	12.4	16.7	25.1	48.9	78.1	93	100
17	3.7	4.4	6.5	12.7	16.9	24	48.1	77.5	91	100
18	3.9	4.7	7	12.9	17.3	25.1	48.9	79	93.1	100
19	3.8	4.6	7.3	13.1	17.8	26.2	48.5	77.8	91	100
20	3.8	4.7	7.3	13.5	19.8	28.2	49.9	77.9	91.1	100
21	3.8	4.6	7.2	13	17.2	24.2	46.8	77.5	90.4	100
22	4.1	5	7.5	14.1	19.3	26.6	48.5	79.7	92.5	100
23	4	5	7.4	14.1	18.8	26.9	49.1	79.9	91.9	100
24	4.2	5.1	7.6	14.4	19.3	26.6	47.9	80.2	92.8	100
25	4	5	7.5	14.4	19.8	27	46.5	80.3	94.4	100
26	4	4.8	7.3	13.1	18.4	25.4	46	78.8	91.6	100
27	4.4	5.3	7.9	14.3	19.1	27.8	52	83.8	94.3	100
28	4.3	5.4	7.9	14.7	19.7	27.1	45.8	76.8	92.2	100
29	3.9	4.6	6.6	14.2	18.3	25.3	47.1	77.7	91.6	100
30	4.2	5.1	7.2	14.4	18.9	25.7	47.8	77	91.3	100
31	3.8	4.7	6.8	12.7	17.2	25.5	50.9	82.6	94.3	100
32	3.8	4.7	7	12.9	17.2	25	49.5	81.5	93.8	100
33	3.9	4.9	7.1	12.9	17	25.5	50.6	82.5	92.9	100
34	3.9	5	7.4	12.8	16.8	25	49.9	80.8	92.1	100
35	3.9	4.7	6.7	12.8	17.2	25	47.8	77	93.6	100
36										
37										
38										
39										
40										
Average	3.87	4.66	6.96	12.98	17.50	25.08	48.27	78.93	92.19	100.00
STD	0.1939	0.3116	0.6458	1.1179	1.5746	1.7146	1.3941	1.8954	1.2093	0

I-75 Cheboygan Co.

Contractors Quality Control Test Data 4E3 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1		85.3	97.8	92.2		
2		85.7	97.9	92.9		
3		84.9	97.3	92.9		
4		85	97.4	92.3		
5		84.9	97.5	94.2		
6		84.7	97.2	93.1		
7		84.8	97.5	92.1		
8		84.9	97.6	92.2		
9		85.8	97.9	92.8		
10		86.2	97.9	92.7		
11		85.5	97.6	92.2		
12		85.6	97.3	92.5		
13		84.6	97.5	93.1		
14		85.1	97.5	90.6		
15		85.4	97.9	92.5		
16		85.5	97.8	91.6		
17		85.8	97.9	91.8		
18		85.6	97.8	92.22		
19		85.7	97.8	92.2		
20		85.4	97.7	91.7		
21		85.3	97.6	93.1		
22		85.4	97.7	92.3		
23		85.6	97.8	92		
24		85.2	97.9	91.6		
25		85.6	97.9	92.6		
26		85.3	97.9	92.2		
27		85.2	97.6	91.9		
28		85	97.7	90.5		
29		85.6	98.1	91.5		
30		85.1	97.8	92.2		
31		85.1	97.7	91.7		
32		85.2	97.9	92.1		
33		85.7	98	91.9		
34		85	97.5	91.9		
35		86.2	98.1	91.1		
36						
37						
38						
39						
40						
Average		85.34	97.71	92.18		
STD		0.3874	0.2251	0.7118		

I-75 Cheboygan Co.

Contractors In Place Density Results 4E3 Mixture

sublot	Core #1	Core #2	Core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	91.4	92.3	93.6	92.433						
2	93.8	95	93.6	94.133						
3	93.6	94.9	92.3	93.600						
4	93.3	94	93.7	93.667						
5	92.8	93.6	94.3	93.567	93.48	80.00	73.33	66.67	1.00	0.00
6	93.2	93.7	92.6	93.167	93.63					
7	94.2	92.9	91.1	92.733	93.35					
8	94.7	92.6	92.9	93.400	93.31					
9	95.2	95.5	93	94.567	93.49					
10	92.9	94.3	95.9	94.367	93.65	93.33	53.33	46.67	1.00	0.00
11	95	94.6	94.3	94.633	93.94					
12	93.3	90.9	92.6	92.267	93.85					
13	94.4	94.8	93.9	94.367	94.04					
14	93.8	91.4	94.1	93.100	93.75					
15	96.4	95	95.6	95.667	94.01	86.67	80.00	73.33	2.00	1.00
16	90.8	93.1	94.1	92.667	93.61					
17	92	92.6	94.9	93.167	93.79					
18	90.4	91.2	95.5	92.367	93.39					
19	94.5	91.3	93.4	93.067	93.39					
20	93.7	91.4	92.3	92.467	92.75	53.33	46.67	33.33	5.00	2.00
21	93.9	92.2	95	93.700	92.95					
22	94.6	93.9	95	94.500	93.22					
23	94	95	94.8	94.600	93.67					
24	94.5	91.3	92.2	92.667	93.59					
25	94.7	95.6	94.1	94.800	94.05	80.00	80.00	80.00	1.00	0.00
26	91.7	92.6	96.8	93.700	94.05					
27	90.5	92.9	92.8	92.067	93.57					
28	91.8	94.2	95.5	93.833	93.41					
29	94.7	96.7	94.3	95.233	93.93					
30	95.5	94.2	95.4	95.033	93.97	80.00	60.00	60.00	3.00	1.00
31	93.5	92.9	93.3	93.233	93.88					
32	90.9	93.8	93.8	92.833	94.03					
33	94.2	92.1	91.9	92.733	93.81					
34	92.3	90.8	94	92.367	93.24	66.67	60.00	46.67	3.00	2.00
35										
36										
37										
38										
39										
40										

Average	93.5452					
STD	1.4419					
Bonus Lots		5	2	1		
Deduct Lots					1	0

I-75 Cheboygan Co.

Contractors Mixture Price Adjustment Table 4E3 Mixture

	TMD				VMA				VOIDS			
Sublot	JMF 154.4	Lot Avg.	Abs. Dev.	Dev.	JMF 14.6	Lot Avg.	Abs. Dev.	Dev.	JMF 4	Lot Avg.	Abs. Dev.	Dev.
1	0.2				0				0.1			
2	0				0.3				0.3			
3	0.07				0.2				0.4			
4	0.1				0.1				0.3			
5	0.14	154.366	0.102	0.034	0.3	14.66	0.18	-0.06	0.2	4.1	0.26	-0.1
6	0.24				0.2				0.5			
7	0				0.2				0.3			
8	0.29				0.2				0.2			
9	0.2				0.1				0.3			
10	0.14	154.438	0.174	-0.038	0.3	14.56	0.2	0.04	0.4	4.06	0.34	-0.06
11	0.15				0.2				0			
12	0.03				0				0.1			
13	0.04				0.2				0.3			
14	0.04				0.2				0.3			
15	0.16	154.392	0.084	0.008	0	14.64	0.12	-0.04	0.1	4.12	0.16	-0.12
16	0.23				0				0.1			
17	0.09				0.3				0.3			
18	0.13				0.3				0.2			
19	0.08				0.1				0.1			
20	0.12	154.37	0.13	0.03	0.1	14.44	0.16	0.16	0	3.86	0.14	0.14
21	0.11				0.1				0.1			
22	0.2				0.3				0.1			
23	0.02				0.1				0.1			
24	0.19				0				0.1			
25	0.09	154.402	0.122	-0.002	0.2	14.46	0.14	0.14	0.3	3.9	0.14	0.1
26	0.07				0.1				0.2			
27	0.09				0.1				0.1			
28	0.09				0.1				0.1			
29	0.16				0.3				0.4			
30	0.08	154.338	0.098	0.062	0	14.52	0.12	0.08	0.1	3.9	0.18	0.1
31	0.12				0.1				0			
32	0.1				0.3				0.1			
33	0				0.3				0.3			
34	0.1				0				0.2			
35	0.09	154.446	0.082	-0.046	0.5	14.36	0.24	0.24	0.5	3.86	0.22	0.14
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			7				7				7	
Deduct Lots				0				0				0

I-75 Cheboygan Co.

Contractors Mixture Price Adjustment Table — 4E3 Mixture

	% A.C.				75um				Crushed			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	5.2	Avg.	Dev.	Dev.	3.7	Avg.	Dev.	Dev.	92	Avg.	Dev.	Dev.
1	0.1				0.1				0.2			
2	0				0				0.9			
3	0.02				0.1				0.9			
4	0.05				0				0.3			
5	0.06	5.218	0.046	-0.018	0.2	3.78	0.08	-0.08	2.2	92.9	0.9	-0.9
6	0.1				0.1				1.1			
7	0.01				0.1				0.1			
8	0.13				0.2				0.2			
9	0.09				0.1				0.8			
10	0.06	5.186	0.078	0.014	0	3.64	0.1	0.06	0.7	92.58	0.58	-0.58
11	0.07				0.1				0.2			
12	0.01				0				0.5			
13	0.02				0.1				1.1			
14	0.01				0.1				1.4			
15	0.06	5.198	0.034	0.002	0.1	3.78	0.08	-0.08	0.5	92.18	0.74	-0.18
16	0.09				0.2				0.4			
17	0.04				0				0.2			
18	0.05				0.2				0.22			
19	0.04				0.1				0.2			
20	0.05	5.214	0.054	-0.014	0.1	3.82	0.12	-0.12	0.3	91.904	0.264	0.096
21	0.05				0.1				1.1			
22	0.1				0.4				0.3			
23	0.01				0.3				0			
24	0.09				0.5				0.4			
25	0.04	5.198	0.058	0.002	0.3	4.02	0.32	-0.32	0.6	92.32	0.48	-0.32
26	0.04				0.3				0.2			
27	0.05				0.7				0.1			
28	0.04				0.6				1.5			
29	0.06				0.2				0.5			
30	0.04	5.226	0.046	-0.026	0.5	4.16	0.46	-0.46	0.2	91.66	0.5	0.34
31	0.05				0.1				0.3			
32	0.05				0.1				0.1			
33	0.01				0.2				0.1			
34	0.05				0.2				0.1			
35	0.04	5.18	0.04	0.02	0.2	3.86	0.16	-0.16	0.9	91.74	0.3	0.26
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			7				7				7	
Deduct Lots				0				0				0

I-75 Cheboygan Co.

MDOT Verification Test Data — 4E3 Mixture

Sublot	TMD	BULK	AIR VOID	%AC	Eff. AC	Fines/AC
4	154.71	148.06	4.3	5.07	4.35	0.62
8	154.82	147.85	4.5	5.02	4.30	0.81
14	153.97	148.12	3.8	5.4	4.68	0.83
17	154.56	149.30	3.4	5.23	4.51	0.69
22	155.18	148.97	4.3	4.86	4.14	1.01
28	155	148.8	4.9	4.94	4.22	1.07
31	154.25	148.08	3.5	5.26	4.54	0.77
Average	154.6414	148.4549	4.1	5.1114	4.3919	0.8294
STD	0.4214	0.5598	0.5507	0.1923	0.1923	0.1621

MDOT Central Lab Test Data

	Specification AC	PG52-28	AC used	PG46-34	+30% RAP
LAB		Fines/AC	%AC	Orig. Pen	Rec. Pen
10/1/97		1.64	5	355	127
10/3/97				350	
10/6/97		2.02	4.4	358	134
10/7/97				360	
10/8/97		1.97	4.7	359	131
10/9/97		1.24	5.1	360	
10/10/97		1.81	4.5	364	130
10/11/97		1.75	4.8	361	135
10/13/97				365	
10/15/97		1.46	5.2		134
10/16/97				400	
10/23/97				400	
10/24/97		1.66	4.9		147
10/25/97				405	
10/26/97		1.71	4.9	370	141
10/28/97				365	
10/29/97		1.76	5	367	142
10/30/97		1.56	4.9		134
10/31/97				390	
11/1/97		1.67	5		
11/3/97				395	
Average		1.69	4.87	372.00	135.50
STD		0.209763	0.234843	18.11077	6.096447

I-75 Cheboygan Co.

MDOT Verification Test Data 4E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
4	2.7	3.2	4.9	8.6	11.4	18	44.3	78.7	94.1	100
8	3.5	4.1	6.3	11.7	16.1	24.6	48.6	74.6	91.1	100
14	3.9	4.7	7.4	13.8	18.7	27.5	52.8	80	95	100
17	3.1	3.9	6.6	12.5	16.6	24.6	51	79.4	93.3	100
22	4.2	5.1	7.8	13.8	18.1	25	45	77.1	93.6	100
28	4.5	5.4	8.1	14.2	18.8	26	45.9	78.7	93	100
31	3.5	4.4	7	13	17.5	26.5	51.9	80.4	94.1	100
Average	3.6285	4.4	6.8714	12.514	16.742	24.6	48.5	78.414	93.4571	100
STD	0.6237	0.7483	1.0765	1.9308	2.5644	3.1010	3.4871	1.9945	1.2259	0

MDOT Central Lab Test Data

LAB	75umm	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
10/1/97	5.2	6.2	9.1	15	19.2	25.8	48.7	81	94.9	100
10/6/97	5.6	6.5	9	14.4	18.4	24	45.1	78.2	93.4	100
10/8/97	6	6.9	9.7	15.9	20.5	27	47.9	78.9	93	100
10/9/97	3.6	4.2	6.2	11.7	15.8	23.7	48.1	75.2	90.1	100
10/10/97	5	5.8	7.8	11.9	15	20	40.3	77.7	94.1	100
10/11/97	5.3	6.3	9.4	15.8	20.3	26.5	49.5	79.4	93.4	100
10/15/97	4.7	5.7	8.7	15.3	19.9	26	47	81.4	94	100
10/24/97	5.1	6.1	9.2	15.8	20.5	26.4	45.9	79	93	100
10/26/97	5.3	6.4	9.3	15.5	19.3	25.1	46.9	79.8	93.5	100
10/29/97	5.7	6.7	9.9	15.7	20.2	26.4	47.9	81.2	95.1	100
10/30/97	4.7	5.7	8.5	14.6	19	24.6	43.9	73.6	88.5	100
11/1/97	5.3	6.4	9.4	15.8	20.7	27.6	47.9	81	94.4	100
Average	5.13	6.08	8.85	14.78	19.07	25.26	46.59	78.87	93.12	100.00
STD	0.6121	0.7008	1.0049	1.4776	1.8588	2.0366	2.5245	2.4332	1.9366	0

I-75 Cheboygan Co.

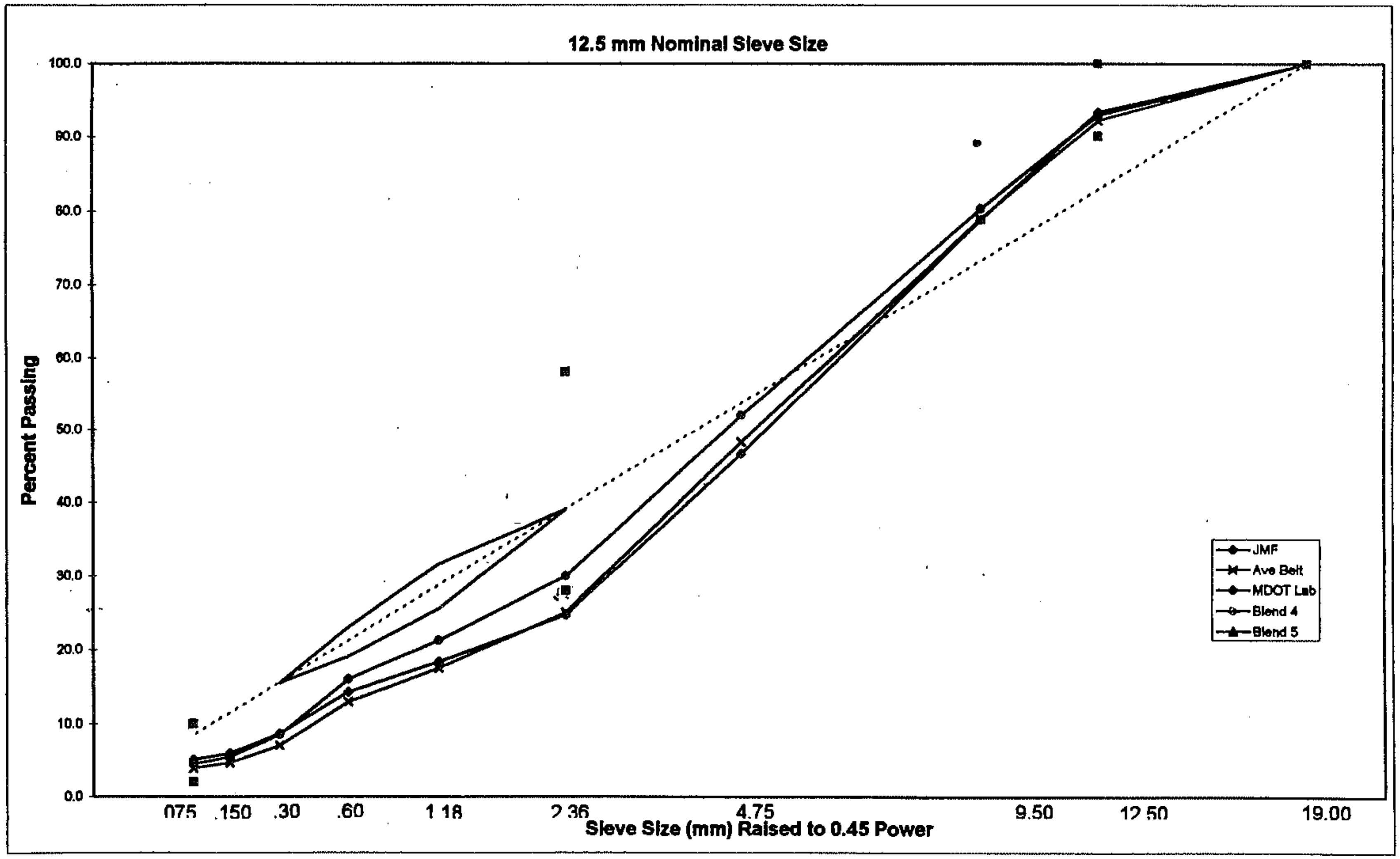
Film Thickness Table 4E3 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	100	100	100
12.5	92.9	92.2	93.1
9.5	80.3	78.9	78.9
4.75	51.9	48.3	46.6
2.36	30	25.1	25.3
1.18	21.3	17.5	19.1
0.6	16	13	14.8
0.3	8.5	7	8.9
0.15	5.4	4.7	6.1
0.075	4.5	3.9	5.1
% AC	5.2	5.2	4.87
Film Thick.	0.00114	0.00130	0.00099

Aggregate Gradation Trials

Project Name: I-75
Technician: Doug
Date: 11/11/97

Filename: I75-4E.XLS
Description: JMF
Nominal Sieve Size: 12.5 mm



Appendix D4

QC/QA Test Data
US-23 Arenac Co.
<3 Million ESAL
2E3, 3E3 and 4E3 Mixtures

FILE 300 ______

Control Section:	NH 06073
Job Number:	32358A
Mix Design No.:	97MD-179
Date:	AUGUST 5, 1997

REPORT OF TEST

1931 (N9/91)

BITUMINOUS MIX DESIGN

Sample Of: BITUMINOUS MIXTURE NO. 2E3
Date Tested: AUGUST 6, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 52-28	AMOCO		1.019
1	COARSE	IX7/8	PIT # 06-08	32.0%	
2	COARSE	3/4 CHIP	PIT # 06-08	27.0%	
3	COARSE	31A	PIT # 06-08	13.0%	
4	FINE	3/8 MINUS	PIT # 06-08	15.0%	
5	FINE	REJECT SAND	PIT # 65-55	12.0%	
6	DEG		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum=	4.7	Air Voids	=	4.0
Density lb/cu.ft =	147.7*			
(kg/cu.m) =	(2366.7)	V.M.A.	=	12.3
Theo.Max. Density=	153.9			
(kg/cu.m) =	(2465.1)	V.F.A.	=	67.8

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
1 IN (25.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90-100
3/4 IN (19.0mm)	17.4	100.0	100.0	100.0	100.0	100.0	73.6	90 MAX
1/2 IN (12.5mm)	2.2	69.2	100.0	100.0	100.0	100.0	60.4	-
3/8 IN (9.5mm)	2.2	39.6	100.0	100.0	98.1	100.0	52.2	-
No. 4 (4.75mm)	2.2	7.2	58.3	76.5	83.5	100.0	32.7	-
No. 8 (2.36mm)	2.1	3.9	14.1	54.3	60.9	100.0	20.0	19-45
No. 16 (1.18mm)	2.1	2.5	2.0	39.7	50.7	100.0	14.6	-
No. 30 (600µm)	2.0	2.0	2.0	30.7	41.2	100.0	12.0	-
No. 50 (300µm)	1.7	2.0	2.0	23.0	15.3	99.0	7.6	
No. 100 (150µm)	1.5	2.0	1.0	14.0	3.2	98.0	4.6	
No. 200 (75µm)	1.0	1.9	0.7	13.2	1.9	80.0	3.9	1-7
CRUSH RET.#4	100.0	100.0	100.0	100.0	46.3	0.0	98.4	50 Min.

Materials submitted by: PAYNE & DOLAN, INC. Plant # 350-07 --(Contractor Furnished)
NOTE TO TMI: ELIMINATE THE DEG & INCREASE THE REJECT SAND TO 13%.

* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 42.9
EFFECTIVE SPECIFIC GRAVITY = 2.652

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: ROBERTS, R. (PE)	(2)	CONTRACTOR	
FIELD ENGINEER		BIT. FILE	
KEN LAMBERT	(2)		
D. ANDREWS	(4)		

______
Bituminous Unit - Supervising Engineer

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
4.7	2.368	148.8	2.466	153.9	4.0	12.3	67.8	1.09
REGRESSION EVERY 0.1%								
4.0	2.324	145.0	2.492	155.5	6.7	13.3	49.4	1.35
4.1	2.333	145.6	2.488	155.3	6.2	13.1	52.4	1.31
4.2	2.341	146.1	2.485	155.1	5.8	12.9	55.0	1.26
4.3	2.348	146.5	2.481	154.8	5.4	12.7	57.8	1.22
4.4	2.354	146.9	2.477	154.6	5.0	12.6	60.5	1.19
4.5	2.359	147.2	2.474	154.4	4.6	12.5	62.7	1.15
4.6	2.364	147.5	2.470	154.1	4.3	12.4	65.3	1.12
4.7	2.368	147.8	2.466	153.9	4.0	12.3	67.8	1.09
4.8	2.371	148.0	2.463	153.7	3.7	12.3	69.7	1.06
4.9	2.373	148.1	2.459	153.4	3.5	12.3	71.6	1.03
5.0	2.375	148.2	2.455	153.2	3.3	12.3	73.6	1.00
5.1	2.376	148.3	2.452	153.0	3.1	12.4	75.0	0.98
5.2	2.376	148.3	2.448	152.8	2.9	12.5	76.5	0.95
5.3	2.375	148.2	2.444	152.5	2.8	12.6	77.6	0.93
5.4	2.374	148.1	2.441	152.3	2.7	12.8	78.5	0.91
5.5	2.372	148.0	2.437	152.1	2.7	12.9	79.3	0.89
SPECIFICATIONS =					4%	12.0	65-78	0.6-1.2

- (PG 52-28 – AMOCO OIL) SP. GR. = 1.019

- EFFECTIVE SPECIFIC GRAVITY = 2.652   1.16 Absorp.

BULK AGGREGATE SPECIFIC GRAVITY = 2.574

DESIGN ESAL'S = <3.0

DESIGN TEMPERATURE = 39 degrees C

MIXING TEMPERATURE = 132 degrees C

COMPACTION TEMPERATURE = 124 degrees C

INITIAL GYRATIONS = 7   %Gmm = 85.0   SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 86

MAXIMUM GYRATIONS = 134   %Gmm = 95.9   SPECIFICATION = 98% MAX.

US-23 Arenac Co.

Contractors Quality Control Test Data

2E3 Mixture

G_b =1.019		G_{se} =2.652		G_{sb} =2.574		Absorb.	=1.16	
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	153.08	147.72	3.50	69.83	11.6	4.71	3.60	1.628
2	153.75	147.05	4.36	65.12	12.5	4.76	3.65	0.824
3	153.82	145.96	5.11	61.43	13.25	4.65	3.54	0.590
4	153.38	146.89	4.23	67.61	13.06	4.93	3.82	0.740
5	153.63	148.51	3.33	72.25	12	4.82	3.71	1.245
6	153.69	149.06	3.01	74.14	11.64	4.79	3.68	1.247
7	153.69	148.42	3.43	71.46	12.02	4.79	3.68	1.331
8	153.69	147.61	4.08	67.18	12.43	4.71	3.60	1.105
9	153.85	147.45	4.16	66.85	12.55	4.73	3.62	1.027
10	153.85	146.22	4.96	62.68	13.29	4.73	3.62	0.702
11	154	146.46	4.94	62.26	13.09	4.65	3.54	0.670
12	153.64	147.46	3.95	68.55	12.56	4.82	3.71	1.053
13	153.5	148.45	3.32	72.56	12.1	4.87	3.76	1.244
14	153.75	146.84	4.49	65.43	12.99	4.77	3.66	1.224
15	153.77	146.45	4.76	63.91	13.19	4.77	3.66	0.568
16	153.63	148.1	3.61	70.53	12.25	4.82	3.71	0.762
17	153.52	148.13	3.48	71.64	12.27	4.88	3.77	1.169
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
Average	153.67	147.46	4.04	67.85	12.52	4.78		1.01
STD	0.2173	0.9090	0.6581	3.9495	0.5520	0.0768		0.3044

US-23 Arenac Co.

Contractors Quality Control Test Data — 2E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	5.86	6.48	9.70	15.33	19.44	26.36	41.76	64.49	73.73	86.04	100.00
2	3.01	4.01	6.60	11.14	14.22	19.55	31.84	51.34	60.68	78.36	100.00
3	2.09	2.93	5.16	8.82	11.17	14.62	22.39	37.70	48.48	68.93	100.00
4	2.83	3.18	5.80	10.42	13.92	18.68	29.26	48.48	59.30	75.82	100.00
5	4.62	5.79	8.77	13.97	17.74	23.92	36.58	54.71	63.30	75.85	100.00
6	4.59	5.83	8.87	14.42	18.43	25.03	39.22	58.83	66.79	83.12	100.00
7	4.90	6.03	8.94	13.92	17.45	23.60	36.65	55.25	63.47	79.08	100.00
8	3.98	4.95	7.66	12.42	15.70	21.29	33.73	54.85	64.59	78.11	100.00
9	3.72	4.59	7.12	12.08	15.34	20.68	34.81	52.68	69.56	81.28	100.00
10	2.54	3.35	5.70	10.04	12.83	17.32	29.70	52.66	63.51	81.40	100.00
11	2.37	3.10	5.42	9.95	12.83	17.14	27.75	47.96	60.47	76.06	100.00
12	3.91	4.91	7.63	12.71	16.36	22.18	35.18	54.95	64.67	80.55	100.00
13	4.68	5.81	8.90	14.51	18.54	25.39	40.72	62.15	72.74	83.40	100.00
14	4.48	5.54	8.53	13.83	17.23	23.24	37.63	63.71	72.77	83.77	100.00
15	2.08	2.85	4.99	9.21	11.57	15.76	26.24	49.90	62.39	77.92	100.00
16	2.83	3.74	6.11	10.62	13.33	17.46	26.16	45.64	55.76	77.22	100.00
17	4.41	5.53	8.12	12.94	16.02	20.75	31.60	53.02	63.68	78.76	100.00
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
Avg.	3.70	4.62	7.30	12.14	15.42	20.76	33.01	53.43	63.89	79.16	100.00
STD	1.125	1.2424	1.5463	2.0385	2.5424	3.5518	5.5450	6.7229	6.3443	4.0099	0

US-23 Arenac Co.

Contractors Quality Control Test Data 2E3 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1				99.4		
2				100		
3				98		
4				99.2		
5				96.3		
6				99.4		
7				100		
8				99.2		
9				99.8		
10				100		
11				98.4		
12				98.2		
13				100		
14				98.8		
15				99.4		
16				98.3		
17				98		
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
average				98.96		
STD				0.999963		

US-23 Arenac Co.

Contractors In Place Density Results 2E3 Mixture

Sublot	core #1	core #2	core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	92.5	91.4	93.63	92.510						
2	91.9	91.17	92.05	91.707						
3	88.98	89.2	92.35	90.177						
4	94.3	92.76	93.63	93.563						
5	93.39	93.68	94.03	93.700	92.33	46.67	40.00	33.33	5.00	2.00
6	92.98	91.92	93.5	92.800	92.39					
7	95.71	94.51	92.38	94.200	92.89					
8	92.29	93.75	94.07	93.370	93.53					
9	92.52	93.6	92.76	92.960	93.41					
10	94.43	92.36	92.29	93.027	93.27	66.67	46.67	40.00	1.00	0.00
11	92.1	91.51	95.44	93.017	93.31					
12	95.85	93.17	92	93.673	93.21					
13	92	92	94.48	92.827	93.10					
14	93.95	93.34	94.59	93.960	93.30					
15	96.65	95.82	95.67	96.047	93.90					
16	97.06	97.29	96.5	96.950	94.69					
17	96.58	93.76	94.75	95.030	94.96	86.67	86.67	80.00	0.00	0.00
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
Average			93.50							
STD			1.8211							
Bonus Lots						1	1	1		
Deduct Lots									1	

US-23 Arenac Co.

Contractors Mixture Price Adjustment Table 2E3 Mixture

	TMD				VMA				VOIDS			
Sublot	JMF 153.9	Lot Avg.	Abs. Dev.	Dev.	JMF 12.3	Lot Avg.	Abs. Dev.	Dev.	JMF 4	Lot Avg.	Abs. Dev.	Dev.
1	0.82				0.7				0.5			
2	0.15				0.2				0.36			
3	0.08				0.95				1.11			
4	0.52				0.76				0.23			
5	0.27	153.53	0.368	0.37	0.3	12.48	0.582	-0.18	0.67	4.11	0.574	-0.11
6	0.21				0.66				0.99			
7	0.21				0.28				0.57			
8	0.01				0.13				0.08			
9	0.05				0.25				0.16			
10	0.05	153.79	0.106	0.11	0.99	12.39	0.462	-0.09	0.96	3.93	0.552	0.07
11	0.1				0.79				0.94			
12	0.26				0.26				0.05			
13	0.4				0.2				0.68			
14	0.15				0.69				0.49			
15	0.13	153.73			0.89	12.79			0.76	4.29		
16	0.27				0.05				0.39			
17	0.38	153.63	0.266	0.27	0.03	12.56	0.372	-0.26	0.52	3.93	0.568	0.07
Specifications			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			3				3				0	
Deduct Lots				0				0				0

US-23 Arenac Co.

Contractors Mixture Price Adjustment Table 2E3 Mixture

	% A.C.				75um				Crushed			
Sublot	JMF 4.7	Lot Avg.	Abs. Dev.	Dev.	JMF 3.9	Lot Avg.	Abs. Dev.	Dev.	JMF 98.4	Lot Avg.	Abs. Dev.	Dev.
1	0.01				1.96				1			
2	0.06				0.89				1.6			
3	0.05				1.81				0.4			
4	0.23				1.07				0.8			
5	0.12	4.774	0.094	-0.074	0.72	3.682	1.29	0.218	2.1	98.58	1.18	-0.18
6	0.09				0.69				1			
7	0.09				1				1.6			
8	0.01				0.08				0.8			
9	0.03				0.18				1.4			
10	0.03	4.75	0.05	-0.05	1.36	3.946	0.662	-0.046	1.6	99.68	1.28	-1.28
11	0.05				1.53				0			
12	0.12				0.01				0.2			
13	0.17				0.78				1.6			
14	0.07				0.58				0.4			
15	0.07	4.776			1.82	3.504			1	98.96		
16	0.12				1.07				0.1			
17	0.18	4.822	0.122	-0.122	0.51	3.696	0.952	0.204	0.4	98.9	0.7	-0.5
18												
19												
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			3				1				3	
Deduct Lots				0				0				0

US-23 Arenac Co.

MDOT Verification Test Data

2E3 Mixture

Sublot	TMD	BULK	AIR VOID	%AC	Eff. AC	VFA
4	154.22	146.02	5.32	4.48	3.37	59.849
5	154.21	149.11	3.31	4.58	3.47	71.016
7	154.08	148.56	3.58	4.63	3.52	69.635
14	153.46	145.56	5.15	4.91	3.80	62.789
15	152.5	144.22	5.43	5.32	4.22	63.752
Average	153.694	146.69	4.558	4.78	3.68	65.41
STD	0.7369	2.0724	1.0254	0.3395	0.3434	4.7387

MDOT Central Lab Test Data

	AC Used	PG52-28	Amoco
Date	Eff. AC	Orig. Pen	Rec. Pen
8/18/97	3.69	205	128
8/19/97	3.59	207	105
8/20/97		209	
8/22/97	3.79	194	122
8/23/97		206	
8/25/97	2.98	210	131
9/3/1997	2.78	229	120
9/3/1997	3.49		
9/4/1997		212	
9/6/1997	3.19	237	149
9/8/1997		227	
9/9/1997	2.58	227	
9/16/97	3.29		141
9/25/97		228	
10/30/97	3.08	262	139
Average	3.25	219.46	129.38
STD	0.3995	17.896	13.9072

US-23 Arenac Co.

MDOT Verification Test Data 2E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
4	4.14	5.12	7.69	12.42	15.7	21.16	33.85	55.16	64.6	84.41	100
5	5.43	6.63	9.67	14.99	18.88	25.63	38.76	58.48	69.11	85.85	100
7	4.94	6.1	8.9	13.85	17.47	23.68	36.36	54.94	64.01	79.15	100
14	4.32	5.38	8.09	13.07	16.35	21.75	34.27	58.08	70.71	86.62	100
15	3.46	4.4	6.83	11.67	14.73	19.91	32.36	54.81	67.92	82.82	100
Avg.	4.46	5.53	8.24	13.20	16.63	22.43	35.12	56.29	67.27	83.77	100.00
STD	0.75	0.86	1.09	1.28	1.60	2.24	2.48	1.82	2.88	2.96	0.00

MDOT Central Lab Test Data

LAB	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
8/18/97	5.3	6.8	10.1	15.6	20.7	25.6	38.5	51.8	53.4	79.8	100
8/19/97	5.9	7.2	10.4	15.8	19.7	25.6	38.5	58.3	68.3	85.1	98.5
8/22/97	5.9	7.3	10.7	16.8	21.4	27.6	45	70.2	81.6	88.7	100
8/25/97	4.8	6	8.9	13.6	18.1	22.7	36.1	55.6	65	76.4	100
9/3/97	4.6	5.6	8.2	13	16.4	22.2	34.5	56.5	65.7	78.4	100
9/3/97	5.4	6.6	9.7	15	18.9	25.6	38.8	58.5	69.1	85.8	100
9/6/97	4.6	5.2	7.9	12.6	16.1	22.8	38.4	61.8	71.5	81.9	100
9/9/97	3.5	4.4	6.6	11	14	18.7	29.8	49.7	59.5	72.4	100
9/16/97	3.6	4.5	7.1	12.1	15	19.8	31.6	56.4	67.7	82.4	100
10/30/7	4	5.1	7.7	12.3	16.3	20	31.5	55	66.4	85.4	100
Avg.	4.76	5.87	8.73	13.78	17.66	23.06	36.27	57.38	66.82	81.63	99.85
STD	0.87	1.07	1.442	1.908	2.482	2.979	4.554	5.643	7.355	4.951	0.474

US-23 Arenac Co.

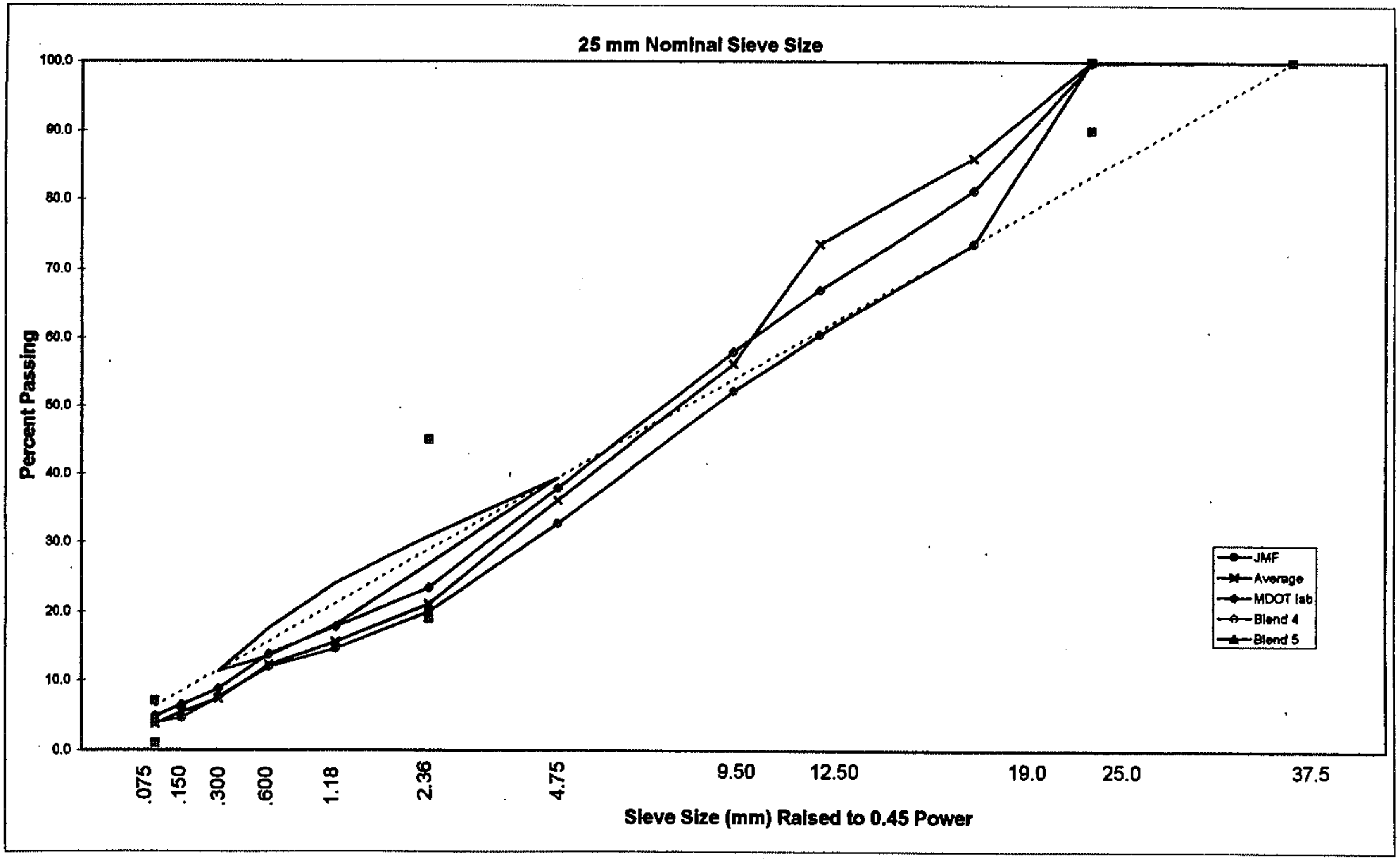
Film Thickness Table 2E3 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	99.8
19	73.6	79.2	81.2
12.5	60.4	63.9	66.9
9.5	52.2	53.4	57.6
4.75	32.7	33	36.8
2.36	20	20.8	23.4
1.18	14.6	15.4	17.8
0.6	12	12.1	13.9
0.3	7.6	7.3	8.8
0.15	4.6	4.6	6
0.075	3.9	3.7	4.8
% AC	4.7	4.8	4.4
Film Thick.	0.00107	0.00111	0.00080

Aggregate Gradation Trials

Project Name: US-2 P&D
Technician: Doug
Date: 1/0/00

Filename: US2P-2E1.XLS
Description: jmf/prod
Nominal Sieve Size: 25 mm



Jett

FILE 300 ____

REPORT OF TEST

BITUMINOUS MIX DESIGN

1931 (N9/91)

Control Section: NH 06 073
Job Number: 32357A
Mix Design No.: 97MD-200
Date: AUGUST 28, 1997

Sample Of: BITUMINOUS MIXTURE NO. 3E3
Date Tested: AUGUST 25, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 52-28	PAYNE & DOLAN		1.019
1	COARSE	1X3/4 CHIP	PIT # 06-08	25.0%	
2	COARSE	3/4 CHIP	PIT # 06-08	29.0%	
3	COARSE	31A	PIT # 06-08	20.0%	
4	FINE	WASHED MAN SAND	PIT # 06-08	15.0%	
5	FINE	REJECT SAND	PIT # 65-55	10.0%	
6	DEG		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 5.3 Air Voids = 4.0
Density lb/cu.ft = 146.7*
(kg/cu.m) =(2349.9) V.M.A. = 13.1
Theo.Max. Density= 153.1
(kg/cu.m) =(2451.7) V.F.A. = 70.1

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
1 IN (25.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
3/4 IN (19.0mm)	81.2	100.0	100.0	100.0	100.0	100.0	95.3	90-100
1/2 IN (12.5mm)	5.9	69.2	100.0	100.0	100.0	100.0	67.5	90 MAX
3/8 IN (9.5mm)	3.7	39.6	100.0	100.0	98.1	100.0	58.2	-
No. 4 (4.75mm)	3.5	7.2	58.3	100.0	83.5	100.0	39.0	-
No. 8 (2.36mm)	3.0	3.9	14.1	95.4	60.9	100.0	26.1	23-49
No. 16 (1.18mm)	2.9	2.5	2.0	64.1	50.7	100.0	17.5	
No. 30 (600µm)	2.8	2.0	2.0	39.2	41.2	100.0	12.7	
No. 50 (300µm)	2.0	2.0	2.0	20.4	15.3	100.0	7.1	
No. 100 (150µm)	1.3	2.0	1.0	6.0	3.2	100.0	3.3	
No. 200 (75µm)	1.1	1.9	0.7	5.0	1.9	100.0	2.9	2-8
CRUSH RET.#4	100.0	100.0	100.0	100.0	46.3	0.0	98.5	75 Min.

Materials submitted by: PAYNE & DOLAN, INC. Plant # 350-07 --(Contractor Furnished)
NOTE TO TMI: ELIMINATE THE DEG & INCREASE THE REJECT SAND TO 11%.

• RECOMMENDED FIELD CONTROL DENSITY AI = 43.7
EFFECTIVE SPECIFIC GRAVITY = 2.658
The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: ROBERTS, R. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
JOHN LIJEWSKI (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

1931A (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: NH 06 073
Job Number: 32357A
Mix Design No.: 97MD-200
Mix Type: 3E3

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM 5.3	2.353	146.8	2.449	152.8	4.0	13.1	70.1	0.73
REGRESSION EVERY 0.1%								
4.4	2.327	145.2	2.482	154.9	6.2	13.3	52.9	0.94
4.5	2.331	145.5	2.479	154.7	6.0	13.2	54.8	0.91
4.6	2.335	145.7	2.475	154.4	5.7	13.2	57.0	0.89
4.7	2.338	145.9	2.471	154.2	5.4	13.1	59.0	0.86
4.8	2.341	146.1	2.467	153.9	5.1	13.1	61.1	0.83
4.9	2.344	146.3	2.464	153.8	4.9	13.1	62.8	0.81
5.0	2.347	146.5	2.460	153.5	4.6	13.1	64.9	0.79
5.1	2.349	146.6	2.456	153.3	4.4	13.1	66.7	0.77
5.2	2.351	146.7	2.453	153.1	4.2	13.1	68.3	0.75
5.3	2.353	146.8	2.449	152.8	3.9	13.1	70.1	0.73
5.4	2.354	146.9	2.446	152.6	3.8	13.2	71.5	0.71
5.5	2.355	147.0	2.442	152.4	3.6	13.2	73.1	0.69
5.6	2.356	147.0	2.438	152.1	3.4	13.3	74.7	0.68
5.7	2.357	147.1	2.435	151.9	3.2	13.3	76.0	0.66
5.8	2.357	147.1	2.431	151.7	3.0	13.4	77.3	0.65
5.9	2.358	147.1	2.428	151.5	2.9	13.5	78.6	0.63
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2

- (PG 52-28 – P&D) SP. GR. = 1.019

- EFFECTIVE SPECIFIC GRAVITY = 2.658

BULK AGGREGATE SPECIFIC GRAVITY = 2.565

DESIGN ESAL'S = <3.0

DESIGN TEMPERATURE = 39 degrees C

MIXING TEMPERATURE = 135 degrees C

COMPACTION TEMPERATURE = 124 degrees C

INITIAL GYRATIONS = 7 %Gmm = 85.7 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 86

MAXIMUM GYRATIONS = 134 %Gmm = 97.6 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
VH 06073	32357A	R. ROBERTS	8-29-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
PAYNE + DOLAN INC	OMER	350-14

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3E3	97MO200	13.1 ±1.20	4.0 ±1.0	146.7 LB/CF ~~kg/m³~~	153.1 ±1.20 ~~kg/m³~~ LB/CF

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
II	2.658	N/A	☐ YES ☒ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	5.3 ±0.50	1 x 3/4" CHIP GLANCY	06-8	25.0
P 37.5 mm		3/4" CHIP "	06-8	29.0
P 25.0 mm	100.0	31A "	06-8	20.0
P 19.0 mm	95.3	WASHED MAN SAND "	06-8	15.0
P 12.5 mm	67.3	REJECT SAND "	06-8	11.0
P 9.5 mm	58.2			
P 4.75 mm ≠	39.0 ±3.0			
P 2.36 mm	26.1			
P 1.18 mm	17.5	RECLAIMED		
P 600 μm ≠	12.7 ±2.0	FILLER		
P 300 μm	7.1	ASPHALT PG 52-28 AMOCO OIL CO ELBERTA		5.3
P 150 μm	3.3	AWI (Spec.) N/A; AWI (Actual) N/A	ANGULARITY INDEX 43.7	
P 75 μm ≠	2.9 ±0.7	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	98.5 ±15	☐ BATCH PLANT ☒ DRUM PLANT	DUST. CORRECTION N/A	

REMARKS:
CONTRACTOR PRODUCED THIS MIX FOR JOINT REPAIR PRIOR TO MIX DESIGN APPROVAL (OK'ED BY P.E.)
≠ RUNNING AVG TOLERANCES.
RUNNING AVG FOR VMA CANNOT FALL BELOW 13.0
SUPER PAVE PROJECT

TRAVELLING MIX INSPECTOR (TMI) Signature: John [signature]

DATE: 9-3-97

D4-15

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 06073	32357 A	R. ROBERTS	9-15-97
CONTRACTOR		PLANT LOCATION	PLANT NO.
PAYNE + DOLAN INC		OMER	350-14

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3 E-3	FIELD MIX DESIGN	13.5 ±1.20	4.0 ±1.0	146.5 ~~kg/m³~~	152.6 ±1.20 ~~kg/m³~~

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IV	2.658	N/A	☐ YES ☒ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %			
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT OLD JMF	PERCENT NEW
ASPHALT, % 5.3	5.4 ±0.5	1 x 3/4" CHIP GLANCY	6-8	25.0	15
P 37.5 mm		3/4" CHIP "	6-8	29.0	29
P 25.0 mm	100.0	31A "	6-8	20.0	33.
P 19.0 mm	95.3	WASHMAN SAND "	6-8	15.0	15.
P 12.5 mm	67.3	REJECT SAND "	65-55	11.0	8.0
P 9.5 mm	58.2				
P 4.75 mm 39.0	43.5 ±3.0				
P 2.36 mm	26.1				
P 1.18 mm	17.5	RECLAIMED			
P 600 μm 12.7	13.0 ±2.0	FILLER			
P 300 μm	7.1	ASPHALT P.G. 52-28 AMOCO OIL CO ESSEXVILLE 5.4			
P 150 μm	3.3	AWI (Spec.) N/A; AWI (Actual) N/A	ANGULARITY INDEX 43.7		
P 75 μm 2.9	3.7 ±1.0	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING			
CRUSHED	98.5 ±15	☐ BATCH PLANT ☒ DRUM PLANT	DUST. CORRECTION N/A		

REMARKS:
EFFECTIVE WITH SUBLOT #6 - APPROVED BY P.E.
RECOMMENDED BY BITUMINOUS MIX DESIGN SECTION THAT IF ANY MORE JMF ADJUSTMENTS ARE REQUESTED FOR THIS MIX - A NEW MIX DESIGN MUST BE SUBMITTED TO BIT LAB LANSING.
TMD FROM 153.1 TO 152.6
VMA FROM 13.1 TO 13.5
A.C. FROM 5.3 TO 5.4

TRAVELLING MIX INSPECTOR (TMI) - Signature: [signature]

DATE: 9-19-97

Michigan Department of Transportation 1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 06073	32357A	R. ROBERTS	9-29-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
Payne + Dolan Inc	OMER	350-14

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3E-3	Field Mix Design	13.5	4.0	146.5 ~~kg/m³~~	152.6 ~~kg/m³~~

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IC	2.658	N/A	☐ YES ☒ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	5.4	1 x 3/4" Chip — Clancy	6-8	15.0
P 37.5 mm		3/4" Chip "	6-8	09.0
P 25.0 mm	100.0	31A "	6-8	33.0
P 19.0 mm	95.3	Washed Man Sand "	6-8	15.0
P 12.5 mm	82.0	Reject Sand "	65-55	8.0
P 9.5 mm	70.0			
P 4.75 mm	43.5			
P 2.36 mm	29.0			
P 1.18 mm	19.0	RECLAIMED		
P 600 μm	13.0	FILLER		
P 300 μm	9.0	ASPHALT PG 52-28 Amoco Oil Co Essexville		5.4
P 150 μm	5.5	AWI (Spec.) N/A; AWI (Actual) N/A		ANGULARITY INDEX 43.7
P 75 μm	3.7	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	98.5	☐ BATCH PLANT ☒ DRUM PLANT		DUST. CORRECTION N/A

REMARKS:
Target Gradation for Non Spec. Sieves Changed to Reflect Actual Gradations Being Produced By Contractor
Agreed By P.E And Contractor to Run Side By Side Tests To Check Testing Procedures - Both Off The Truck And Reheated Samples.
Contractor Also Agreed to use A Recalculated Number of 2.558 in the GSB, Starting with Sublot 4 As Per P.E.
Meeting Between the Bit Lab, Federal Engs.; P.E And TMI's Held This Date

TRAVELLING MIX INSPECTOR (TMI) - Signature	DATE
Julian Lynch	9-29-97

D4-17

US-23 Arenac Co.

Contractors Quality Control Test Data 3E3 Mixture

G_b =1.019		G_{se} =2.658		G_{sb} =2.565		Absorb. =1.38		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff AC	FINE/AC
1	152.44	146.30	4.03	70.37	13.6	5.47	4.16	0.984
2	152.52	145.66	4.50	67.74	13.95	5.44	4.13	0.778
3	152.33	145.57	4.44	68.49	14.09	5.53	4.22	1.039
4	152.34	146.29	3.97	70.96	13.67	5.53	4.22	0.704
5	152.26	146.17	4.00	70.93	13.76	5.56	4.25	0.772
6	152.28	147.30	3.27	75.06	13.11	5.56	4.25	0.942
7	152.59	147.51	3.33	74.09	12.85	5.42	4.11	0.987
8	152.60	145.60	4.59	67.17	13.98	5.42	4.11	1.030
9	152.77	145.62	4.68	66.26	13.87	5.33	4.01	0.929
10	152.69	146.44	4.09	69.50	13.41	5.36	4.04	1.103
11	152.83	146.26	4.3	68.12	13.49	5.31	3.99	1.014
12	152.63	146.43	4.06	69.79	13.44	5.39	4.07	0.950
13	152.69	146.03	4.36	68.06	13.65	5.36	4.04	0.964
14	152.57	145.87	4.39	68.21	13.81	5.42	4.11	0.938
15	152.75	145.23	4.92	65.08	14.09	5.33	4.01	0.765
16	152.33	145.52	4.47	68.34	14.12	5.53	4.22	0.752
17	152.17	145.46	4.41	68.36	13.94	5.58	4.27	0.752
18	152.13	146.33	3.81	71.71	13.47	5.61	4.30	0.719
19	152.24	146.73	3.62	72.51	13.17	5.56	4.25	0.883
20	152.13	145.63	4.27	69.46	13.98	5.61	4.30	0.800
21	152.53	146.11	4.21	68.72	13.46	5.44	4.13	0.953
22	152.91	146.66	4.09	68.49	12.98	5.28	3.96	1.072
23	152.28	145.59	4.39	68.37	13.88	5.56	4.25	0.824
24	152.3	144.88	4.87	65.80	14.24	5.53	4.22	0.821
25	152.26	146.22	3.97	70.59	13.5	5.56	4.25	0.946
26	152.3	147.6	3.09			5.5	4.19	1.099
27	152.7	147.2	3.60			5.3	3.98	0.929
28	152.5	147	3.61			5.4	4.09	1.175
29	152.6	145.1	4.91			5.4	4.09	0.979
30	152.3	146.8	3.61			5.5	4.19	0.955
31	153	147	3.92			5.2	3.88	1.339
32	152.7	146.5	4.06			5.4	4.09	0.955
33	152.3	146.7	3.68			5.5	4.19	1.075
34	152.5	146	4.26			5.4	4.09	0.759
35	152.4	146.5	3.87			5.5	4.19	0.000
36	152.4	145.8	4.33			5.5	4.19	0.812
37	152.1	145.27	4.69	66.40	13.96	5.48	4.17	1.049
38	151.84	147.2	3.06	76.66	13.11	5.76	4.45	1.054
39	152.8	146.86	3.9	69.72	12.88	5.31	3.99	0.876
40	152.51	146.79	3.73	71.37	13.03	5.45	4.14	1.090
41	152.59	147.69	3.2	74.42	12.51	5.43	4.12	0.991
42	152.69	145.36	4.79	65.34	13.82	5.37	4.05	0.797
43	152.76	146.6	4.05	69.04	13.08	5.34	4.02	0.954
44	152.63	145.76	4.49	66.99	13.6	5.4	4.09	0.737
45	152.53	147.33	3.41	73.23	12.74	5.45	4.14	1.088
46	152.67	146.74	3.87	70.18	12.98	5.27	3.95	0.981
47	152.57	146.62	3.94	70.08	13.17	5.43	4.12	0.955
Average	152.49	146.29	4.07	69.60	13.51	5.45	4.13	0.92
STD	0.2394	0.7096	0.4806	2.7431	0.4519	0.1075	0.1090	0.1916

US-23 Arenac Co.

Contractors Quality Control Test Data

3E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	4.09	5.41	8.74	14.03	19.64	29.84	39.00	58.20	82.68	96.86	100.00
2	3.21	4.45	7.49	12.04	16.58	24.50	41.22	68.20	77.05	98.74	100.00
3	4.38	5.74	9.20	14.47	19.77	28.99	50.19	77.19	84.91	98.50	100.00
4	2.97	4.13	7.15	11.99	16.90	25.32	39.93	62.66	74.22	97.43	100.00
5	3.28	4.37	7.38	12.39	17.47	26.01	41.94	68.84	79.40	94.51	100.00
6	4.00	5.27	8.55	13.82	19.37	28.21	42.80	67.46	77.85	98.97	100.00
7	4.05	5.49	9.44	15.19	20.77	29.83	44.64	67.69	77.73	98.31	100.00
8	4.23	5.47	8.74	13.99	19.51	29.66	48.32	74.19	83.70	98.58	100.00
9	3.73	4.92	8.04	12.96	18.23	27.59	44.65	69.15	79.00	95.81	100.00
10	4.46	5.74	9.17	14.59	19.98	29.36	47.54	72.76	82.73	98.74	100.00
11	4.05	5.22	8.71	12.76	19.04	28.19	45.35	74.01	82.91	98.47	100.00
12	3.87	5.09	8.28	13.43	18.99	29.1	47.45	71.8	82.2	97.84	100.00
13	3.9	5.09	8.2	13.26	18.5	26.88	43.13	69.85	79.97	95.21	100.00
14	3.85	5.02	8.29	13.14	19.26	29.83	43.27	63.91	72.47	95.71	100.00
15	3.07	4.19	7.03	11.49	15.99	23.74	40.83	63.34	73.55	97.34	100.00
16	3.17	3.86	7.13	12.09	17.57	25.3	41.38	60.93	73.47	96.27	100.00
17	3.21	4.3	7.29	12.22	16.95	25.54	44.17	68.59	78.22	92.31	100.00
18	3.09	4.17	7.18	12.19	17.19	26.54	45.27	69.24	78.7	96.63	100.00
19	3.75	5.05	8.59	14.28	19.76	28.93	47.85	70.88	79.96	95.63	100.00
20	3.44	4.57	7.67	12.85	17.85	26.55	46.07	70.87	79.81	97.84	100.00
21	3.93	5.03	7.95	13.03	17.94	27.08	48.63	73.15	79.47	97.81	100.00
22	4.25	5.58	8.9	14.16	19.04	27.28	46.42	72.52	82.37	98.53	100.00
23	3.5	4.62	7.43	12	16.16	23.58	43.21	68.83	77.41	96.04	100.00
24	3.46	4.53	7.3	11.81	16.19	23.97	42.48	69.13	79.64	98.64	100.00
25	4.02	5.16	8.01	12.68	17.07	24.91	44.18	70.1	77.61	97.71	100.00
26	4.6	6	10	16.9	22.6	31.1	48.1	68.8	78.3	94.2	100
27	3.7	4.9	8.2	13.6	18.2	25.9	41.8	63.9	73.1	98.2	100
28	4.8	6	9.5	15.4	20.4	29	48.9	77.1	85	97.2	100
29	4	5.1	8	12.5	16.8	25.3	46.5	72.5	80.9	98.3	100
30	4	5.2	8.4	13.3	17.6	25	42.5	68.9	79.9	96	100
31	5.2	6.5	10	15.9	21	29.3	48.7	73.5	81.3	94.8	100
32	3.9	5.1	7.8	12.8	16.8	24.1	43.6	67.3	76	95.4	100
33	4.5	5.6	8.9	14.4	19.1	27.1	47.8	73.9	83.6	98.8	100
34	3.1	4.1	6.9	11.6	15.5	21.8	38.5	62.2	72	97.4	100
35											100
36	3.4	4.4	7.3	12.1	16.5	24.4	42.7	66.4	74.5	95.3	100
37	4.37	5.62	8.73	13.79	18.34	26.29	45.8	73.82	83.03	97.29	100
38	4.69	5.98	9.25	14.49	19.8	29.17	44.55	72.57	83.85	98.65	100
39	3.5	4.65	7.25	11.66	15.4	21.9	33.47	60.42	72.36	96.05	100
40	4.51	5.69	8.69	14.05	18.92	27.72	47.41	75.53	84.66	98.4	100
41	4.08	5.22	8	12.78	16.89	23.54	35.67	62.77	75.47	96.41	100
42	3.23	4.17	6.64	10.99	14.91	21.9	34.95	63.59	77.69	97.9	100
43	3.84	4.87	7.52	12.3	16.66	24.6	39.06	66.47	77.86	96.12	100
44	3.01	3.94	6.41	10.81	14.71	21.7	36.17	64.62	78.19	97.56	100
45	4.5	5.69	8.78	13.99	18.49	26.19	40.93	72.42	83.73	96.95	100
46	3.88	5.02	7.85	12.62	16.69	23.59	38.27	67.97	79.7	95.56	100
47	3.93	6.33	8.75	12.81	19.32	29.07	42.69	72.63	81.49	96.87	100
Avg.	3.86	5.06	8.15	13.17	18.05	26.42	43.43	68.93	79.12	97.00	100.00
STD	0.534	0.652	0.872	1.287	1.721	2.515	4.009	4.571	3.661	1.491	0

US-23 Arenac Co.

Contractors Quality Control Test Data 3E3 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1				100		
2				98.7		
3				98.3		
4				97.74		
5				99.11		
6				100		
7				98.43		
8				97.56		
9				99.56		
9				99.17		
10				97.32		
11				100		
12				97.32		
13				98.19		
14				99.26		
15				99.36		
16				98.62		
17				99.5		
18				99.4		
19				98.1		
20				98.47		
21				98.87		
22				99.14		
23				98.32		
24				97.31		
25				97.3		
26				98.3		
27				97.5		
28				100		
29				96.4		
30				58.3		
31				97.4		
32				99.1		
33				98.7		
34				97.9		
35				98.3		
36				99.2		
37				99		
38				99		
39				99		
40				99		
41				99		
42				99		
43				99		
44				99		
45				99		
46				99		
average				97.82		
STD				5.8824		

US-23 Arenac Co.

Contractors In Place Density Results

3E3 Mixture

sublot	core #1	core #2	core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	91.73	92.6	91.45	91.927						
2	93.15	90.98	90.44	91.523						
3	93.84	93.84	93.84	93.840						
4	93.03	93.35	94.94	93.773						
5	91.85	94.59	95.31	93.917	93.00	66.67	60.00	40.00	5.00	2.00
6	91.56	89.64	93.1	91.433	92.90					
7	95.8	93.45	95.06	94.770	93.55					
8	94.23	91.66	89.62	91.837	93.15					
9	91.34	92.36	92	91.900	92.77					
10	95.17	90.89	92.94	93.000	92.59	46.67	40.00	26.67	6.00	3.00
11	93.99	90.33	88.94	91.087	92.52					
12	94.85	92.67	94.16	93.893	92.34					
13	92.83	93.85	91.03	92.570	92.49					
14	92	92	92	92.000	92.51					
15	94.95	93.5	92	93.483	92.61	53.33	40.00	33.33	3.00	2.00
16	91.74	92.49	95.09	93.107	93.01					
17	93.05	92.89	95.58	93.840	93.00					
18	92.34	95.12	93.01	93.490	93.18					
19	93.62	93.62	93.9	93.713	93.53					
20	91.76	94.67	93.32	93.250	93.48	73.33	66.67	46.67	2.00	0.00
21	91.88	94.37	93.61	93.287	93.52					
22	94.49	95.4	94.4	94.763	93.70					
23	90.23	88.61	89.81	89.550	92.91					
24	91.46	95.58	92.67	93.237	92.82					
25	92.87	94.65	93.22	93.580	92.88	66.67	53.33	46.67	5.00	3.00
26	93.74	93.73	90.62	92.697	92.77					
27	95.73	97.06	93.59	95.460	92.90					
28	97.1	96.61	95.36	96.357	94.27					
29	96.91	94.07	93.57	94.850	94.59					
30	95.36	91.16	95.35	93.957	94.66	86.67	86.67	86.67	2.00	1.00
31	93.69	94.23	96.34	94.753	95.08					
32	94.45	94.36	95.13	94.647	94.91					
33	93.73	94.75	94.44	94.307	94.50					
34	92.99	94.02	95.13	94.047	94.34					
35	95.36	91.77	92.34	93.157	94.18	86.67	80.00	80.00	1.00	0.00
36	92.52	93.47	92.2	92.730	93.78					
37	91.22	93.49	92.82	92.510	93.35					
38	96.53	95.49	97.41	96.477	93.78					
39	94.37	93.42	94.59	94.127	93.80					
40	94.24	95.44	97.15	95.610	94.29	86.67	73.33	53.33	1.00	0.00
41	97.25	96.15	92.88	95.427	94.83					
42	95.59	93.79	95.78	95.053	95.34					
43	92.93	93.23	93.56	93.240	94.69					
44	95.48	96.52	95.35	95.783	95.02					
45	96.13	95.84	96.82	96.263	95.15					
46	96.69	96.69	95.47	96.283	95.32					
47	95.58	95.48		95.530	95.41	93.33	86.67	80.00	0.00	0.00
Average			93.7324							
STD			1.883							
Bonus Lots						4	3	3		
Deduct Lots									3	0

US-23 Arenac Co.

Contractors Mixture Price Adjustment Table — 3E3 Mixture

	TMD				VMA				VOIDS			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	152.6	Avg.	Dev.	Dev.	13.5	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.
1	0.16				0.1				0.03			
2	0.08				0.45				0.5			
3	0.27				0.59				0.44			
4	0.26				0.17				0.03			
5	0.34	152.38	0.222	0.22	0.26	13.81	0.314	-0.31	0	4.19	0.2	-0.19
6	0.32				0.39				0.73			
7	0.01				0.65				0.67			
8	0				0.48				0.59			
9	0.17				0.37				0.68			
10	0.09	152.59	0.118	0.01	0.09	13.44	0.396	0.06	0.09	3.99	0.552	0.01
11	0.23				0.01				0.3			
12	0.03				0.06				0.06			
13	0.09				0.15				0.36			
14	0.03				0.31				0.39			
15	0.15	152.69	0.106	-0.09	0.59	13.70	0.224	-0.20	0.92	4.41	0.406	-0.41
16	0.27				0.62				0.47			
17	0.43				0.44				0.41			
18	0.47				0.03				0.19			
19	0.36				0.33				0.38			
20	0.47	152.20	0.4	0.40	0.48	13.74	0.38	-0.24	0.27	4.12	0.344	-0.12
21	0.07				0.04				0.21			
22	0.31				0.52				0.09			
23	0.32				0.38				0.39			
24	0.3				0.74				0.87			
25	0.34	152.46	0.268	0.14	0	13.61	0.336	-0.11	0.03	4.31	0.318	-0.31
26	0.3								0.91			
27	0.1								0.39			
28	0.1								0.39			
29	0								0.91			
30	0.3	152.48	0.16	0.12			13.5		0.38	3.76	0.6018	0.24
31	0.4								0.07			
32	0.1								0.06			
33	0.3								0.32			
34	0.1								0.26			
35	0.2	152.58	0.22	0.02			13.5		0.12	3.96	0.1705	0.04
36	0.2								0.33			
37	0.5				0.46				0.69			
38	0.76				0.39				0.94			
39	0.2				0.62				0.1			
40	0.09	152.33	0.35	0.27	0.47	13.25	3.088	0.25	0.27	3.94	0.4661	0.06
41	0.01				0.99				0.8			
42	0.09				0.32				0.79			
43	0.16				0.42				0.05			
44	0.03				0.1				0.49			
45	0.07	152.64			0.76	13.15			0.59	3.99		
46	0.07				0.52				0.13			
47	0.03	152.63	0.072	-0.03	0.33	13.11	0.426	0.39	0.06	3.95	0.264	0.05
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			9				6				7	
Deduct Lots				0				0				0

US-23 Arenac Co.

Contractors Mixture Price Adjustment Table — 3E3 Mixture

	% A.C.				75um				Crushed			
Sublot	JMF 5.4	Lot Avg.	Abs. Dev.	Dev.	JMF 3.7	Lot Avg.	Abs. Dev.	Dev.	JMF 98.5	Lot Avg.	Abs. Dev.	Dev.
1	0.07				0.39				1.5			
2	0.04				0.49				0.2			
3	0.13				0.68				0.2			
4	0.13				0.73				0.76			
5	0.16	5.506	0.106	-0.106	0.42	3.586	0.542	0.114	0.61	98.77	0.654	-0.27
6	0.16				0.3				1.5			
7	0.02				0.35				0.07			
8	0.02				0.53				0.94			
9	0.07				0.03				1.06			
10	0.04	5.418	0.062	-0.018	0.76	4.094	0.394	-0.394	0.67	98.944	0.848	-0.444
11	0.09				0.35				1.18			
12	0.01				0.17				1.5			
13	0.04				0.2				1.18			
14	0.02				0.15				0.31			
15	0.07	5.362	0.046	0.038	0.63	3.748	0.3	-0.048	0.76	98.418	0.986	0.082
16	0.13				0.53				0.86			
17	0.18				0.49				0.12			
18	0.21				0.61				1			
19	0.16				0.05				0.9			
20	0.21	5.578	0.178	-0.178	0.26	3.332	0.388	0.368	0.4	98.996	0.656	-0.496
21	0.04				0.23				0.03			
22	0.12				0.55				0.37			
23	0.16				0.2				0.64			
24	0.13				0.24				0.18			
25	0.16	5.474	0.122	-0.074	0.32	3.832	0.308	-0.132	1.19	98.422	0.482	0.078
26	0.1				0.9				1.2			
27	0.1				0				0.2			
28	0				1.1				1			
29	0				0.3				1.5			
30	0.1	5.42	0.06	-0.02	0.3	4.22	0.52	-0.52	2.1	97.9	1.2	0.6
31	0.2				1.5				40.2			
32	0				0.2				1.1			
33	0.1				0.8				0.6			
34	0				0.6				0.2			
35	0.1	5.4	0.08	0	3.7	4.175	1.36	-0.475	0.6	90.28	8.54	8.22
36	0.1				0.3				0.2			
37	0.08				0.67				0.7			
38	0.36				0.99				0.5			
39	0.09				0.2				0.5			
40	0.05	5.5	0.136	-0.1	0.81	4.094	0.594	-0.394	0.5	98.9	0.48	-0.4
41	0.03				0.38				0.5			
42	0.03				0.47				0.5			
43	0.06				0.14				0.5			
44	0				0.69				0.5			
45	0.05	5.398			0.8	3.732			0.5			
46	0.13				0.18				0.5			
47	0.03	5.378	0.054	0.022	0.23	3.832	0.408	-0.132	0.5	99	0.5	-0.5
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			9				8				9	
Deduct Lots				0				0				0

US-23 Arenac Co.

MDOT Verification Test Data 3E3 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	VFA	Fines/AC
5	152.72	145.97	4.42	13.71	5.37	4.05	67.761	1.135
10	152.94	146.46	4.24	13.61	5.26	3.94	68.846	1.156
13	153.06	144.41	5.65	14.46	5.2	3.88	60.927	1.110
14	152.67	143.85	5.78	14.94	5.37	4.05	61.312	1.137
15	153.66	143.81	6.41	14.62	4.96	3.64	56.156	1.042
16	153.52	143.48	6.54	14.62	5.01	3.69	55.267	1.062
18	153.21	144.09	5.95	14.4	5.17	3.85	58.681	0.963
22	152.94	146.59	4.15	13.01	5.28	3.96	68.101	1.125
26	152.7	148.1			5.4	4.09		1.224
31	152.6	148.4			5.4	4.09		1.346
39	152.83	145.98	4.48	13.41	5.31	3.99	66.592	1.194
44	152.1	144.96	4.69	14.33	5.65	4.34	67.271	0.961
17	152.5	144.5			5.4	4.09		0.930
27	152.5	148.1			5.4	4.09		0.979
29	153	145.2			5.2	3.88		1.056
35	152.5	147			5.4	4.09		1.028
average	152.84	145.68	5.23	14.11	5.30	3.98	63.09	1.09
STD	0.3984	1.6417	0.9287	0.6302	0.1675	0.1699	5.2322	0.1106

MDOT Central Lab Test Data

					PG52-28	Amoco	
LAB #			%AC	Eff. AC	Orig. Pen	Rec. Pen	Fines/AC
9/18/97	P&D	SPLIT	4.7	3.38	227	151	1.333
9/18/97	MDOT	SPLIT	4.9	3.58	210	113	1.593
8/26/97			5.1	3.78	219	129	1.296
8/27/97					212		
9/13/97			4.6	3.27	260	132	1.466
9/15/97					261		
9/16/97			5.2	3.88	239	132	1.082
9/18/97			5.3	3.98	235	132	1.029
9/22/97					245		
9/23/97			4.3	2.97	257	128	1.313
9/26/97			4.3	2.97	255	141	1.212
9/27/97					245		
9/29/97					246		
9/30/97			4.8	3.48	244	140	1.151
10/1/97			5.4	4.09	250		0.979
10/2/97			5.1	3.78	249	145	1.270
10/3/97					248		
10/6/97			5.3	3.98	248	135	1.155
10/23/97			5.5	4.19	230	125	1.242
Average			4.96	3.64	241.05	133.58	1.24
STD			0.3990	0.4045	15.2113	9.9494	0.1701

US-23 Arenac Co.

MDOT Verification Test Data

3E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
5	4.6	5.81	9.04	14.44	20.18	30.66	47.92	71.6	84.22	99.17	100
10	4.56	5.77	9.03	14.33	19.63	28.99	46.57	70.13	83.75	97.86	100
13	4.31	5.56	8.56	13.62	19	28.19	45.12	73.36	85.77	100	100
14	4.61	5.8	8.94	14.02	19.35	28.67	47	72.2	85.16	98.16	100
15	3.79	4.92	7.91	12.68	17.39	25.67	40.96	65.7	79.99	98.84	100
16	3.92	5.06	7.93	12.53	17.27	25.67	41.93	68.5	82.21	98.85	100
18	3.71	4.8	7.77	12.69	17.54	25.97	42.02	63.19	75.94	97.69	100
22	4.46	5.75	9.02	14.25	19.23	27.54	45.85	69.42	82.46	99.55	100
26	5	6.3	10.3	16.7	22.1	30.5	46.5	68.3	78.2	96.7	100
31	5.5	6.8	10.5	16.5	21.7	30.3	49.6	75	83.1	98	100
39	4.77	6.1	8.93	13.84	18.23	25.88	39.6	68.03	82.23	96.39	100
44	4.17	5.26	7.91	12.86	17.54	26.08	41.29	71.14	84.76	99.49	100
17	3.8	4.9	8	13.1	18.3	27.4	45.2	71.7	82.2	100	100
27	4	5.2	8.6	14.4	19.2	27.3	43.2	62.8	73.2	95.4	100
29	4.1	5.2	7.9	12.6	16.9	24.9	42.2	64.6	77.2	97.7	100
35	4.2	5.4	8.6	13.8	18.4	26.5	45	70.5	81.2	98.9	100
Avg.	4.34	5.54	8.68	13.90	18.87	27.51	44.37	69.14	81.35	98.29	100.00
STD	0.4871	0.5549	0.8209	1.2595	1.5132	1.8687	2.8462	3.5723	3.5676	1.3197	0.0000

MDOT Central Lab Test Data

LAB	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
9/18/97	4.5	5.9	9.1	14.2	19.9	28.8	46.4	71.8	80.8	97.2	100
9/18/97	5.7	7.1	10.9	17.1	23.4	32.9	51.3	75.4	86.2	98.5	100
8/26/97	4.9	6.5	10.5	16.4	22	30.9	44.5	66.3	76.5	97.7	100
9/13/97	4.8	6	8.9	13.7	19	27.3	42.6	67	80.3	94.3	100
9/16/97	4.2	5.4	8.5	13.4	19	27.9	46.2	70.8	81	95.8	100
9/18/97	4.1	5.5	8.8	14.5	21	30.7	48.4	72.9	82.4	95.9	100
9/23/97	3.9	5	7.8	12.1	16.6	23.2	38.4	61.1	71.4	92.2	100
9/26/97	3.6	4.7	7.3	11.7	15.5	21.2	34.2	57.1	69.6	95.3	100
9/30/97	4	5.8	7.9	12.4	16.9	24.9	47	66.8	77.7	94.4	100
10/1/97	4	5.1	8.6	14.4	19.2	27.3	41.9	62.8	73.2	95.4	100
10/2/97	4.8	6	9.1	14.4	19	27.4	45.3	71.6	82.6	98.9	100
10/6/97	4.6	5.9	9.2	15	19.7	27.6	48.2	71.9	81.6	97.3	100
10/23/7	5.2	6.7	10	15.6	20.9	29.8	46.8	72.3	82.8	99.4	100
Avg.	4.48	5.82	8.97	14.22	19.39	27.68	44.71	68.29	78.93	96.33	100.00
STD	0.5913	0.687	1.037	1.602	2.193	3.197	4.536	5.364	4.950	2.073	0

US-23 Arenac Co.

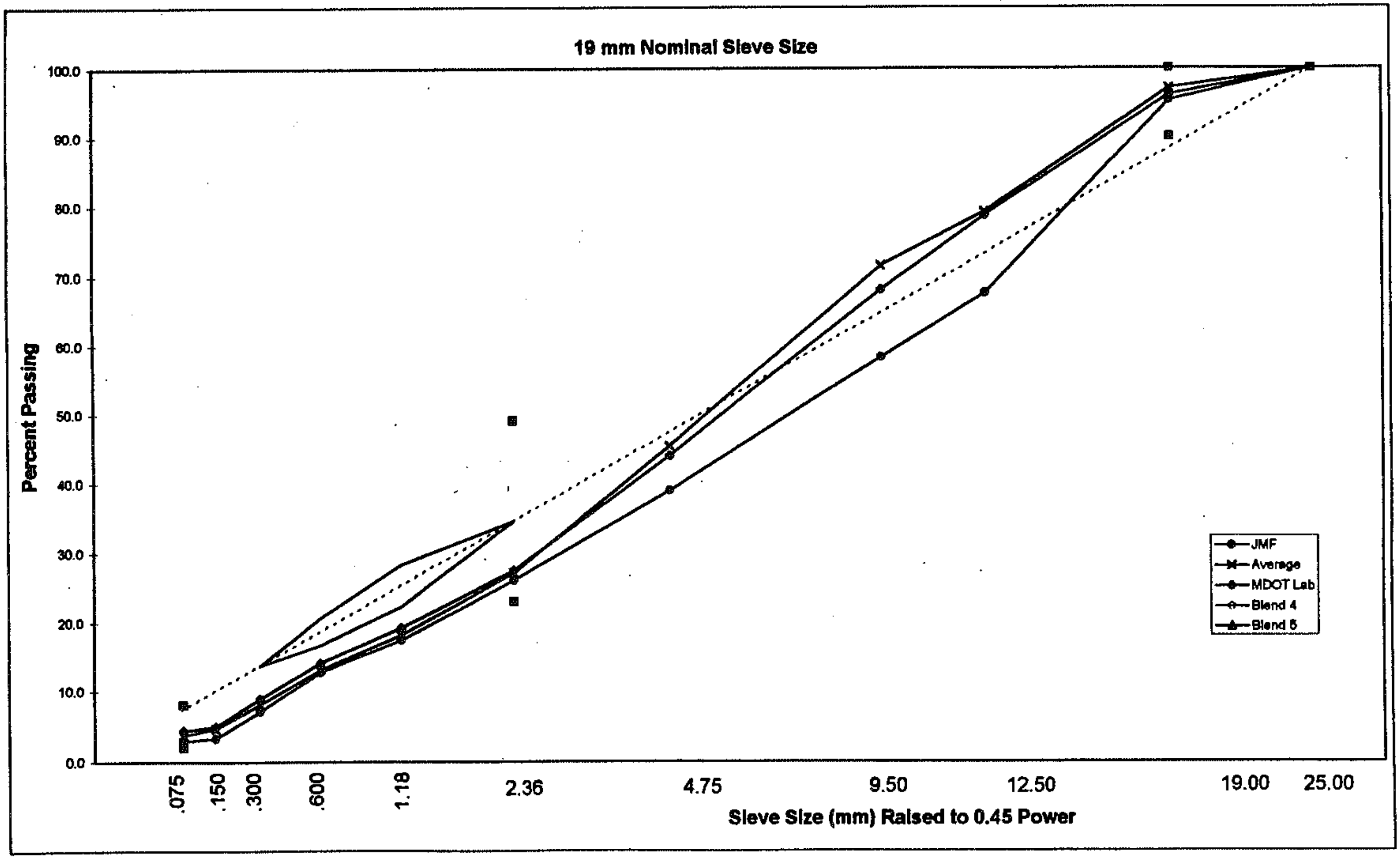
Film Thickness Table 3E3 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	95.3	97	96.4
12.5	67.5	79.1	80.2
9.5	58.2	68.9	69.1
4.75	39	43.4	44.7
2.36	26.1	26.4	27.7
1.18	17.5	18.1	19.4
0.6	12.7	13.2	14.2
0.3	7.1	8.2	9
0.15	3.3	5.1	5.8
0.075	2.9	3.9	4.5
% AC	5.3	5.45	4.96
Film Thick.	0.00136	0.00112	0.00089

Aggregate Gradation Trials

Project Name: US-23 P&D
Technician: Doug
Date: 1/0/00

Filename: US2p-3E1.XLS
Description: JMF/PROD
Nominal Sieve Size: 19 mm



FILE 300 __

MICHIGAN DEPARTMENT OF TRANSPORTATION

REPORT OF TEST

1931 (N9/91) BITUMINOUS MIX DESIGN

Control Section: NH 06073
Job Number: 32358A
Mix Design No.: 97MD-235
Date: SEPTEMBER 29, 1997

Sample Of: BITUMINOUS MIXTURE NO. 4E3
Date Tested: SEPTEMBER 25, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 52-28	AMOCO		1.019
1	COARSE GRADED	3/4 CHIP	PIT # 06-08	20.0%	
2	COARSE GRADED	31A	PIT # 06-08	43.0%	
3	FINE GRADED	WASH MAN SAND	PIT # 06-08	24.0%	
4	FINE GRADED	REJECT SAND	PIT # 65-55	12.0%	
5	DEGRADATION		PLANT	1.0%	

Note to TMI: Eliminate the Degradation & increase the Reject Sand to 13%.

MIX DESIGN

Asphalt @ Optimum= 6.1 Air Voids = 4.0
Density lb/cu.ft = 145.0
(kg/cu.m) =(2317.0) V.M.A. = 14.5
Theo.Max. Density= 150.7
(kg/cu.m) =(2417.5) V.F.A. = 73.8

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100
1/2 IN (12.5mm)	69.2	100.0	100.0	100.0	100.0	93.8	90-100
3/8 IN (9.5mm)	39.6	100.0	100.0	98.1	100.0	87.7	90 MAX
No. 4 (4.75mm)	7.2	58.3	100.0	83.5	100.0	61.5	
No. 8 (2.36mm)	3.9	14.1	95.4	60.9	100.0	38.0	28-58
No. 16 (1.18mm)	2.5	2.0	64.1	50.7	100.0	23.8	
No. 30 (600μm)	2.0	2.0	39.2	41.2	100.0	16.6	
No. 50 (300μm)	2.0	2.0	20.4	15.3	100.0	9.0	
No. 100 (150μm)	2.0	1.0	6.0	3.2	100.0	3.7	
No. 200 (75μm)	2.0	1.0	6.0	3.0	100.0	3.6	2-10
CRUSH RET.#4	100.0	100.0	100.0	46.3	100.0	97.2	75 Min.
A.W.I.	332.0	332.0		262.7		328.4	260 Min.

Materials submitted by: PAYNE & DOLAN, INC. Plant # 350-00 --(Contractor Furnished)
NOTE TO TMI: ELIMINATE THE DEGRADATION & INCREASE THE REJECT SAND TO 13%.

* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 43.6
EFFECTIVE SPECIFIC GRAVITY = 2.651

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: ROBERTS, R. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
JOHN LIJEWSKI (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

Wt

1931A (N9/91)

REPORT OF TEST

BITUMINOUS MIX DESIGN

Control Section: NH 06073
Job Number: 32358A
Mix Design No.: 97MD-235
Mix Type: 4E3

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
6.1	2.323	145	2.415	150.7	4.0	14.5	73.8	0.77

REGRESSION EVERY 0.1%

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
5.4	2.292	143.0	2.440	152.3	6.1	15.0	59.7	0.90
5.5	2.296	143.3	2.436	152.0	5.7	15.0	61.6	0.88
5.6	2.300	143.5	2.433	151.8	5.5	14.9	63.4	0.86
5.7	2.305	143.8	2.429	151.6	5.1	14.8	65.6	0.84
5.8	2.309	144.1	2.426	151.4	4.8	14.8	67.3	0.82
5.9	2.314	144.4	2.422	151.1	4.5	14.7	69.6	0.80
6.0	2.318	144.6	2.419	150.9	4.2	14.6	71.4	0.78
6.1	2.323	145.0	2.415	150.7	3.8	14.5	73.8	0.77
6.2	2.327	145.2	2.412	150.5	3.5	14.5	75.6	0.75
6.3	2.332	145.5	2.408	150.3	3.2	14.4	78.0	0.73
6.4	2.336	145.8	2.405	150.1	2.9	14.3	80.0	0.72
6.5	2.341	146.1	2.401	149.8	2.5	14.2	82.4	0.71
6.6	2.345	146.3	2.398	149.6	2.2	14.2	84.4	0.69
6.7	2.350	146.6	2.394	149.4	1.8	14.1	87.0	0.68
6.8	2.355	147.0	2.391	149.2	1.5	14.0	89.2	0.67
6.9	2.359	147.2	2.387	148.9	1.2	13.9	91.6	0.65
SPECIFICATIONS =					4%	14.0	65-78	0.6-1.2

- (PG 52-28 – AMOCO OIL) SP. GR. = 1.019

- EFFECTIVE SPECIFIC GRAVITY = 2.651

BULK AGGREGATE SPECIFIC GRAVITY = 2.552

DESIGN ESAL'S = <3.0

DESIGN TEMPERATURE = 38 degrees C

MIXING TEMPERATURE = 135 degrees C

COMPACTION TEMPERATURE = 123 degrees C

INITIAL GYRATIONS = 7 %Gmm = 86.1 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 86

MAXIMUM GYRATIONS = 134 %Gmm = 97.5 SPECIFICATION = 98% MAX.

1990 STD SPEC SUPP

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 06073	32358A	R. ROBERTS	9-30-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
PAYNE + DOLAN INC	OMER	350-14

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
4E 3	97MD 235	14.5 ±1.2	4.0 ±1.0	145.0 ~~kg/m³~~	150.7 ±1.2 ~~kg/m³~~

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
IV	2.651	N/A	☐ YES ☒ NO

MIX/AGG. GRADATION, % ITEM	PERCENT	MIX/AGG. BLEND PROPORTION, % MATERIAL/PRODUCER		PIT NO.	PERCENT
ASPHALT, %	6.1 ±0.5	3/4" CHIP	GLANCY	6-8	20.0
P 37.5 mm		31A	"	6-8	43.0
P 25.0 mm		WASHED MAN SAND	"	6-8	24.0
P 19.0 mm	100.0	REJECT SAND	"	65-55	13.0
P 12.5 mm	93.8				
P 9.5 mm	87.7				
P 4.75 mm *	61.3				
P 2.36 mm	38.0				
P 1.18 mm	23.8	RECLAIMED			
P 600 μm *	16.6	FILLER			
P 300 μm	9.0	ASPHALT	PG 52-28 Amoco Oil Co Elberta		6.1
P 150 μm	3.7	AWI (Spec.) 260	AWI (Actual) 328.4	ANGULARITY INDEX 43.6	
P 75 μm *	3.6	TYPE OF TESTING	☒ QUALITY ASSURANCE TESTING	☐ REGULAR TESTING	
CRUSHED	97.2 ±15	☐ BATCH PLANT	☒ DRUM PLANT	DUST. CORRECTION N/A	

REMARKS:
* QUALITY CONTROL SIEVES
MIX DESIGN RECIEVED FROM BIT LAB THIS DATE.
INTIAL SUBLOT SIZE - 800 TON.

TRAVELLING MIX INSPECTOR (TMI) - Signature: John French

DATE: 9-30-97

MICHIGAN DEPARTMENT OF TRANSPORTATION 1911

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

CONTROL SECTION/JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 06073 32357A	R. ROBERTS	10-09-97
CONTRACTOR	PLANT LOCATION	PLANT NO.
PAYNE & DOLAN INC.	OMER	350-14

TYPE OF MIXTURE	MIX DESIGN NO.	AIR VOIDS	T.M.D.	MARSHALL DENSITY
4E3	97MD-235 MOD	4.0	150.7 lbs/ft³	145.0 lbs/ft³

TESTING OPTION	MIX DESIGN V.M.A.	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY
I II III IV V — IV	14.5	2.651

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROP. %			
ITEM	PERCENT	MATERIAL / PRODUCER		PIT NO.	PERCENT
ASPHALT, %	6.1	3/4 CHIP		06-08	24.0 %
P 1.5"		31A		06-08	40.0 %
P 1.0"		WASH MAN SAND		06-08	24.0 %
P 3/4"	100.0	REJECT SAND		65-55	12.0 %
P 1/2"	93.8				%
P 3/8"	87.7				%
P # 4	56.0				%
P # 8	38.0	RECLAIMED			%
P # 16	23.8	FILLER			%
P # 30	14.6	ASPHALT	52-28 AMOCO ELBERTA		6.1 %
P # 50	9.0	AWI (SPEC.) 260	AWI (ACT.) 329	ANGULARITY INDEX	43.6
P #100	3.7	PLANT TYPE	X DRUM	BATCH	CONTIN.
P # 200	3.6	ACTUAL MIX TIME		DRY	WET
CRUSHED, %	~~97.0~~ 2	X QUALITY ASSRANCE TESTING			
DUST. CORR.	0.4 %	REGULAR TESTING			

REMARKS: CONTRACTOR MADE BLEND PERCENT CHANGES AND #4 TO 56.0 AND #30 TO 14.6

CHANGED BULK AGGREGATE SPECIFIC GRAVITY FROM 2.552 TO 2.555

CHANGED TO 1200 TON SUBLOTS STARTING WITH SUBLOT #6. CHANGES APPROVED BY P.E.

SIGNATURE: Michael R Mueller DATE: 10-09-97

US-23 Arenac Co.

Contractors Quality Control Test Data

4E3 Mixture

G_b =1.019		G_{se} =2.651		G_{sb} =2.552		Absorb. =1.49		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	151.29	144.97	4.17	70.74	14.25	5.83	4.43	0.94
2	151.83	146.05	3.81	71.63	13.43	5.6	4.19	1.19
3	150.8	144.89	3.94	72.90	14.54	6.06	4.66	0.72
4	150.76	144.39	4.26	71.35	14.87	6.08	4.68	0.73
5	150.77	144.33	4.23	71.50	14.84	6.08	4.68	0.82
6	150.8	145.47	3.53	75.28	14.28	6.06	4.66	0.99
7	150.88	145.68	3.45	75.60	14.14	6.03	4.63	0.81
8	150.94	145.45	3.67	74.28	14.27	6	4.60	0.77
9	150.74	146.77	2.64	80.49	13.53	6.08	4.68	0.92
10	150.89	145.83	3.04	78.30	14.01	6.03	4.63	0.74
11	151.2	144.14	4.65	68.81	14.91	5.89	4.49	0.68
12	150.97	144.56	3.95	72.80	14.52	6	4.60	0.80
13	150.98	144.82	4.09	71.95	14.58	5.97	4.57	0.67
14	150.65	144.53	4.07	72.74	14.93	6.14	4.74	0.61
15	150.68	144.59	4.06	72.66	14.85	6.11	4.71	0.64
16	150.76	144.58	4.07	72.50	14.8	6.08	4.68	0.60
17	150.86	144.33	4.39	70.69	14.98	6.03	4.63	0.67
18	150.67	145.42	3.52	75.50	14.37	6.11	4.71	0.95
19	150.84	144.71	4.04	72.57	14.73	6.06	4.66	0.82
20	150.69	145.95	3.19	77.36	14.09	6.11	4.71	0.79
21	151.01	145.83	3.43	75.50	14	5.97	4.57	0.88
22	151	144.59	4.24	71.18	14.71	5.97	4.57	0.97
23	151.13	145.64	3.61	74.27	14.03	5.91	4.51	0.86
24	151.07	144.89	4.09	71.83	14.52	5.94	4.54	0.70
25	151	144.59	4.25	71.15	14.73	5.97	4.57	0.87
26	150.94	144.61	4.18	76.41	17.72	6	4.60	0.79
27	150.95	144.21	4.45	70.25	14.96	6	4.60	0.71
28	151.08	145.39	3.76	73.56	14.22	5.94	4.54	1.04
29	150.95	145.27	3.78	73.70	14.37	6	4.60	0.84
30	151.04	144.59	4.24	71.20	14.72	5.97	4.57	0.90
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
Average	150.94	145.04	3.89	73.29	14.56	6.00	4.60	0.81
STD	0.2320	0.6529	0.4449	2.6020	0.7212	0.1043	0.1059	0.1359

US-23 Arenac Co.

Contractors Quality Control Test Data 4E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	4.17	5.79	10.77	18.89	26.95	40.23	63.29	89.68	94.79	100
2	4.98	4.98	11.78	20.4	29	41.4	62.82	89.15	95.9	100
3	3.36	4.59	8.46	14.76	20.99	33.21	53.95	83.37	93.64	100
4	3.4	4.26	7.59	13.31	19.55	32.34	52.82	84.29	94.08	100
5	3.85	5.08	8.5	14.6	21.32	35.35	58.51	88.6	96.23	100
6	4.6	5.91	9.45	15.69	22	35.22	54.85	86.36	95.75	100
7	3.76	5	8.32	13.96	19.79	32.37	52.01	81.81	91.53	100
8	3.53	4.7	8.03	13.76	19.77	32.38	51.66	84.31	94.26	100
9	4.31	5.67	10.02	17.7	25.75	38.54	52.53	87.01	96.2	100
10	3.43	4.61	8.18	14.59	21.16	32.12	51.34	84.93	95.08	100
11	3.03	4.2	8.18	14.99	21.8	33.43	54.84	85.5	93.77	100
12	3.68	5.1	9.27	16.26	23.13	34.57	56.43	87.17	95.4	100
13	3.07	4.34	8.24	14.77	21.26	32.74	53.13	85.3	95.29	100
14	2.91	4.22	8.16	14.66	21.02	32.86	53.9	85.51	95.28	100
15	3.01	4.23	8.16	14.71	21.28	32.62	53.07	84.17	92.74	100
16	2.79	4.15	8.47	15.32	21.66	33.41	52.95	83.11	93.87	100
17	3.11	4.36	8.2	14.69	21.46	34.2	55.22	86.21	95.76	100
18	4.47	5.78	9.78	16.67	24.13	36.52	56.33	87.89	97.77	100
19	3.8	5.09	9.04	16.1	23.5	32.26	54.98	85.88	94.91	100
20	3.74	5.09	9.31	16.51	23.88	36.45	56.45	86.91	95.76	100
21	4.03	5.33	9.23	15.81	22.81	35.16	55.27	85.98	94.7	100
22	4.42	5.87	10.56	17.95	25.22	38.52	61.06	89.71	95.36	100
23	3.87	5.16	9.34	16.45	23.54	34.95	56.21	88.42	96.05	100
24	3.17	4.33	8.09	15.14	22.18	33.78	53.09	86.19	95.68	100
25	3.99	5.2	8.98	15.62	22.73	34.8	55.64	88.16	96.18	100
26	3.65	5.08	8.82	15.35	22.21	34.15	54.85	84.92	95.81	100
27	3.28	4.47	8.25	14.68	21.19	32.24	53.01	85.65	94.56	100
28	4.73	5.91	9.69	16.73	24.16	37.27	59.4	89.29	95.61	100
29	3.86	5.21	9.4	16.28	22.85	34.15	53.06	83.06	92.37	100
30	4.11	5.33	9.19	15.98	23.05	34.67	55.59	89.86	97.37	100
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
average	3.74	4.97	8.98	15.74	22.64	34.73	55.28	86.28	95.06	100.00
STD	0.5728	0.5731	0.9424	1.5233	2.1039	2.4392	3.0726	2.1885	1.3521	0

US-23 Arenac Co.

Contractors Quality Control Test Data 4E3 Mixture

Sublot	Marshall A.V.	% G_{mm} At N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1				96.4		
2				97.9		
3				98.5		
4				97.2		
5				98.3		
6				98.5		
7				97.7		
8				97.1		
9				97.9		
10				98.4		
11				98.2		
12				96.9		
13				99.1		
14				98.6		
15				97.2		
16				98.4		
17				97.3		
18				97.8		
19				98.6		
20				98.8		
21				97.2		
22				98.4		
23				97.3		
24				98.4		
25				96.3		
26				97.4		
27				98.4		
28				99.1		
29				98.7		
30				96.5		
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
Avg.				97.88		
STD				0.7970		

US-23 Arenac Co.

Contractors In Place Density Results

4E3 Mixture

sublot	core #1	core #2	core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	92	92	92	92.000						
2	92	92	92	92.000						
3	92	92	92	92.000						
4	92.41	91.36	92.31	92.027						
5	87.35	93.24	95.6	92.063	92.02	13.33	13.33	6.67	2.00	1.00
6	92.44	93.2	93.79	93.143	92.25					
7	93.34	93.74	96.01	94.363	92.72					
8	90.94	94.16	94.59	93.230	92.97					
9	95.74	92.93	94.38	94.350	93.43					
10	95.09	94.29	94.38	94.587	93.93	86.67	80.00	66.67	1.00	1.00
11	92.37	96.5	95.95	94.940	94.29					
12	95.07	93.24	92.46	93.590	94.14					
13	93.5	92.19	94.23	93.307	94.15					
14	94.21	96.04	93.61	94.620	94.21					
15	96.11	94.31	91.78	94.067	94.10	73.33	73.33	60.00	1.00	0.00
16	94.89	89.42	93.92	92.743	93.67					
17	96.79	95.18	97.01	96.327	94.21					
18	92.4	92.67	94.19	93.087	94.17					
19	89.82	96.31	93.82	93.317	93.91					
20	93.25	93.6	96.78	94.543	94.00	80.00	73.33	66.67	2.00	2.00
21	93.7	93.07	92.98	93.250	94.10					
22	93.85	92.98	94.23	93.687	93.58					
23	92.7	90.34	92.05	91.697	93.30					
24	93.58	94.71	94.13	94.140	93.46					
25	90.33	94.9	93.01	92.747	93.10	80.00	60.00	46.67	2.00	2.00
26	93.81	91.35	94.34	93.167	93.09					
27	91.19	92.34	91.07	91.533	92.66					
28	92.68	92.01	94.43	93.040	92.93					
29	92.21	94.83	95.81	94.283	92.95					
30	90.91	95.45	91.15	92.503	92.91	46.67	40.00	40.00	5.00	1.00
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
Average			93.345							
STD			1.7967							
Bonus Lots						3	1	0		
Deduct Lots									1	0

US-23 Arenac Co.

Contractors Mixture Price Adjustment Table 4E3 Mixture

	TMD				VMA				VOIDS			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	150.7	Avg.	Dev.	Dev.	14.5	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.
1	0.59				0.25				0.17			
2	1.13				1.07				0.19			
3	0.1				0.04				0.06			
4	0.06				0.37				0.26			
5	0.07	151.09	0.39	-0.39	0.34	14.386	0.414	0.114	0.23	4.082	0.182	-0.082
6	0.1				0.22				0.47			
7	0.18				0.36				0.55			
8	0.24				0.23				0.33			
9	0.04				0.97				1.36			
10	0.19	150.85	0.15	-0.15	0.49	14.046	0.454	0.454	0.96	3.266	0.734	0.734
11	0.5				0.41				0.85			
12	0.27				0.02				0.05			
13	0.28				0.08				0.09			
14	0.05				0.43				0.07			
15	0.02	150.89	0.224	-0.196	0.35	14.758	0.258	-0.258	0.06	4.164	0.184	-0.164
16	0.06				0.3				0.07			
17	0.16				0.48				0.39			
18	0.03				0.13				0.48			
19	0.14				0.23				0.04			
20	0.01	150.76	0.08	-0.064	0.41	14.594	0.31	-0.094	0.81	3.842	0.358	0.158
21	0.31				0.5				0.57			
22	0.3				0.21				0.24			
23	0.43				0.47				0.39			
24	0.37				0.02				0.09			
25	0.3	151.04	0.342	-0.342	0.23	14.398	0.286	0.102	0.25	3.924	0.308	0.076
26	0.24				3.22				0.18			
27	0.25				0.46				0.45			
28	0.38				0.28				0.24			
29	0.25				0.13				0.22			
30	0.34	150.99	0.292	-0.292	0.22	15.198	0.862	-0.698	0.24	4.082	0.266	-0.082
31												
32												
33												
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			6				5				5	
Deduct Lots				0				0				1

US-23 Arenac Co.

Contractors Mixture Price Adjustment Table — 4E3 Mixture

	% A.C.				75um				Crushed			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	6.1	Avg.	Dev.	Dev.	3.6	Avg.	Dev.	Dev.	97.2	Avg.	Dev.	Dev.
1	0.27				0.57				0.8			
2	0.5				1.38				0.7			
3	0.04				0.24				1.3			
4	0.02				0.2				0			
5	0.02	5.93	0.17	0.17	0.25	3.952	0.528	-0.352	1.1	97.66	0.78	-0.46
6	0.04				1				1.3			
7	0.07				0.16				0.5			
8	0.1				0.07				0.1			
9	0.02				0.71				0.7			
10	0.07	6.04	0.06	0.06	0.17	3.926	0.422	-0.326	1.2	97.92	0.76	-0.72
11	0.21				0.57				1			
12	0.1				0.08				0.3			
13	0.13				0.53				1.9			
14	0.04				0.69				1.4			
15	0.01	6.022	0.098	0.078	0.59	3.14	0.492	0.46	0	98	0.92	-0.8
16	0.02				0.81				1.2			
17	0.07				0.49				0.1			
18	0.01				0.87				0.6			
19	0.04				0.2				1.4			
20	0.01	6.078	0.03	0.022	0.14	3.582	0.502	0.018	1.6	98.18	0.98	-0.98
21	0.13				0.43				0			
22	0.13				0.82				1.2			
23	0.19				0.27				0.1			
24	0.16				0.43				1.2			
25	0.13	5.952	0.148	0.148	0.39	3.696	0.468	-0.296	0.9	97.52	0.68	-0.32
26	0.1				0.05				0.2			
27	0.1				0.32				1.2			
28	0.16				1.13				1.9			
29	0.1				0.26				1.5			
30	0.13	5.982	0.118	0.118	0.51	3.926	0.454	-0.326	0.7	98.02	1.1	-0.82
31												
32												
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			6				6				6	
Deduct Lots				0				0				0

US-23 Arenac Co.

MDOT Verification Test Data 4E3 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff AC	VFA	Fines/AC
5	151.61	144.62	4.61	14.34	5.69	4.28	67.852	0.978
8	151.45	145.71	3.79	13.88	5.77	4.36	72.695	0.981
11	151.55	144.60	4.59	14.48	5.72	4.31	68.301	0.876
19	151.37	146.37	3.3	13.51	5.8	4.40	75.574	1.012
22	151.37	145.14	4.12	14.24	5.8	4.40	71.067	0.962
28	151.16	145.26	3.9	14.29	5.91	4.51	72.708	1.096
average	151.4183	145.28	4.051666	14.12	5.78	4.38	71.37	0.98
STD	0.1590	0.6769	0.5025	0.3608	0.0768	0.0779	2.9360	0.0714

MDOT Central Lab Test Data

		AC used	PG52-28	Amoco	
LAB	%AC	Eff AC	Orig. Pen	Rec. Pen	Fines/AC
9/5/1997	5.7	4.29	233	126	1.025
9/9/1997	5.8	4.40		143	1.138
10/7/1997			245		
10/8/1997	5.7	4.29	230	134	0.838
10/10/97	5.8	4.40	250	132	0.910
10/14/97	5.2	3.79	230	151	1.188
10/15/97			234		
10/16/97	5.5	4.09	230	130	1.076
10/17/97			240		
10/20/97			241		
10/21/97	5.7	4.29	239	114	0.815
10/22/97			242		
10/24/97	5.8	4.40	230	126	0.887
10/25/97	5.5	4.09	213	132	0.978
10/28/97			305		
10/29/97	5.8	4.40	292	133	0.956
Average	5.65	4.24	243.60	132.10	0.98
STD	0.1957	0.1987	24.0232	9.9269	0.1250

US-23 Arenac Co.

MDOT Verification Test Data

4E3 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
5	4.19	5.55	8.93	14.87	21.44	35.15	54.83	85.62	96.04	100
8	4.28	5.61	9.06	15.05	21.51	34.88	52.75	85.48	97.56	100
11	3.78	5.1	9.02	15.92	23.23	36.27	57.16	86.61	95.69	100
19	4.45	5.87	9.82	16.66	24.21	37.02	56.53	86.43	96.25	100
22	4.23	5.67	9.67	16.39	23.19	34.5	54.17	84.46	94.94	99.36
28	4.94	6.24	10.03	16.92	24.33	37.42	58.53	87.27	96.82	100
Avg.	4.31	5.67	9.42	15.97	22.99	35.87	55.66	85.98	96.22	99.89
STD	0.3792	0.3762	0.4742	0.8502	1.2629	1.2050	2.1270	0.9953	0.9064	0.2613

MDOT Central Lab Test Data

LAB	75umm	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
9/5/97	4.4	6.4	12.3	20.3	29.1	40.3	62.8	88	95.1	100
9/9/97	5	5.8	11.5	20.4	29.3	43.4	65.8	91.6	97.6	100
10/8/97	3.6	5	8.8	15.2	21.4	33.7	54.7	84.8	94.7	100
10/10/97	4	5.2	8.6	14	20.3	32.1	51.8	82.9	93.5	100
10/14/97	4.5	4.9	9	15.2	21.1	31.2	49	80.2	93.3	100
10/16/97	4.4	5.9	10.3	17.1	14	34.9	52.4	80.9	93.2	100
10/21/97	3.5	4.6	8.6	15.1	21.8	34.1	53	84.7	94.5	100
10/24/97	3.9	5.1	8.8	15.2	22.2	34.2	53.7	84.8	93.2	100
10/25/97	4	5.1	8.9	14.9	22.1	32.6	53.9	86.8	97.3	100
10/29/97	4.2	5.7	10.1	16.9	24.1	35.4	56	86.9	95.6	100
Average	4.15	5.37	9.69	16.43	22.54	35.19	55.31	85.16	94.80	100.00
STD	0.4478	0.5538	1.3203	2.2598	4.3886	3.8036	5.1371	3.3925	1.6323	0

US-23 Arenac Co.

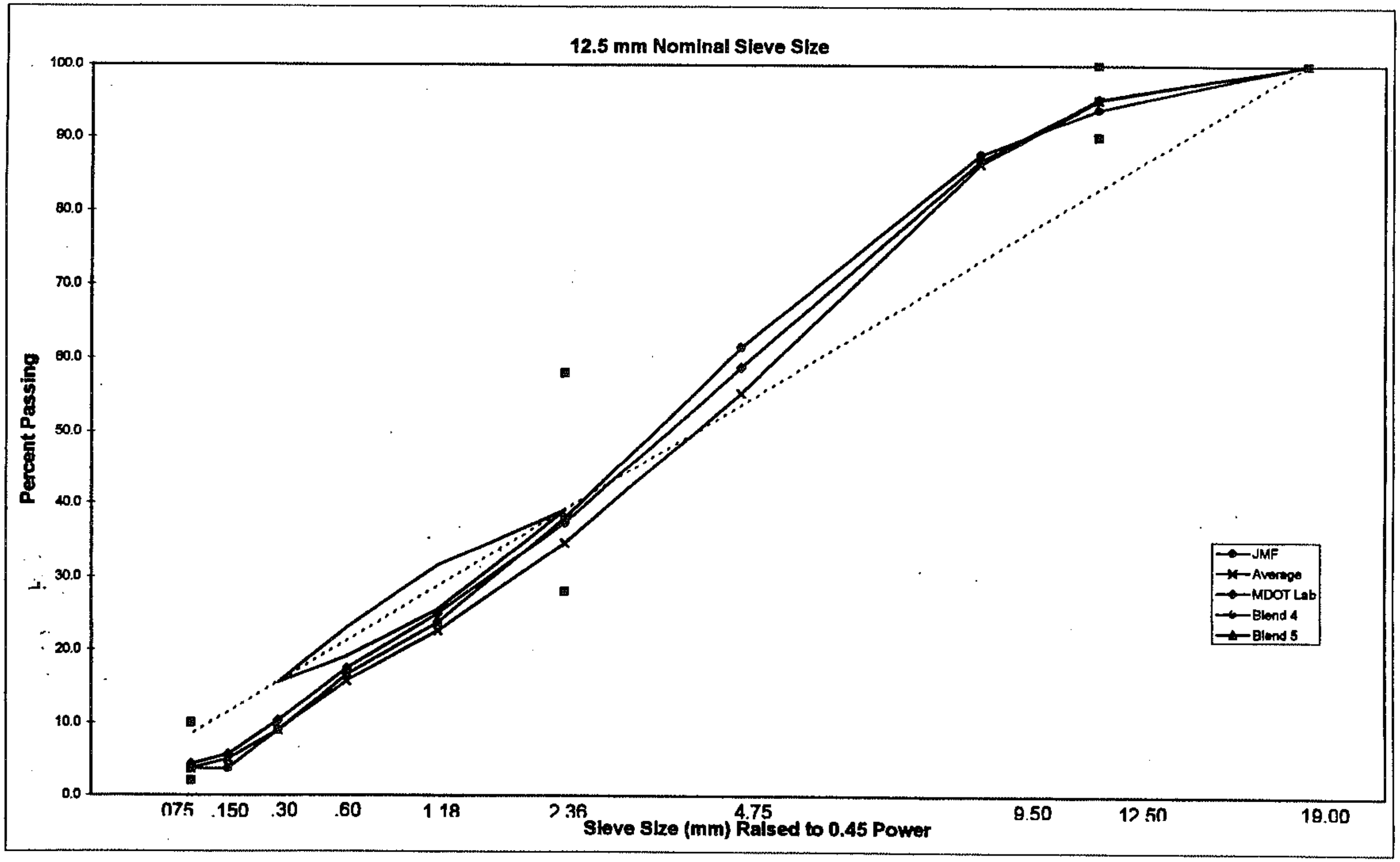
Film Thickness Table 4E3 Mixture

Gradation	DESIGN % Pass	PLANT % Pass	MDOT LAB % Pass
37.5	100	100	100
25	100	100	100
19	100	100	100
12.5	93.8	95.1	94.8
9.5	87.7	86.3	85.2
4.75	61.5	55.3	55.3
2.36	38	34.8	35.2
1.18	23.8	22.6	22.5
0.6	16.6	15.7	16.4
0.3	9	9	9.7
0.15	3.7	5	5.4
0.075	3.6	3.7	4.2
% AC	6.1	6	5.65
Film Thick.	0.00127	0.00119	0.00102

Aggregate Gradation Trials

Project Name: US-23 P&D
Technician: Doug
Date: 11/11/97

Filename: US23p-4E.XLS
Description: JMF/PROD
Nominal Sieve Size: 12.5 mm



Appendix D5

QC/QA Test Data
US-131 St. Joseph Co.
<10 Million ESAL
3E10 Mixture

FILE 300 ______

REPORT OF TEST

1931 (N9/91) BITUMINOUS MIX DESIGN

Control Section: NH 78013
Job Number: 38066A
Mix Design No.: 97MD-193
Date: AUGUST 20, 1997

Sample Of: BITUMINOUS MIXTURE NO. 3E10 --Recycled
Date Tested: AUGUST 20, 1997 Specification: 4.00 MOD, 1996 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 52-28	LAKETON		1.034
1	COARSE	1200	PIT # 39-69	30.0%	
2	FINE	1300	PIT # 14-06	15.0%	
3	FINE	1305 (E2)	PIT # 49-65	30.0%	
4	COARSE	140	PIT # 14-06	10.0%	
5	RAP		YARD	15.0%	

MIX DESIGN

Asphalt @ Optimum= 5.2 Air Voids = 4.0
Density lb/cu.ft = 151.1*
(kg/cu.m) =(2419.9) V.M.A. = 13.8
Theo.Max. Density= 157.3
(kg/cu.m) =(2519.9) V.F.A. = 71.2

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	90-100
1/2 IN (12.5mm)	46.0	100.0	100.0	100.0	96.0	83.2	90 MAX
3/8 IN (9.5mm)	9.0	99.3	100.0	60.0	88.0	66.8	
No. 4 (4.75mm)	3.5	71.0	94.0	5.0	68.0	50.6	
No. 8 (2.36mm)	3.0	44.0	35.0	3.7	54.0	26.5	23-49
No. 16 (1.18mm)	2.5	27.5	6.5	3.3	44.0	13.8	
No. 30 (600μm)	2.1	18.0	5.0	3.1	36.0	10.5	
No. 50 (300μm)	1.9	11.0	4.5	2.9	23.0	7.3	
No. 100 (150μm)	1.7	8.0	4.3	2.7	12.0	5.1	
No. 200 (75μm)	1.5	7.0	4.0	2.5	10.0	4.5	2-8
1-2 Sided crush Ret 4.75mm	99-96	100-97	1000-100	90-84	85-80	96-90	85/80 Min.

Materials submitted by: KLETT CONSTRUCTION COMPANY Plant # 240-03 --(Contractor Furnished)
RAP CONTAINS 4.0% ASPHALT - 4.6 NEW ASPHALT ADDED TO THE MIXTURE
PG58-28 GRADE ASPHALT REQUIRED FOR THE PROJECT
* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 46.7
EFFECTIVE SPECIFIC GRAVITY = 2.737

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: JOHNSON, G. (PE)	(2)	CONTRACTOR	
FIELD ENGINEER		BIT. FILE	
FRED MORIN	(2)		
D. ANDREWS	(4)		

Bituminous Unit - Supervising Engineer

1931A (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: NH 78013
Job Number: 38066A
Mix Design No.: 97MD-193
Mix Type: 3E10 RP

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM 5.2	2.421	151.1	2.521	157.3	4.0	13.8	71.2	1.07
REGRESSION EVERY 0.1%								
4.7	2.420	151.0	2.540	158.5	4.7	13.4	64.6	1.22
4.8	2.419	150.9	2.536	158.2	4.6	13.5	65.8	1.19
4.9	2.418	150.9	2.533	158.1	4.5	13.6	66.7	1.16
5.0	2.418	150.9	2.529	157.8	4.4	13.7	68.0	1.13
5.1	2.419	150.9	2.525	157.6	4.2	13.8	69.5	1.10
5.2	2.421	151.1	2.521	157.3	4.0	13.8	71.2	1.07
5.3	2.424	151.3	2.517	157.1	3.7	13.8	73.2	1.05
5.4	2.427	151.4	2.513	156.8	3.4	13.8	75.1	1.02
5.5	2.432	151.8	2.510	156.6	3.1	13.7	77.3	1.00
5.6	2.437	152.1	2.506	156.4	2.8	13.6	79.7	0.98
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2

- (PG 52-28 – LAKETON) SP. GR. = 1.034

- EFFECTIVE SPECIFIC GRAVITY = 2.737

BULK AGGREGATE SPECIFIC GRAVITY = 2.662

DESIGN ESAL'S = <10

DESIGN TEMPERATURE = 39 degrees C

MIXING TEMPERATURE = 143 degrees C

COMPACTION TEMPERATURE = 132 degrees C

INITIAL GYRATIONS = 8 %Gmm = 85.1 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 96

MAXIMUM GYRATIONS = 152 %Gmm = 97.8 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 78013	38066A	Greg Johnson	8-26-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
Klett Const. Co.	Cassopolis	240-03

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3E10	97MD193	13.8	4.0	2419.9 151.1 kg/m³	2519.9 157.3 kg/m³

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
II Mod	2.737	5-10-97	☒ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	5.2	Coarse 1200	39-69	30.0
P 37.5 mm		Fine 1300	14-06	15.0
P 25.0 mm		Fine 1305(E2)	49-65	~~30.0~~
P 19.0 mm	100.0	Coarse 140	14-06	15.0 10%
P 12.5 mm	83.2			
P 9.5 mm	66.8			
P 4.75 mm	50.6			
P 2.36 mm	26.5			
P 1.18 mm	13.8	RECLAIMED	240-03	15.0
P 600 μm	10.5	FILLER		
P 300 μm	7.3	ASPHALT	Laketon PG 52-28	4.6
P 150 μm	5.1	AWI (Spec.) – / AWI (Actual) –	ANGULARITY INDEX 46.7	
P 75 μm	4.5	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED *	96/90	☐ BATCH PLANT ☒ DRUM PLANT	DUST. CORRECTION –	

REMARKS: * 96% one side; 90% two side. R.A.P. contains 4.0% asphalt. Add 4.6% new asphalt PG 52-28 to obtain 5.2% PG 58-28.** Use furnace for gradation. Back calculating TMD for asphalt content. Recomend field density control.

US-131-Three Rivers - Schoolcraft.

TRAVELLING MIX INSPECTOR (TMI) - Signature: Fred Ma[illegible]

DATE: 8-26-97

US-131 St. Joseph Co.

Contractors Quality Control Test Data 3E10 Mixture

G_b =1.034		G_{se} =2.737		G_{sb} =2.662		Absorb. =1.064		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff AC	FINE/AC
1	2537	2490	3.6	70.97	12.4	4.7	3.69	1.28
2	2530.9	2469	4.3	68.15	13.5	4.9	3.89	1.13
3	2545	2465	4.9	62.88	13.2	4.5	3.48	1.18
4	2538.6	2467	4.7	64.66	13.3	4.7	3.69	1.25
5	2530.9	2461	4.6	66.42	13.7	4.9	3.89	1.21
6	2529.7	2473	4.1	69.17	13.3	4.9	3.89	1.23
7	2520.2	2470.9	3.8	72.26	13.7	5.2	4.19	1.12
8	2538.9	2471	4.5	65.91	13.2	4.7	3.69	1.28
9	2540.8	2471	4.5	65.65	13.1	4.6	3.58	1.31
10	2537.2	2467	4.6	65.41	13.3	4.7	3.69	1.25
11	2533.1	2483	3.8	70.77	13	4.8	3.79	1.29
12	2525.7	2473	3.9	70.68	13.3	5	3.99	1.30
13	2525.3	2479	3.7	71.97	13.2	5	3.99	1.23
14	2537.1	2460	4.9	63.97	13.6	4.7	3.69	1.33
15	2528.9	2470	4.2	68.66	13.4	4.9	3.89	1.23
16	2531.9	2486	3.6	71.88	12.8	4.9	3.89	1.26
17	2536.5	2470	4.4	66.67	13.2	4.8	3.79	1.24
18	2538.4	2477	4.3	66.92	13	4.7	3.69	1.30
19	2528.7	2478	3.8	70.99	13.1	5	3.99	1.33
20	2529.4	2467	4.3	68.15	13.5	4.9	3.89	1.21
21	2523	2471	3.9	71.32	13.6	5.1	4.09	1.17
22	2533.1	2472	4.2	68.18	13.2	4.8	3.79	1.45
23	2534.1	2472	4.3	67.67	13.3	4.8	3.79	1.35
24	2539.3	2471	4.5	65.91	13.2	4.7	3.69	1.33
25	2529.2	2482	3.7	71.54	13	4.9	3.89	1.29
26	2538.8	2482	4.8	64.44	13.5	4.7	3.69	0.84
27	2533	2480	3.9	70.00	13	4.8	3.79	1.35
28	2532.8	2478	4	69.47	13.1	4.8	3.79	1.24
29	2522.8	2463	4.3	69.06	13.9	5.1	4.09	0.98
30	2525.7	2472	4	70.37	13.5	5	3.99	1.18
31	2538.8	2466	4.7	64.93	13.4	4.7	3.69	1.33
32	2525.4	2469	4.1	69.85	13.6	5	3.99	1.23
33	2538.1	2471	4.5	65.91	13.2	4.7	3.69	1.36
34	2533.3	2475	4.1	68.70	13.1	4.8	3.79	1.29
35	2523.7	2466	4.1	70.29	13.8	5.1	4.09	1.15
36	2528.6	2474	4	70.15	13.4	5	3.99	1.25
37	2522.9	2472	4	70.59	13.6	5.1	4.09	1.22
38	2522.2	2489	3.2	75.38	13	5.1	4.09	1.37
39	2526.9	2481	3.7	71.97	13.2	5	3.99	1.25
40	2531.3	2483	3.9	70.23	13.1	4.9	3.89	1.21
41	2537.3	2476	4.3	66.92	13	4.7	3.69	1.33
42	2525.3	2465	4.1	69.85	13.6	5	3.99	1.20
43	2531.9	2477	4.1	68.94	13.2	4.9	3.89	1.23
44	2522.8	2483	3.4	74.05	13.1	5.1	4.09	1.27
45	2540.3	2472	4.6	65.15	13.2	4.7	3.69	1.30
Average	2531.66	2473.55	4.15	68.73	13.28	4.87	3.85	1.25
STD	6.2025	7.1249	0.3946	2.8128	0.2817	0.1623	0.1640	0.1004

US-131 St. Joseph Co.

Contractors Quality Control Test Data 3E10 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	4.7	6	8.1	11.3	14.8	23.9	48.4	66.8	81	100
2	4.4	5.6	7	9.3	12.1	21.1	47.1	63.5	79.9	100
3	4.1	5.1	6.3	8.4	11.1	19.8	43.8	62	74.9	100
4	4.6	5.7	6.9	8.8	11.6	21.4	52.5	68	82	100
5	4.7	5.8	7.1	9.1	12	21.1	48.7	66.1	84	100
6	4.8	5.9	7.2	9.3	12.2	21.5	47.8	64.1	80.4	100
7	4.7	5.9	7.3	9.5	12.5	22.8	54.2	72.2	84.7	100
8	4.7	5.8	7.2	9.3	12.1	21.5	50.3	67	81.5	100
9	4.7	5.8	7.1	9	11.7	20.4	47.9	66.3	83.2	100
10	4.6	5.8	7.2	9.2	12.1	21.9	51.6	68.3	85.3	100
11	4.9	6.1	7.6	9.7	12.6	22.6	52.7	69.3	82.9	100
12	5.2	6.6	8	10.3	13.5	23.8	54.7	71.3	83.3	100
13	4.9	6.1	7.5	9.6	12.5	22.7	52.3	69.8	86.8	100
14	4.9	6.1	7.4	9.4	12.1	21.6	51.4	70.7	86.4	100
15	4.8	6	7.4	9.5	12.5	22.2	51.1	67.7	85	100
16	4.9	6.2	7.6	9.9	13.2	23.8	54	70.7	84.9	100
17	4.7	6	7.2	9.3	12.2	21.8	50.8	69	84.9	100
18	4.8	6.1	7.5	9.8	12.8	22.4	50.6	68.4	82.1	100
19	5.3	6.6	8.1	10.5	13.8	26.5	54.2	66.8	83.2	100
20	4.7	6	7.3	9.4	12.3	21.8	51.5	68.2	82.4	100
21	4.8	6	7.3	9.5	12.3	21.4	47.9	65.9	83.5	100
22	5.5	6.9	8.3	10.6	13.7	24.7	56.2	72	85.1	100
23	5.1	6.5	7.9	10.2	13.4	24.2	55.8	74.6	88.3	100
24	4.9	6.1	7.4	9.5	12.4	21.8	47.7	64.8	81.6	100
25	5	6.3	7.6	9.7	12.7	22.7	50.5	68.4	84.5	100
26	3.1	4	5.2	7.2	10	19.2	46.8	63.9	77.6	100
27	5.1	6.3	7.7	9.8	12.9	22.3	49.2	65.7	81	100
28	4.7	5.9	7.3	9.5	12.4	22	49.8	67	81.2	100
29	4	5	7.2	10.4	12.1	21.2	51.9	70.7	82.2	100
30	4.7	5.8	7.2	9.5	12.4	22.1	51.1	68.1	82.7	100
31	4.9	6.1	7.5	9.8	13	23.8	56.2	72.7	85.6	100
32	4.9	6.1	7.4	9.6	12.7	22.1	48.4	68.6	83.6	100
33	5	6.5	8	10.3	13.6	25	59.2	75.7	87.3	100
34	4.9	6.1	7.5	9.7	12.8	22.8	51.2	69.4	83.4	100
35	4.7	6	7.3	9.5	12.6	22.6	50.7	67.6	84.5	100
36	5	6.3	7.7	10	13.1	22.7	51.9	71	84.6	100
37	5	6.5	8.2	10.7	13.9	23.5	50.5	65.5	78.7	100
38	5.6	7.4	9	11.3	14.3	23.5	50.5	70.6	85.4	100
39	5	6.7	8.3	10.5	13.4	22.3	47.6	66.4	79.9	100
40	4.7	6.3	7.8	9.9	12.7	21.5	46.2	65.4	80.5	100
41	4.9	7	8.6	10.8	13.7	22.6	49.3	70.8	87.6	100
42	4.8	6.8	8.3	10.3	13	21.2	46	66.2	81.1	100
43	4.8	6.7	8.3	10.6	13.5	22.4	49.5	67.7	82.2	100
44	5.2	6.8	8.4	10.8	14	24.2	53.5	71.3	85.9	100
45	4.8	6.9	8.4	10.8	14	24.5	52.6	72.2	87.6	100
Average	4.80	6.14	7.57	9.80	12.76	22.46	50.80	68.41	83.21	100.00
STD	0.3855	0.5686	0.6379	0.7563	0.8806	1.3889	3.0841	2.9518	2.7583	0

US-131 St. Joseph Co.

Contractors Quality Control Test Data 3E10 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1		85	98.2	96	91	
2		84.8	97.5	97	92	
3		83.8	96.9	96	91	
4		83.9	97.2	96	90	
5		84.1	97.3	96	92	
6		84.5	97.7	97	91	
7		84.7	98	96	91	
8		84	97.3	95	92	
9		84	97.3	96	90	
10		84	97.2	93	89	
11		84.6	96.2	94	89	
12		84.7	97.9	95	90	
13		84.7	98.2	95	89	
14		83.7	97	95	90	
15		84.4	97.7	95	90	
16				96	90	
17				95	89	
18				96	91	
19				96	91	
20				95	89	
21				95	92	
22				92	90	
23				94	89	
24				95	90	
25				95	90	
26				95	89	
27				96	92	
28				94	90	
29				93	89	
30				94	90	
31				93	91	
32				96	90	
33				97	91	
34				96	90	
35				95	89	
36				97	91	
37				94	90	
38				92	89	
39				95	91	
40				94	90	
41				92	89	
42				95	91	
43				94	90	
44				92	89	
45				94	90	
Average		84.33	97.44	94.87	90.20	
STD		0.416561	0.535590	1.375103	0.9676	

US-131 St. Joseph Co.

Contractors In Place Density Results

3E10 Mixture

Sublot	Core #1	Core #2	Core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	92.3	94	94.4	93.567						
2	95.3	92.8	93.3	93.800						
3	93.4	94.4	96.3	94.700						
4	97	95.4	92.9	95.100						
5	93.7	92.1	94.7	93.500	94.13	86.67	73.33	60.00	0.00	0.00
6	90.7	94.6	93.9	93.067	94.03					
7	93.4	95.8	94.4	94.533	94.18					
8	93.2	92.6	93	92.933	93.83					
9	95.4	94.6	93.5	94.500	93.71					
10	95	93.5	93.6	94.033	93.81	93.33	80.00	53.33	1.00	1.00
11	93.5	94.2	93	93.567	93.91					
12	94.9	95	94.3	94.733	93.95					
13	95.7	94.5	95.4	95.200	94.41					
14	93.7	92.1	92.1	92.633	94.03					
15	95.5	94.5	93.2	94.400	94.11	86.67	80.00	66.67	0.00	0.00
16	93.6	95	94.7	94.433	94.28					
17	94.4	94.7	94.9	94.667	94.27					
18	93	93.9	94	93.633	93.95					
19	93.6	94.3	96.1	94.667	94.36					
20	94.8	94.5	95.6	94.967	94.47	100.00	93.33	93.33	0.00	0.00
21	95.1	95.8	95.9	95.600	94.71					
22	93.8	93.6	94.6	94.000	94.57					
23	94.9	94	94.3	94.400	94.73					
24	95.7	94.5	93.9	94.700	94.73					
25	94.5	94.1	94.9	94.500	94.64	100.00	100.00	100.00	0.00	0.00
26	93.5	94.6	93.7	93.933	94.31					
27	93.7	93.7	93.3	93.567	94.22					
28	93.9	93.6	94.2	93.900	94.12					
29	95	94.3	93.3	94.200	94.02					
30	94.2	95.1	95.2	94.833	94.09	100.00	100.00	80.00	0.00	0.00
31	93.9	93.9	95.4	94.400	94.18					
32	95	93.4	94.6	94.333	94.33					
33	94.9	94.5	95.4	94.933	94.54					
34	93.9	94.6	94.8	94.433	94.59					
35	94.7	94.3	93.7	94.233	94.47	100.00	100.00	93.33	0.00	0.00
36	95	94.8	93.6	94.467	94.48					
37	94.6	95.5	94.7	94.933	94.60					
38	92.4	94.4	94.9	93.900	94.39					
39	95.7	96.8	96.3	96.267	94.76					
40	94.8	93	93.2	93.667	94.65	93.33	86.67	80.00	0.00	0.00
41	95	93.9	91.7	93.533	94.46					
42	93	95.4	94.1	94.167	94.31					
43	95	92	93.5	93.500	94.23					
44	92.6	93	93.8	93.133	93.60					
45	93.3	92.2	93.5	93.000	93.47	80.00	60.00	40.00	1.00	0.00
Average			94.203							
STD			1.0686							
Bonus Lots						9	7	5		
Deduct Lots									0	0

US-131 St. Joseph Co.

Contractors Mixture Price Adjustment Table 3E10 Mixture

	TMD				VMA				VOIDS			
Sublot	JMF 158.01	Lot Avg.	Abs. Dev.	Dev.	JMF 13.6	Lot Avg.	Abs. Dev.	Dev.	JMF 4	Lot Avg.	Abs. Dev.	Dev.
1	0.298				1.2				0.4			
2	0.081				0.1				0.3			
3	0.798				0.4				0.9			
4	0.398				0.3				0.7			
5	0.081	158.276	0.33182	0.26635	0.1	13.22	0.42	0.38	0.6	4.42	0.58	-0.42
6	0.156				0.3				0.1			
7	0.749				0.1				0.2			
8	0.417				0.4				0.5			
9	0.535				0.5				0.5			
10	0.311	158.081	0.43416	0.07166	0.3	13.32	0.32	0.28	0.6	4.3	0.38	-0.3
11	0.055				0.6				0.2			
12	0.406				0.3				0.1			
13	0.431				0.4				0.3			
14	0.305				0				0.9			
15	0.206	157.873	0.28094	0.13675	0.2	13.3	0.3	0.3	0.2	4.1	0.34	-0.1
16	0.019				0.8				0.4			
17	0.267				0.4				0.4			
18	0.386				0.6				0.3			
19	0.219				0.5				0.2			
20	0.175	158.057	0.21355	0.04795	0.1	13.12	0.48	0.48	0.3	4.08	0.32	-0.08
21	0.574				0				0.1			
22	0.055				0.4				0.2			
23	0.117				0.3				0.3			
24	0.442				0.4				0.5			
25	0.187	157.980	0.27566	0.02942	0.6	13.26	0.34	0.34	0.3	4.12	0.28	-0.12
26	0.411				0.1				0.8			
27	0.049				0.6				0.1			
28	0.036				0.5				0			
29	0.587				0.3				0.3			
30	0.406	157.910	0.29812	0.09931	0.1	13.4	0.32	0.2	0	4.2	0.24	-0.2
31	0.411				0.2				0.7			
32	0.425				0				0.1			
33	0.367				0.4				0.5			
34	0.067				0.5				0.1			
35	0.531	157.988	0.36052	0.02193	0.2	13.42	0.26	0.18	0.1	4.3	0.3	-0.3
36	0.225				0.2				0			
37	0.581				0				0			
38	0.624				0.6				0.8			
39	0.331				0.4				0.3			
40	0.056	157.646	0.36388	0.36388	0.5	13.26	0.34	0.34	0.1	3.76	0.24	0.24
41	0.317				0.6				0.3			
42	0.431				0				0.1			
43	0.019				0.4				0.1			
44	0.587				0.5				0.6			
45	0.504	157.966	0.37204	0.04315	0.4	13.22	0.38	0.38	0.6	4.1	0.34	-0.1
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			9.00				9.00				8.00	
Deduct Lots				0.00				0.00				0.00

US-131 St. Joseph Co.
Contractors Mixture Price Adjustment Table 3E10 Mixture

	% A.C.				75um				Crushed			
Sublot	JMF 4.9	Lot Avg.	Abs. Dev.	Dev.	JMF 4.5	Lot Avg.	Abs. Dev.	Dev.	JMF 96	Lot Avg.	Abs. Dev.	Dev.
1	0.2				0.2				0			
2	0				0.1				1			
3	0.4				0.4				0			
4	0.2				0.1				0			
5	0	4.74	0.16	0.16	0.2	4.5	0.2	0	0	96.2	0.2	-0.2
6	0				0.3				1			
7	0.3				0.2				0			
8	0.2				0.2				1			
9	0.3				0.2				0			
10	0.2	4.82	0.2	0.08	0.1	4.7	0.2	-0.2	3	95.4	1	0.6
11	0.1				0.4				2			
12	0.1				0.7				1			
13	0.1				0.4				1			
14	0.2				0.4				1			
15	0	4.88	0.1	0.02	0.3	4.94	0.44	-0.44	1	94.8	1.2	1.2
16	0				0.4				0			
17	0.1				0.2				1			
18	0.2				0.3				0			
19	0.1				0.8				0			
20	0	4.86	0.08	0.04	0.2	4.88	0.38	-0.38	1	95.6	0.4	0.4
21	0.2				0.3				1			
22	0.1				1				4			
23	0.1				0.6				2			
24	0.2				0.4				1			
25	0	4.86	0.12	0.04	0.5	5.06	0.56	-0.56	1	94.2	1.8	1.8
26	0.2				1.4				1			
27	0.1				0.6				0			
28	0.1				0.2				2			
29	0.2				0.5				3			
30	0.1	4.88	0.14	0.02	0.2	4.32	0.58	0.18	2	94.4	1.6	1.6
31	0.2				0.4				3			
32	0.1				0.4				0			
33	0.2				0.5				1			
34	0.1				0.4				0			
35	0.2	4.86	0.16	0.04	0.2	4.88	0.38	-0.38	1	95.4	1	0.6
36	0.1				0.5				1			
37	0.2				0.5				2			
38	0.2				1.1				4			
39	0.1				0.5				1			
40	0	5.02	0.12	-0.12	0.2	5.06	0.56	-0.56	2	94.4	2	1.6
41	0.2				0.4				4			
42	0.1				0.3				1			
43	0				0.3				2			
44	0.2				0.7				4			
45	0.2	4.88	0.14	0.02	0.3	4.9	0.4	-0.4	2	93.4	2.6	2.6
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			9.00				9.00				9.00	
Deduct Lots				0.00				0.00				0.00

US-131 St. Joseph Co.

MDOT Verification Test Data 3E10 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	VFA	Fines/AC
4	2542	2462	4.9	13.4	4.6	3.58	63.43	1.255
7	2530.2	2479.6	3.9	13.1	4.9	3.89	70.23	1.260
14	2554.5	2457.2	5.6	13.3	4.3	3.28	57.89	1.280
17	2539.5	2478.2	4.3	13	4.7	3.69	66.92	1.248
20	2549.9	2472.0	4.9	12.9	4.4	3.38	62.02	1.390
22	2533.1	2481.2	3.9	12.9	4.8	3.79	69.77	1.294
27	2533.7	2484.6	3.7	12.8	4.8	3.79	71.09	1.294
29	2542.1	2421.6	6.6	14.9	4.6	3.58	55.70	0.697
34	2547.7	2492.9	4.0	12.2	4.5	3.48	67.21	1.550
36	2534.2	2498.5	3.2	12.3	4.8	3.79	73.98	1.400
43	2541.2	2488.9	3.9	12.5	4.6	3.58	68.80	1.506
average	2540.736	2474.245	4.445	13.027	4.636	3.621	66.096	1.288
STD	7.6725	21.3729	0.9802	0.7281	0.1859	0.1878	5.7095	0.2217

MDOT Central Lab Test Data

	Specification	PG58-28		AC Used	PG52-28	+7% RAP	Laketon
Date			%AC	Eff. AC	Orig. Pen	Rec. Pen	Fines/AC
9/13/97					167		
9/15/97			4	2.98	170	82	1.511
9/24/97			3.7	2.67	171	86	1.009
9/25/97					168		
9/26/97					170		
9/29/97			4	2.98	169	82	1.545
9/30/97						75	
Average			3.90	2.88	169.17	81.25	1.35
STD			0.1732	0.1750	1.4719	4.5734	0.2997

US-131 St. Joseph Co.

MDOT Verification Test Data 3E10 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
4	4.5	5.6	6.9	8.7	11.3	21.2	45	61.1	78.5	100
7	4.9	6.1	7.5	9.4	12.4	23.4	52.1	69.8	86.1	100
14	4.2	5.5	6.9	8.7	11.4	20.8	47.8	63.6	84	100
17	4.6	5.9	7.3	9.2	12	22.2	49.8	66.8	86.2	100
20	4.7	6	7.5	9.4	12.3	23	51.5	68.6	83.7	100
22	4.9	6.2	7.6	9.5	12.3	23.7	51.9	67.3	83.9	100
27	4.9	6.3	7.9	10	13.2	24.7	55.1	69.9	87	100
29	2.5	3.6	5.2	7.3	10.6	21.8	52	69.5	86	100
34	5.4	6.7	8.1	10.3	13.5	24.3	53.7	70.5	84.3	100
36	5.3	6.8	8.5	10.9	14.5	27.7	59.1	75	88.3	100
43	5.4	7.3	9.2	11.6	15	26.7	57.1	77.4	91.1	100
Avg.	4.663	6	7.509	9.545	12.590	23.590	52.281	69.045	85.372	100
STD	0.8115	0.9560	1.0232	1.1605	1.3509	2.1755	3.9975	4.5820	3.1759	0.0000

MDOT Central Lab Test Data

LAB	75umm	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
9/15/97	4.5	5.2	6.4	7.9	10.2	17.1	40.7	16.6	75.8	100
9/24/97	2.7	3.2	4.2	5.6	7.8	13.9	35.6	51.8	71.7	100
9/29/97	4.6	5.4	6.6	8.2	10.6	19.6	43.2	61.3	79.2	100
9/30/97	5.1	5.8	7	8.7	11.3	19.5	45.7	63.6	81.2	100
Avg.	4.23	4.90	6.05	7.60	9.98	17.53	41.30	48.33	76.98	100.00
STD	1.05	1.1604	1.2583	1.3735	1.5195	2.6787	4.3135	21.757	4.1636	0

US-131 St. Joseph Co.

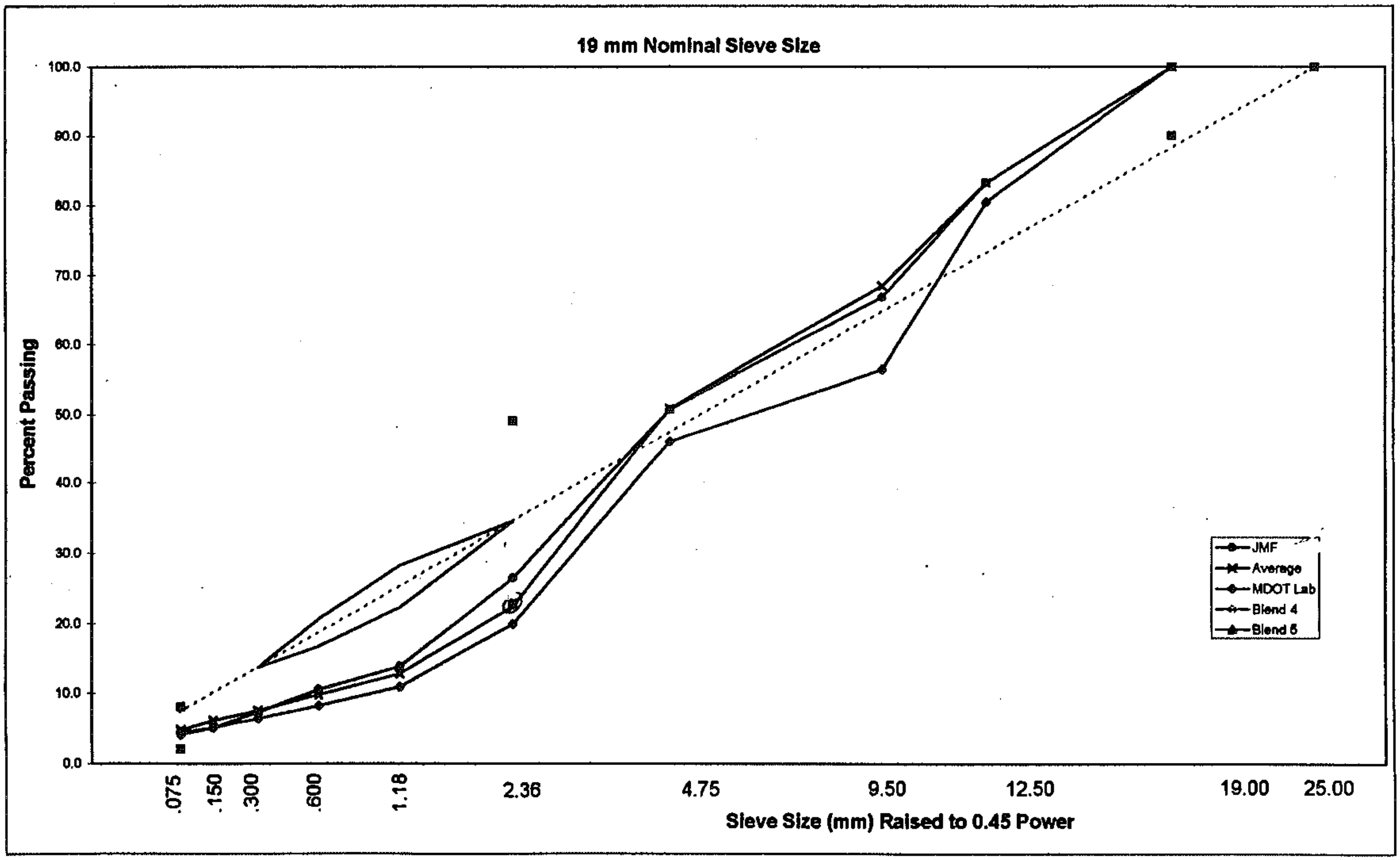
Film Thickness Table 3E10 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	100	100	100
12.5	83.2	83.21	77
9.5	66.8	68.4	48.3
4.75	50.6	50.8	41.3
2.36	26.5	22.5	17.5
1.18	13.8	12.8	10
0.6	10.5	9.8	7.6
0.3	7.3	7.6	6.1
0.15	5.1	6.1	4.9
0.075	4.5	4.8	4.2
% AC	5.2	4.87	3.9
Film Thick.	0.00115	0.00100	0.00088

Aggregate Gradation Trials

Project Name: US-131
Technician: Doug
Date: 1/0/00

Filename: US131-3E1.XLS
Description: 3E10.
Nominal Sieve Size: 19 mm



Appendix D6

QC/QA Test Data
M-53 Macomb Co.
< 1 Million ESAL
2E1 and 3E1 Mixture

FILE 300 ______

REPORT OF TEST

BITUMINOUS MIX DESIGN

1931 (N9/91)

Control Section: DSTT50012
Job Number: 35997A
Mix Design No.: 97MD-202
Date: SEPTEMBER 3, 1997

Sample Of: BITUMINOUS MIXTURE NO. 2E1
Date Tested: AUGUST 27, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	MARATHON		1.025
1	COARSE	1 1/2-3/8	PIT # 44-71	29.7%	
2	COARSE	3/4	PIT # 44-71	19.9%	
3	COARSE	1/2	PIT # 44-71	24.7%	
4	FINE	Q SAND	PIT # 44-71	24.7%	
5	BKDOWN		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 4.6 Air Voids = 4.0
Density lb/cu.ft = 150.1*
(kg/cu.m) =(2403.7) V.M.A. = 13.4
Theo.Max. Density= 156.2
(kg/cu.m) =(2501.8) V.F.A. = 70.8

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
1 ½ IN (37.5mm)	100.0	100.0	100.0	100.0	100.0	100.0	100
1 IN (25.0mm)	85.5	100.0	100.0	100.0	100.0	95.7	90-100
3/4 IN (19.0mm)	63.6	100.0	100.0	100.0	100.0	89.2	90 MAX
1/2 IN (12.5mm)	32.0	58.9	94.6	100.0	100.0	70.3	
3/8 IN (9.5mm)	10.8	21.4	37.2	97.4	100.0	41.7	
No. 4 (4.75mm)	5.1	4.1	5.4	80.2	100.0	24.5	
No. 8 (2.36mm)	5.0	3.8	4.3	65.2	95.0	20.4	19-45
No. 16 (1.18mm)	4.9	3.6	4.0	51.0	90.0	16.7	
No. 30 (600µm)	4.8	3.4	3.8	36.6	85.0	12.9	
No. 50 (300µm)	4.5	3.2	3.5	17.1	80.0	7.9	
No. 100 (150µm)	3.3	2.5	2.7	6.4	75.0	4.5	
No. 200 (75µm)	2.4	2.0	2.2	4.3	70.0	3.4	1-7
CRUSH RET.#4	85.0	88.0	88.0	20.0	0.0	82.5	65 Min.

Materials submitted by: JOHN CARLO, INC. Plant # 115-02 --(Contractor Furnished)

* RECOMMENDED FIELD CONTROL DENSITY

EFFECTIVE SPECIFIC GRAVITY = 2.690

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: MASKO, M.L. (PE) (2) CONTRACTOR
JIM HANSON BIT. FILE
TED HANLON (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

NOTE TO TMI: Eliminate the BKDOWN & increase the 1 1/2-3/8 to 30%, 3/4" Stone to 20%, 1/2" Stone to 25%, & Q Sand to 25%.

1931A (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: DSTT50012
Job Number: 35997A
Mix Design No.: 97MD-202
Mix Type: 2E1

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
4.6	2.405	150.1	2.503	156.2	4.0	13.4	70.8	0.84
REGRESSION EVERY 0.1%								
3.5	2.398	149.6	2.545	158.8	5.8	12.6	54.3	1.16
3.6	2.399	149.7	2.541	158.6	5.6	12.7	56.0	1.12
3.7	2.400	149.8	2.537	158.3	5.4	12.8	57.7	1.09
3.8	2.401	149.8	2.534	158.1	5.2	12.8	59.0	1.05
3.9	2.402	149.9	2.530	157.9	5.1	12.9	60.7	1.02
4.0	2.402	149.9	2.526	157.6	4.9	13.0	62.1	0.99
4.1	2.403	149.9	2.522	157.4	4.7	13.0	63.7	0.96
4.2	2.403	149.9	2.518	157.1	4.6	13.1	65.1	0.94
4.3	2.404	150.0	2.514	156.9	4.4	13.2	66.7	0.91
4.4	2.404	150.0	2.511	156.7	4.3	13.2	67.8	0.89
4.5	2.405	150.1	2.507	156.4	4.1	13.3	69.4	0.86
4.6	2.405	150.1	2.503	156.2	3.9	13.4	70.8	0.84
4.7	2.405	150.1	2.499	155.9	3.8	13.5	72.1	0.82
4.8	2.405	150.1	2.495	155.7	3.6	13.6	73.4	0.80
4.9	2.405	150.1	2.492	155.5	3.5	13.7	74.4	0.78
5.0	2.405	150.1	2.488	155.3	3.3	13.8	75.7	0.77
SPECIFICATIONS =					4%	12.0	65-78	0.6-1.2

- (PG 58-28 – MARATHON OIL) SP. GR. = 1.025

- EFFECTIVE SPECIFIC GRAVITY = 2.690

BULK AGGREGATE SPECIFIC GRAVITY = 2.649

DESIGN ESAL'S = <1.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 145 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 7 %Gmm = 86.8 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 76

MAXIMUM GYRATIONS = 117 %Gmm = 97.2 SPECIFICATION = 98% MAX.

Michigan Department
of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
DSTT 50012	35997A	J. Hanson, HRC for M. L. Mesko	10-13-97
CONTRACTOR		PLANT LOCATION	PLANT NO.
John Carlo, Inc.		Utica	115-02

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
2E1	97MD-202	13.4	4.0	2403.7 1500 kg/m³	2501.8 156.1 kg/m³

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
* 111	2.690	9-10-97	☒ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	4.6	Coarse agg 1 1/2 ~~"~~ - 3/8	44-71	29.9
P 37.5 mm	100.0	" " 3/4"	44-71	20.1
P 25.0 mm	95.7	" " 1/2	44-71	25.0
P 19.0 mm	89.2 *	fine " Q sand	44-71	25.0
P 12.5 mm	70.3			
P 9.5 mm	41.7			
P 4.75 mm	24.5			
P 2.36 mm	20.4			
P 1.18 mm	16.7	RECLAIMED		
P 600 μm	12.9	FILLER	Marathon	
P 300 μm	7.9	ASPHALT	~~Amoco~~, Det. PG 58-28	4.6
P 150 μm	4.5	AWI (Spec.) N/A	AWI (Actual) —	ANGULARITY INDEX N/A
P 75 μm	3.4	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING		☐ REGULAR TESTING
CRUSHED	82.5	☐ BATCH PLANT ☒ DRUM PLANT		DUST. CORRECTION —

REMARKS:
AC SpGr = 1.025, G_{SB} = 2.649, Design temp = 35°C, Mix temp = 135°C
Mixing temp = 145°C, F/A = 0.84 Absorb AC = 0.59, VFA = 70.8
*Contractor will use calculated AC% and ignition furnace for comb. agg. gradation.

TRAVELLING MIX INSPECTOR (TMI) - Signature: [signature] | DATE: 10/13/97

M-53 Macomb Co.

Contractors Quality Control Test Data — 2E1 Mixture

G_b =1.025		G_{se} =2.69		G_{sb} =2.649		Absorb. =0.590		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff AC	FINE/AC
1	2514.84	2436	4.8	64.44	13.5	4.3	3.74	1.00
2	2538.24	2359	8.9	44.38	16	3.7	3.13	1.21
3	2528.9	2364	8.1	48.41	15.7	3.92	3.35	1.15
4								
5								
6								
7								
8								
9								
Average	2527.33	2386.33	7.27	52.41	15.07	3.97	3.41	1.12
STD	11.7791	43.0852	2.1733	10.6162	1.3650	0.3035	0.3053	0.1081

M-53 Macomb Co.

Contractors Quality Control Test Data — 2E1 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	3.74	5.58	9.68	14.27	17.27	20.34	24.29	41.47	71.01	85.88	96.57
2	3.79	5.26	8.05	11.1	13.04	15.32	17.99	34.68	67.58	86.25	93.67
3	3.87	5.5	8.21	12.38	15.76	17.49	19.41	35.89	68.51	86.1	94.14
4											
5											
6											
7											
8											
9											
10											
Avg.	3.80	5.45	8.65	12.58	15.36	17.72	20.56	37.35	69.03	86.08	94.79
STD	0.0655	0.1665	0.8984	1.5947	2.1436	2.5176	3.3045	3.6217	1.7738	0.1861	1.5564

M-53 Macomb Co.

Contractors Quality Control Test Data 2E1 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1		85.61	96.9	72.5		
2		81.6	92.9	67.4		
3		82.5	93.3	75.45		
4						
5						
6						
7						
8						
9						
10						
Avg.		83.24	94.37	71.78		
STD		2.1040	2.2030	4.0725		

M-53 Macomb Co.

Contractors In Place Density Results 2E1 Mixture

Sublot	core #1	core #2	core #3	Sublot avg.	Lot avg.	+2%	+4%	+6%	-10%	-25%
1	94.85	95.29	92.01	94.050						
2	95.43	94.84	92.22	94.163						
3										
4										
5					94.11	26.67	26.67	26.67		
6					94.16					
7										
8										
9										
10										
Average			94.106							
STD			1.561							
Bonus Lots						0	0	0		
Deduct Lots									0	0

M-53 Macomb Co.

Contractors Mixture Price Adjustment Table 2E1 Mixture

	TMD				VMA				VOIDS			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	156.2	Avg.	Dev.	Dev.	13.4	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.
1	0.726				0.1				0.8			
2	2.186				2.6				4.9			
3	1.603	157.70	1.505	1.505	2.3	15.06	1.666	1.666	4.1	7.266	3.266	3.266
4												
5												
6												
7												
8												
9												
10												
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			0				0				0	
Deduct Lots				1				1				1

M-53 Macomb Co.

Contractors Price Adjustment Table 2E1 Mixture

	% A.C.				75um				Crushed			
	JMF		Abs		JMF		Abs		JMF		Abs	
Sublot	4.6	Ave	Dev.	Dev.	3.4	Ave	Dev.	Dev.	82.5	Ave	Dev.	Dev.
1	0.3				0.34				10			
2	0.9				0.39				15.1			
3	0.68	3.97	0.62	0.62	0.47	3.8	0.4	0.4	7.05	17.71	10.71	64.78
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			0				1				0	
Deduct Lots				1				0				1

M-53 Macomb Co.

MDOT Verification Test Data 2E1 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	VFA	Fines/AC
1	2531	2386.6	7.4	14.9	3.9	3.33	50.336	1.098
2	2526	2356.9	8.2	16	4	3.43	48.750	1.013
average	2528.5	2371.75	7.8	15.45	3.95	3.38	49.54	1.06
STD	3.5355	21.0011	0.5657	0.7778	0.0707	0.0711	1.1212	0.0598

MDOT Central Lab Test Data

	Specification AC PG58-28		AC Used	PG58-28 Marathon		
LAB		%AC	Eff. AC	Orig. Pen	Rec. Pen	Fines/AC
10/13/97		4.6	4.04	108	68	1.288
10/17/97		3.4	2.83	114	45	1.484
Average		4.00	3.43	111.00	56.50	1.39
STD		0.8485	0.8535	4.2426	16.2635	0.1386

M-53 Macomb Co.

MDOT Verification Test Data 2E1 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	3.66	5.1	7.87	10.51	12.4	14.55	17.32	33.77	64.49	83.88	92.11
2	3.48	4.81	7.74	11.03	13.29	15.4	17.78	33.69	70.25	86.97	95.93
Average	3.57	4.96	7.81	10.77	12.85	14.98	17.55	33.73	67.37	85.43	94.02
STD	0.1273	0.2051	0.0919	0.3677	0.6293	0.6010	0.3253	0.0566	4.0729	2.1850	2.7011

MDOT Central Lab Test Data

LAB	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
10/13/97	5.2	6.7	10.5	14.9	18.2	21	24.8	43.3	79.4	93.5	98
10/17/97	4.2	5.7	8.7	12.1	14.4	16.8	20.6	36.1	69.2	85.9	93.5
Average	4.70	6.20	9.60	13.50	16.30	18.90	22.70	39.70	74.30	89.70	95.75
STD	0.7071	0.7071	1.2727	1.9798	2.6870	2.9698	2.9698	5.0911	7.2124	5.3740	3.1819

M-53 Macomb Co.

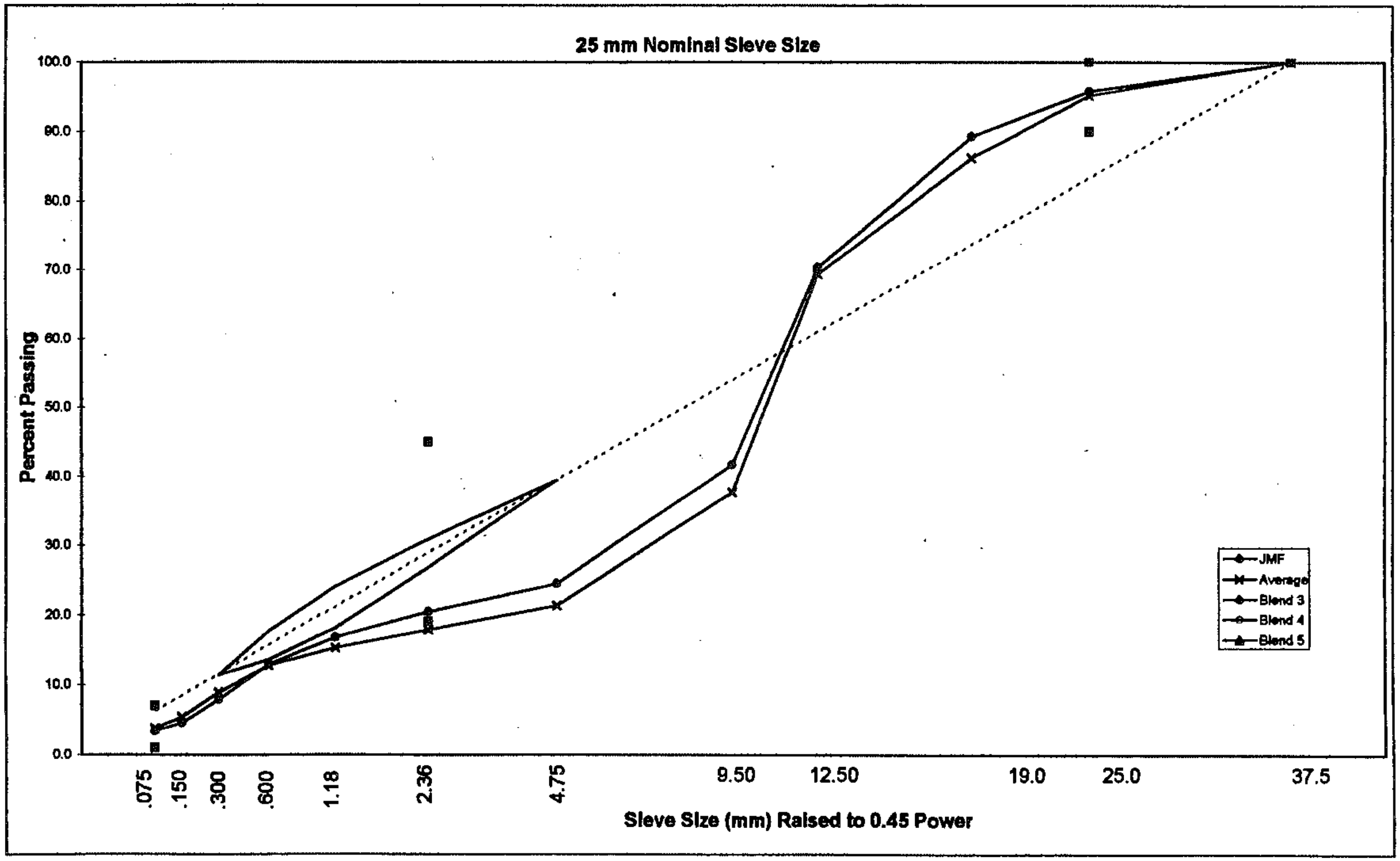
Film Thickness Table 2E1 Mixture

Gradation	DESIGN % Pass	PLANT % Pass	MDOT LAB % Pass
37.5	100	100	100
25	95.7	94.8	95.8
19	89.2	86.1	89.7
12.5	70.3	69	74.3
9.5	41.7	37.4	39.7
4.75	24.5	20.6	22.7
2.36	20.4	17.7	18.9
1.18	16.7	15.4	16.3
0.6	12.9	12.6	13.5
0.3	7.9	8.7	9.6
0.15	4.5	5.5	6.2
0.075	3.4	3.8	4.7
% AC	4.6	3.97	4
Film Thick.	0.00129	0.00100	0.00087

Aggregate Gradation Trials

Project Name: M-53
Technician: Doug
Date: 1/0/00

Filename: M53-2E1.XLS
Description: JMF
Nominal Sieve Size: 25 mm



FILE 300 ___

MICHIGAN DEPARTMENT OF TRANSPORTATION

REPORT OF TEST

BITUMINOUS MIX DESIGN

1931 (N9/91)

Control Section: DSTT50012
Job Number: 35997A
Mix Design No.: 97MD-209
Date: SEPTEMBER 9, 1997

Sample Of: BITUMINOUS MIXTURE NO. 3E1
Date Tested: AUGUST 28, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	MARATHON		1.025
1	COARSE	3/4 STONE	PIT # 44-71	27.5%	
2	FINE	3/8 CRUSH	PIT # 44-71	9.7%	
3	COARSE	1/2 STONE	PIT # 44-71	44.9%	
4	FINE	3CS	PIT # 63-47	16.9%	
5	BKDOWN		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 4.8 Air Voids = 4.0
Density lb/cu.ft = 150.3*
(kg/cu.m) =(2406.8) V.M.A. = 13.4
Theo.Max. Density= 156.6
(kg/cu.m) =(2508.2) V.F.A. = 69.9

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	90-100
1/2 IN (12.5mm)	58.9	100.0	94.6	100.0	100.0	86.3	90 MAX
3/8 IN (9.5mm)	21.4	99.7	37.2	100.0	100.0	50.2	
No. 4 (4.75mm)	4.1	75.4	5.4	99.5	100.0	28.7	
No. 8 (2.36mm)	3.8	54.6	4.3	81.5	95.0	23.0	23-49
No. 16 (1.18mm)	3.6	41.7	4.0	54.5	90.0	16.9	
No. 30 (600μm)	3.4	33.8	3.8	31.6	85.0	12.1	
No. 50 (300μm)	3.2	26.2	3.5	15.1	80.0	8.3	
No. 100 (150μm)	2.5	16.3	2.7	3.7	75.0	4.9	
No. 200 (75μm)	2.0	11.8	2.2	1.2	70.0	3.6	2-8
CRUSH RET.#4	88.0	98.0	88.0	10.0	0.0	88.2	65 Min.

Materials submitted by: JOHN CARLO, INC. Plant # 115-02 --(Contractor Furnished)
NOTE TO TMI: ELIMINATE THE BKDOWN & INCREASE THE 3/4 STONE TO 28%, 3/8 CRUSH TO 10%, 1/2 STONE TO 45%, 3CS TO 17%.
* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 41.5
EFFECTIVE SPECIFIC GRAVITY = 2.707

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: JIM HANSON (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
TED HANLON (2)
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

1931A (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: DSTT50012
Job Number: 35997A
Mix Design No.: 97MD-209
Mix Type: 3E1

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM 4.8	2.408	150.3	2.509	156.6	4.0	13.4	69.9	0.9
REGRESSION EVERY 0.1%								
4.0	2.386	148.9	2.540	158.5	6.1	13.5	55.0	1.13
4.1	2.389	149.1	2.536	158.2	5.8	13.4	56.9	1.10
4.2	2.392	149.3	2.532	158.0	5.5	13.4	58.8	1.07
4.3	2.396	149.5	2.529	157.8	5.3	13.4	60.7	1.03
4.4	2.398	149.6	2.525	157.6	5.0	13.4	62.4	1.01
4.5	2.401	149.8	2.521	157.3	4.8	13.4	64.4	0.98
4.6	2.404	150.0	2.517	157.1	4.5	13.4	66.4	0.95
4.7	2.406	150.1	2.513	156.8	4.3	13.4	68.2	0.93
4.8	2.408	150.3	2.509	156.6	4.0	13.4	69.9	0.90
4.9	2.410	150.4	2.506	156.4	3.8	13.4	71.4	0.88
5.0	2.411	150.4	2.502	156.1	3.6	13.5	73.0	0.86
5.1	2.413	150.6	2.498	155.9	3.4	13.5	74.8	0.84
5.2	2.414	150.6	2.494	155.6	3.2	13.5	76.3	0.82
5.3	2.415	150.7	2.490	155.4	3.0	13.6	77.9	0.80
5.4	2.416	150.8	2.487	155.2	2.9	13.7	79.1	0.78
5.5	2.417	150.8	2.483	154.9	2.7	13.7	80.6	0.77
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2

- (PG 58-28 – MARATHON) SP. GR. = 1.025

- EFFECTIVE SPECIFIC GRAVITY = 2.707

BULK AGGREGATE SPECIFIC GRAVITY = 2.647

DESIGN ESAL'S = <1.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 150 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 7 %Gmm = 86.5 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 76

MAXIMUM GYRATIONS = 117 %Gmm = 97.1 SPECIFICATION = 98% MAX.

M-53 Macomb Co.
Contractors Quality Control Test Data 3E2 Mixture

G_b =1.025		G_{se} =2.707		G_{sb} =2.647		Absorb. =0.858		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff AC	FINE/AC
1	2494.5	2484.1	1.2	89.74	11.7	5.2	4.39	0.99
2	2514.8	2403.9	6	59.46	14.8	4.68	3.86	0.96
3	2513.7	2397.6	6.2	58.94	15.1	4.7	3.88	0.92
4	2496.6	2478.7	2.2	82.40	12.5	5.13	4.32	1.02
5								
6								
7								
8								
9								
10								
Average	2504.90	2441.08	3.90	72.64	13.53	4.93	4.11	0.97
STD	10.8397	46.6864	2.5742	15.8029	1.6820	0.2758	0.2782	0.0421

M-53 Macomb Co.
Contractors Quality Control Test Data 3E1 Mixture

Sublot	75um	150um	300um	800um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	4.34	6.62	13.3	18.8	22.41	26.7	29.46	42.43	80.26	100
2	3.69	5.39	10.11	15.07	17.85	20.28	23.1	15.12	83.95	100
3	3.58	5.2	9.54	13.29	16.07	20.01	24.94	53.1	85.6	100
4	4.4	6.3	11.46	16.64	20.45	25.35	30.81	56.74	90.61	100
5										
6										
7										
8										
9										
10										
Average	4.00	5.88	11.10	15.95	19.15	23.09	27.08	41.85	85.11	100.00
STD	0.4274	0.6895	1.6716	2.3415	2.8316	3.4410	3.6513	18.824	4.2956	0

M-53 Monroe Co.

Contractors Quality Control Test Data — 3E1 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1		88.4	99.9	80.47		
2		83.3	94.7	81.12		
3		82.5	94	89.14		
4				88.77		
5						
6						
7						
8						
9						
10						
Average		84.73	96.20	84.88		
STD		3.2005	3.2233	4.7210		

M-53 Macomb Co.

Contractors In Place Density Results — 3E1 Mixture

Sublot	core #1	core #2	core #3	Sublot avg.	Lot avg.	+2%	+4%	+6%	-10%	-25%
1	93.94	91.76	95.42	93.707						
2	95.79	85.28	96.37	92.480						
3	92.39	92.24	92.31	92.313						
4	92.48	92.48	96.82	93.927						
5					93.11	33.33	33.33	33.33	2.00	1.00
6					92.91					
7					93.12					
8					93.93					
9										
10										
Average			93.106							
STD			3.0665							
Bonus Lots						0	0	0		
Deduct Lots									0	0

M-53 Macomb Co.

Contractors Mixture Price Adjustment Table 3E1 Mixture

	TMD				VMA				VOIDS			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	156.6	Avg.	Dev.	Dev.	13.4	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.
1	0.943				1.7				2.8			
2	0.323				1.4				2			
3	0.254				1.7				2.2			
4	0.812	156.30	0.583	0.294	0.9	13.525	1.425	0.125	1.8	3.9	2.2	0.1
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			1				0				0	
Deduct Lots				0				0				0

M-53 Macomb Co.

Contractors Mixture Price Adjustment Table 3E1 Mixture

	% A.C.				75um				Crushed			
	JMF		Abs		JMF		Abs		JMF		Abs	
Sublot	4.8	Ave.	Dev.	Dev.	3.6	Ave.	Dev.	Dev.	88.2	Ave.	Dev.	Dev.
1	0.4				0.74				7.73			
2	0.12				0.09				7.08			
3	0.1				0.02				0.94			
4	0.33	4.9275	0.2375	0.1275	0.8	4.0025	0.4125	0.4025	0.57	84.875	4.08	3.325
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			1				1				1	
Deduct Lots				0				0				0

M-53 Macomb Co.

MDOT Verification Test Data 3E1 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	VFA	Fines/AC
	2489	2486	1.3	12.2	5.4	4.59	89.34	
2	2518	2385	6.9	15.5	4.6	3.78	55.48	1.03
	2506	2356	7.7	16.6	4.9	4.08	53.61	
average	2504.333	2409.00	5.3	14.77	4.97	4.15	66.15	1.03
STD	14.5717	68.2422	3.4871	2.2898	0.4041	0.4076	20.1107	

MDOT Central Lab Test Data

	Specification AC	PG58-28		AC Used	PG58-28		
Date			%AC	Eff. AC	Orig. Pen	Rec. Pen	Fines/AC
10/13/97			4.9	4.08	110		0.955000
10/18/97			3.8	2.97	115	63	1.210
11/9/97			4.4	3.58	96	62	1.481
average			4.37	3.55	107.00	62.50	1.22
STD			0.5508	0.5555	9.8489	0.7071	0.2629

M-53 Monroe Co.

MDOT Verification Test Data 3E1 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
2	3.9	5.6	10.7	14.7	17.5	20.4	23.4	42.8	81.7	100
Average	3.90	5.60	10.70	14.70	17.50	20.40	23.40	42.80	81.70	100.00

MDOT Central Lab Test Data

Date	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
10/13/97	3.9	6.1	12.2	17.4	20.9	24.3	27.4	40.9	75.2	100
10/18/97	3.6	5	9.7	13.5	16.1	18.3	21.5	39.9	81.4	100
11/9/97	5.3	6.5	9.8	13.2	15.9	18.7	24	51	79.9	100
average	4.27	5.87	10.57	14.70	17.63	20.43	24.30	43.93	78.83	100.00
STD	0.907	0.776	1.415	2.343	2.830	3.354	2.961	6.140	3.234	0

M-53 Monroe Co.

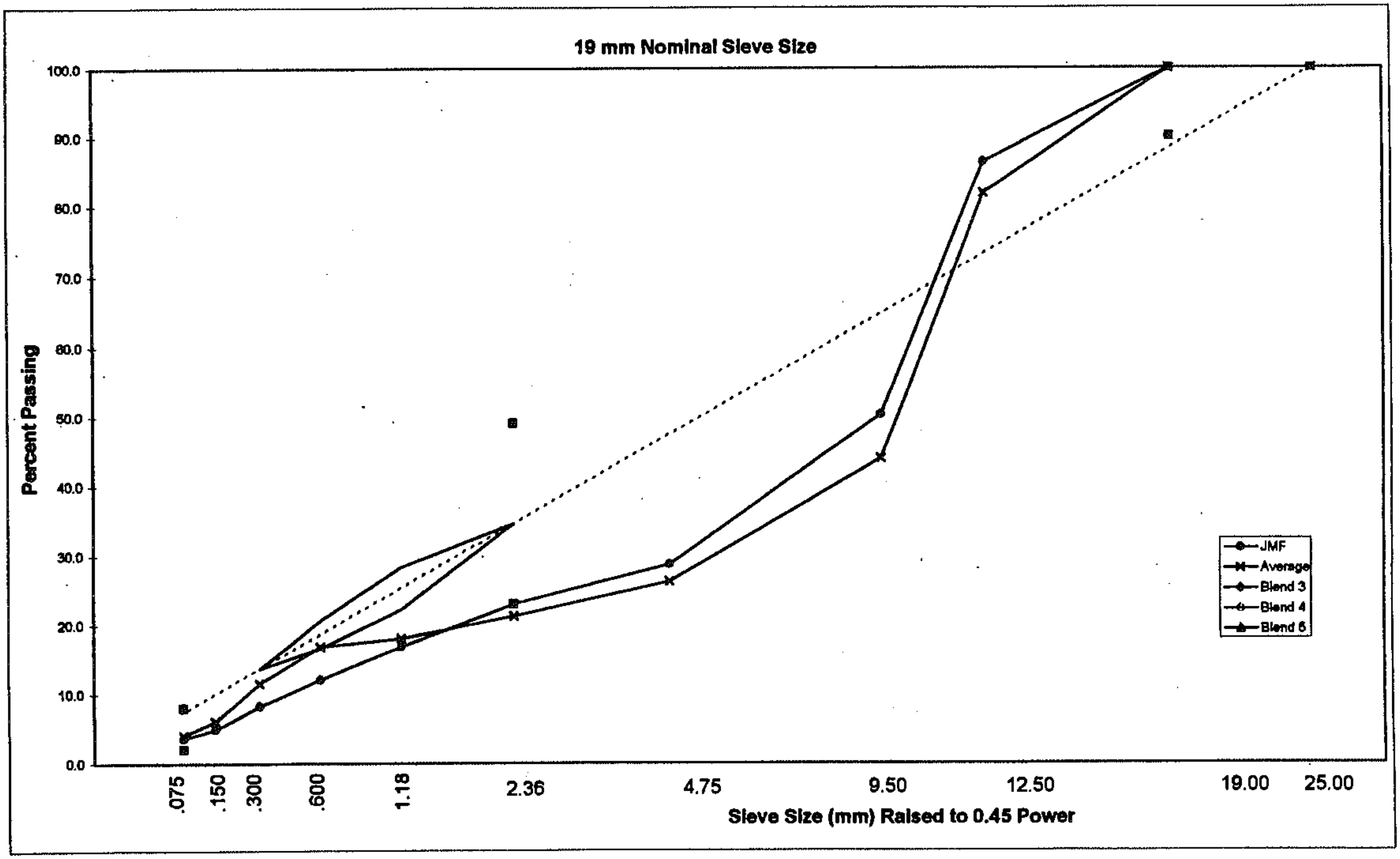
Film Thickness Table 3E1 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	100	100	100
12.5	86.3	85.1	78.8
9.5	50.2	41.8	43.9
4.75	28.7	27.1	24.3
2.36	23	23.1	20.4
1.18	16.9	19.2	17.6
0.6	12.1	16	14.7
0.3	8.3	11.1	10.6
0.15	4.9	5.9	5.9
0.075	3.6	4	4.3
% AC	4.8	4.93	4.37
Film Thick.	0.00121	0.00108	0.00092

Aggregate Gradation Trials

Project Name: M-53
Technician: Doug
Date: 1/0/00

Filename: M53-3E1.XLS
Description: 3E1.
Nominal Sieve Size: 19 mm



FILE 300 ___

MICHIGAN DEPARTMENT OF TRANSPORTATION

REPORT OF TEST

Control Section: DSTT50012
Job Number: 35997A
Mix Design No.: 97MD-218
Date: SEPTEMBER 10, 1997

1931 (N9/91)

BITUMINOUS MIX DESIGN

Sample Of: BITUMINOUS MIXTURE NO. 4E1
Date Tested: SEPTEMBER 11, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	MARATHON		1.025
1	COARSE	1/2 STONE	PIT # 44-71	14.9%	
2	DENSE	97 3/8 CRUSH	PIT # 44-71	49.2%	
3	FINE	3CS	PIT # 63-47	34.9%	
4	BKDOWN		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 5.5 Air Voids = 4.0
Density lb/cu.ft = 148.6*
(kg/cu.m) =(2379.6) V.M.A. = 14.3
Theo.Max. Density= 154.8
(kg/cu.m) =(2479.4) V.F.A. = 71.9

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	COMBINED GRADATION		MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0		100
1/2 IN (12.5mm)	94.6	100.0	100.0	100.0	99.2		90-100
3/8 IN (9.5mm)	37.2	97.4	100.0	100.0	89.4		90 MAX
No. 4 (4.75mm)	5.4	64.8	99.5	100.0	68.4		
No. 8 (2.36mm)	4.3	45.9	81.5	95.0	52.6	39	28-58
No. 16 (1.18mm)	4.0	33.3	54.5	90.0	36.9	31.6	
No. 30 (600μm)	3.8	26.7	31.6	85.0	25.6	23.1	
No. 50 (300μm)	3.5	20.0	15.1	80.0	16.4	15.5	
No. 100 (150μm)	2.7	13.0	3.7	75.0	8.8		
No. 200 (75μm)	2.2	7.6	1.2	70.0	5.2		2-10
CRUSH RET.#4	88.0	98.0	10.0		93.1		65 Min.
A.W.I.	313.4	320.8	222.7		317.0		260 Min.

Materials submitted by: JOHN CARLO, INC. Plant # 115-02 --(Contractor Furnished)

NOTE TO TMI: ELIMINATE THE BKDOWN & INCREASE THE 1/2 STONE TO 15%, 3/8 CR TO 50%, 3CS SAND TO 35%.

* RECOMMENDED FIELD CONTROL DENSITY

ANGULARITY INDEX NUMBER = 41.7

EFFECTIVE SPECIFIC GRAVITY = 2.704

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: JIM HANSON (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
TED HANLON (2) TROY SCHREUR - APT
D. ANDREWS (4)

Bituminous Unit - Supervising Engineer

1931A (N9/91)

REPORT OF TEST

BITUMINOUS MIX DESIGN

Control Section: DSTT50012
Job Number: 35997A
Mix Design No.: 97MD-218
Mix Type: 4E1

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM 5.5	2.381	148.6	2.481	154.8	4.0	14.3	71.9	1.17

REGRESSION EVERY 0.1%

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
4.8	2.354	146.9	2.507	156.4	6.1	14.7	58.5	1.39
4.9	2.358	147.1	2.503	156.2	5.8	14.6	60.4	1.35
5.0	2.362	147.4	2.499	155.9	5.5	14.6	62.4	1.32
5.1	2.366	147.6	2.496	155.8	5.2	14.5	64.2	1.29
5.2	2.370	147.9	2.492	155.5	4.9	14.5	66.2	1.25
5.3	2.373	148.1	2.488	155.3	4.6	14.5	68.0	1.22
5.4	2.377	148.3	2.484	155.0	4.3	14.4	70.1	1.20
5.5	2.381	148.6	2.481	154.8	4.0	14.3	71.9	1.17
5.6	2.384	148.8	2.477	154.6	3.8	14.3	73.8	1.14
5.7	2.388	149.0	2.473	154.3	3.4	14.3	75.9	1.12
5.8	2.391	149.2	2.469	154.1	3.2	14.3	77.8	1.09
5.9	2.394	149.4	2.466	153.9	2.9	14.2	79.5	1.07
6.0	2.397	149.6	2.462	153.6	2.6	14.2	81.4	1.05
6.1	2.400	149.8	2.458	153.4	2.4	14.2	83.4	1.03
6.2	2.403	149.9	2.455	153.2	2.1	14.2	85.1	1.01
6.3	2.406	150.1	2.451	152.9	1.8	14.2	87.1	0.99
SPECIFICATIONS =					4%	14.0	65-78	0.6-1.2

- (PG 58-28 – MARATHON OIL) SP. GR. = 1.025

- EFFECTIVE SPECIFIC GRAVITY = 2.704

BULK AGGREGATE SPECIFIC GRAVITY = 2.627

DESIGN ESAL'S = <1.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 155 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 7 %Gmm = 88.7 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 76

MAXIMUM GYRATIONS = 117 %Gmm = 97.0 SPECIFICATION = 98% MAX.

Appendix D7

QC/QA Test Data
US-12 Wayne Co.
< 10 Million ESAL
3E10 and 4E10 Mixture

1931 (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: NH 82061
Job Number: 38075A
Mix Design No.: 97MD-168
Date: AUGUST 6, 1997

Sample Of: BITUMINOUS MIXTURE NO. 3E10 --Recycled
Date Tested: AUGUST 6, 1997 Specification: 4.00 MOD, 1990 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	MARATHON		1.025
1	COARSE	1/2	PIT # 82-02	20.0%	
2	COARSE	#4'S	PIT # 82-02	20.0%	
3	COARSE	26A	PIT # 58-08	15.0%	
4	FINE	MFG SAND	PIT # 58-08	29.0%	
5	RAP		YARD	15.0%	
6	DEG.		PLANT	1.0%	

MIX DESIGN

Asphalt @ Optimum= 5.8 Air Voids = 4.0
Density lb/cu.ft = 147.0*
(kg/cu.m) =(2355.0) V.M.A. = 14.3
Theo.Max. Density= 153.1
(kg/cu.m) =(2451.8) V.F.A. = 72.4

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
1 IN (25.0mm) 25000	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
3/4 IN (19.0mm) 19000	99.0	100.0	100.0	100.0	100.0	100.0	99.8	90-100
1/2 IN (12.5mm) 12,500	39.0	100.0	91.0	100.0	95.0	100.0	85.7	90 MAX
3/8 IN (9.5mm) 9500	3.5	96.0	63.0	100.0	89.0	100.0	72.7	
No. 4 (4.75mm) 4750	2.0	24.0	11.0	80.0	71.0	100.0	41.7	
No. 8 (2.36mm) 2360	2.0	6.0	3.0	44.0	56.0	100.0	24.2	23-49
No. 16 (1.18mm) 1180	1.5	5.0	2.0	25.0	44.0	100.0	16.5	
No. 30 (600µm)	1.5	5.0	2.0	15.0	34.0	100.0	12.1	
No. 50 (300µm)	1.5	4.0	2.0	10.0	21.0	95.0	8.4	
No. 100 (150µm)	1.3	3.0	2.0	7.0	11.0	85.0	5.7	
No. 200 (75µm)	1.0	2.5	2.0	5.8	6.2	75.0	4.4	2-8
CRUSH RET.#4	100.0	100.0	100.0	100.0	96.3	0.0	99.7	85 Min.

Materials submitted by: ANGELO IAFRATE CONSTR. CO. Plant # 035-01 --(Contractor Furnished)
RAP CONTAINS 3.9% ASPHALT - 5.1% NEW ASPHALT ADDED TO THE MIXTURE
PG 58-28 GRADE ASPHALT REQUIRED FOR THE PROJECT
* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 45.6
EFFECTIVE SPECIFIC GRAVITY = 2.683

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: SANFORD, J. (PE)	(2)	CONTRACTOR	
FIELD ENGINEER		BIT. FILE	
TED HANLON	(2)		
D. ANDREWS	(4)		

Bituminous Unit - Supervising Engineer

1931A (N9/91)

REPORT OF TEST

BITUMINOUS MIX DESIGN

Control Section: NH 82061
Job Number: 38075A
Mix Design No.: 97MD-168
Mix Type: 3E10 RP

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
5.8	2.356	147	2.453	153.1	4.0	14.3	72.4	0.98
REGRESSION EVERY 0.1%								
5.0	2.339	146.0	2.482	154.9	5.8	14.2	59.4	1.19
5.1	2.341	146.1	2.479	154.7	5.6	14.2	60.9	1.16
5.2	2.343	146.2	2.475	154.4	5.3	14.2	62.5	1.13
5.3	2.346	146.4	2.471	154.2	5.1	14.2	64.4	1.10
5.4	2.348	146.5	2.467	153.9	4.8	14.2	66.1	1.07
5.5	2.350	146.6	2.464	153.8	4.6	14.3	67.5	1.05
5.6	2.352	146.8	2.460	153.5	4.4	14.3	69.2	1.02
5.7	2.354	146.9	2.457	153.3	4.2	14.3	70.7	1.00
5.8	2.356	147.0	2.453	153.1	4.0	14.3	72.4	0.98
5.9	2.358	147.1	2.449	152.8	3.7	14.3	74.1	0.95
6.0	2.360	147.3	2.446	152.6	3.5	14.3	75.5	0.93
6.1	2.362	147.4	2.442	152.4	3.3	14.4	77.2	0.91
6.2	2.364	147.5	2.438	152.1	3.0	14.4	78.9	0.90
6.3	2.366	147.6	2.435	151.9	2.8	14.4	80.3	0.88
6.4	2.367	147.7	2.431	151.7	2.6	14.5	81.8	0.86
6.5	2.369	147.8	2.428	151.5	2.4	14.5	83.2	0.84
SPECIFICATIONS =					4.0 %	13.0	65-78	0.6-1.2

- (PG 58-28 – MARATHON OIL) SP. GR. = 1.025

- EFFECTIVE SPECIFIC GRAVITY = 2.683

BULK AGGREGATE SPECIFIC GRAVITY = 2.590

DESIGN ESAL'S = <10.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 148 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 8 %Gmm = 84.1 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 96

MAXIMUM GYRATIONS = 152 %Gmm = 97.9 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M·DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
DSTT 50012	35997A	J. Hanson, HRC for M. Masko	10-13-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
John Carlo, Inc.	Utica	115-02

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY kg/m³	THEORETICAL MAX. DENSITY kg/m³
3E1	97MD-209	13.4	4.0	2406.8 150.2	2508.2 156.5

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
111 *	2.707	9-10-97	☒ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	4.8	Coarse agg 3/4" Stone	44-71	28.0
P 37.5 mm		Fine agg 3/8" crushed	44-71	10.0
P 25.0 mm		Coarse " 1/2" Stone	44-71	45.0
P 19.0 mm	100.0	fine " 3CS	63-47	17.0
P 12.5 mm	86.3			
P 9.5 mm	50.2			
P 4.75 mm	28.7			
P 2.36 mm	23.0			
P 1.18 mm	16.9	RECLAIMED		
P 600 µm	12.1	FILLER Marathon		
P 300 µm	8.3	ASPHALT ~~Amoco~~ Amoco, Det PG 58-28		4.8
P 150 µm	4.9	AWI (Spec.) N/A; AWI (Actual) —	ANGULARITY INDEX 41.5	
P 75 µm	3.6	TYPE OF TESTING ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	88.2	☐ BATCH PLANT ☒ DRUM PLANT	DUST. CORRECTION —	

REMARKS:

VFA = 69.9, Asphalt binder Sp.Gr = 1.025, Gsb = 2.647
Aging Temp = 35°C, Mixing Temp = 150°C, Compaction temp = 135°C
Gmm @ Nmax = 97.1 (98% max), F/A = 0.9 Absorbed AC = 0.86
Contractor will use calculated AC% & ignition furnace for combined agg gradation.

TRAVELLING MIX INSPECTOR (TMI) - Signature	DATE
K. Hanlon	

US-12 Wayne Co.

Contractors Quality Control Test Data 3E10 Mixture

G_b =1.025		G_{se} =2.683		G_{sb} =2.59		Absorb. =1.372		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff AC	FINE/AC
1	2471.2	2397.5	2.9	76.61	12.4	5.3	4.00	1.69
2	2464.5	2395	2.8	77.78	12.6	4.68	3.37	2.04
3	2456	2350	4.3	70.14	14.4	5.72	4.43	1.16
4	2464	2323.6	5.7	62.50	15.2	5.48	4.18	1.16
5	2456.6	2372.4	3.46	74.61	13.63	5.69	4.40	1.08
6	2459.5	2365.6	3.81	72.37	13.79	5.66	4.37	1.13
7	2460.2	2352.2	4.39	69.21	14.26	5.6	4.31	1.08
8	2449.1	2348.7	4.1	72.05	14.67	5.9	4.61	1.01
9	2454.2	2350.9	4.18	71.05	14.44	5.76	4.47	1.01
10	2444.9	2337.4	4.37	71.17	15.16	6.02	4.73	0.96
11	2446.3	2348.2	3.98	73.00	14.74	5.98	4.69	0.98
12	2444	2358.5	3.5	75.69	14.4	6.05	4.76	1.13
13	2454.9	2336.7	4.82	67.78	14.96	5.74	4.45	1.04
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
Average	2455.80	2356.67	4.02	71.84	14.20	5.66	4.37	1.19
STD	8.2177	21.5321	0.7748	4.0499	0.8872	0.3638	0.3688	0.3149

US-12 Wayne Co.

Contractors Quality Control Test Data — 3E10 Mixture

Sublot	75um	150mm	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	6.76	8.22	12.87	17.44	22.25	29.97	47.46	75.68	88.46	100
2	6.88	8.38	12.81	17.32	22.48	30.97	48.75	76.91	87.82	100
3	5.12	6.66	10.51	13.84	17.51	24.06	41.12	73.97	84.29	100
4	4.86	5.99	9.51	12.6	15.86	20.85	32.52	56.88	71.78	100
5	4.74	6.07	9.33	12.8	16.45	22.48	37.17	65.42	81	100
6	4.94	6.26	9.62	13.27	17.08	23.34	39.25	70.88	86.33	100
7	4.63	5.56	9.12	12.44	15.85	21.28	36.19	65.83	81.07	100
8	4.65	5.94	9.14	12.46	16.21	22.64	36.93	67.89	80.93	100
9	4.53	5.93	9.79	13.55	17.44	24	38.83	68.69	85.79	100
10	4.52	5.82	9.53	12.97	16.64	22.98	38.95	72.49	88.05	100
11	4.6	6.13	9.76	13.39	17.17	23.3	37.63	65.61	78.79	100
12	5.4	6.7	10.7	14.4	18.3	24.7	39.3	68.8	83.4	100
13	4.64	5.83	9.04	12.33	15.73	21.13	33.94	62.88	76.97	100
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
Average	5.10	6.42	10.15	13.75	17.61	23.98	39.08	68.61	82.67	100.00
STD	0.8048	0.8922	1.2934	1.7180	2.2393	3.1143	4.6208	5.5204	4.9141	0

US-12 Wayne Co.

Contractors Quality Control Test Data 3E10 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{max}	%G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1				100		
2				100		
3				100		
4				100		
5		84.6	98.4	100		
6		84.1	98.1	100		
7		83.5	97	100		
8		83.8	97.9	100		
9		84.1	97.6	100		
10		84	97.6	100		
11		84.5	97.8	100		
12		83.9	97.1	100		
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
Avg.		84.06	97.69	100.00		
STD		0.3583	0.4733	0		

US-12 Wayne Co.

Contractors In Place Density Results 3E10 Mixture

Sublot	Core #1	core #2	core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	91.52	87.03	88.07	88.873						
2	91.99	89.55	94.69	92.077						
3	90.92	93.07	88.87	90.953						
4	92.69	93.28	91.22	92.397						
5	95.32	94.21	95.6	95.043	91.87	46.67	40.00	26.67	8.00	5.00
6	95.62	94.13	94.19	94.647	93.02					
7	95.22	94.55	96.89	95.553	93.72					
8	96.38	96.69	95.46	96.177	94.76					
9	96.79	96.47	95.78	96.347	95.55					
10	95.12	95.51	94.57	95.067	95.56	100.00	100.00	100.00	0.00	0.00
11	96.6	97.37	95.86	96.610	95.95					
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
Average			93.9766							
STD			2.7129							
Bonus Lots						0	0	1		
Deduct Lots									0	1

US-12 Wayne Co.

Contractors Mixture Price Adjustment Table

3E10 Mixture

	TMD				VMA				VOIDS			
Sublot	JMF 153.1	Lot Avg.	Abs. Dev.	Dev.	JMF 14.3	Lot Avg.	Abs. Dev.	Dev.	JMF 4	Lot Avg.	Abs. Dev.	Dev.
1	1.102				1.9				1.1			
2	0.684				1.7				1.2			
3	0.154				0.1				0.3			
4	0.653				0.9				1.7			
5	0.191	153.65	0.557	0.557	0.67	13.646	1.054	0.654	0.54	3.832	0.968	0.168
6	0.372				0.51				0.19			
7	0.416				0.04				0.39			
8	0.276				0.37				0.1			
9	0.042				0.14				0.18			
10	0.538	153.10	0.329	0.003	0.86	14.464	0.384	0.164	0.37	4.17	0.246	0.17
11	0.450				0.44				0.02			
12	0.594				0.1				0.5			
13	0.085	152.80	0.342	0.291	0.66	14.74	0.44	0.44	0.82	4.17	0.378	0.17
14												
15												
16												
17												
18												
19												
20												
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			3				2				2	
Deduct Lots				0				1				0

US-12 Wayne Co.
Contractors Mixture Price Adjustment Table

3E10 Mixture

	% A.C.				75um				Crushed			
Sublot	JMF 5.8	Lot Avg.	Abs Dev.	Dev.	JMF 4.4	Lot Avg.	Abs Dev.	Dev.	JMF 99.7	Lot Avg.	Abs Dev.	Dev.
1	0.5				2.36				0.3			
2	1.12				2.48				0.3			
3	0.08				0.72				0.3			
4	0.32				0.46				0.3			
5	0.11	5.374	0.426	0.426	0.34	5.672	1.272	1.272	0.3	100	0.3	0.3
6	0.14				0.54				0.3			
7	0.2				0.23				0.3			
8	0.1				0.25				0.3			
9	0.04				0.13				0.3			
10	0.22	5.788	0.14	0.012	0.12	4.654	0.254	0.254	0.3	100	0.3	0.3
11	0.18				0.2				0.3			
12	0.25				1				0.3			
13	0.06	5.91	0.15	0.11	0.24	4.738	0.338	0.338		100		0.3
14												
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			2				2				2	
Deduct Lots				1				1				0

US-12 Wayne Co.

MDOT Verification Test Data 3E10 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	VFA	Fines/AC
5	2452.08	2412.98	3.44	13.9	5.82	4.53	75.252	1.060
9	2450.3	2385.89	4.5	14.9	5.87	4.58	69.799	1.083
average	2451.19	2399.44	3.97	14.40	5.85	4.55	72.53	1.07
STD	1.2587	19.1555	0.7495	0.7071	0.0354	0.0358	3.8560	0.0164

MDOT Central Lab Test Data

	Specification AC	PG58-28		AC Used	PG58-28 +15% RAP		
Date			%AC	%AC	Orig. Pen	Rec. Pen	Fines/AC
8/27/97			5	3.70	111	65	1.569
8/28/97			5.3	4.00	106	68	1.400
10/5/97					120		
10/10/97			5.3	4.00	102	63	1.250
11/8/97						80	
11/9/97			5.4	4.10	91	60	1.292
11/11/97					101		
Average			5.25	3.95	105.17	67.20	1.38
STD			0.1732	0.1755	9.8268	7.7265	0.1423

US-12 Wayne Co.

MDOT Verification Test Data 3E10 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
5	4.8	6.29	9.99	13.54	17.35	23.59	37.7	64.21	81.08	100
9	4.96	6.45	10.77	14.55	18.62	25.43	40.96	73.17	87.77	100
Average	4.88	6.37	10.38	14.05	17.99	24.51	39.33	68.69	84.43	100.00
STD	0.1131	0.1131	0.5515	0.7142	0.8980	1.3011	2.3052	6.3357	4.7305	0.0000

MDOT Central Lab Test Data

Date	75umm	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm
8/27/97	5.8	7.1	10.5	14.3	19.2	24.1	36.8	64.2	80.9	100
8/28/97	5.6	6.9	9.9	12.9	17.6	22.2	36.2	65.9	83	100
10/10/97	5	6.5	9.9	13.2	17.1	23.6	38	68.7	83.1	100
11/9/97	5.3	6.7	9.9	13.1	16.7	22.5	36.5	68.2	84.8	100
Average	5.43	6.80	10.05	13.38	17.65	23.10	36.88	66.75	82.95	100.00
STD	0.35	0.2581	0.3	0.6291	1.0969	0.8981	0.7889	2.0920	1.5968	0

US-12 Wayne Co.

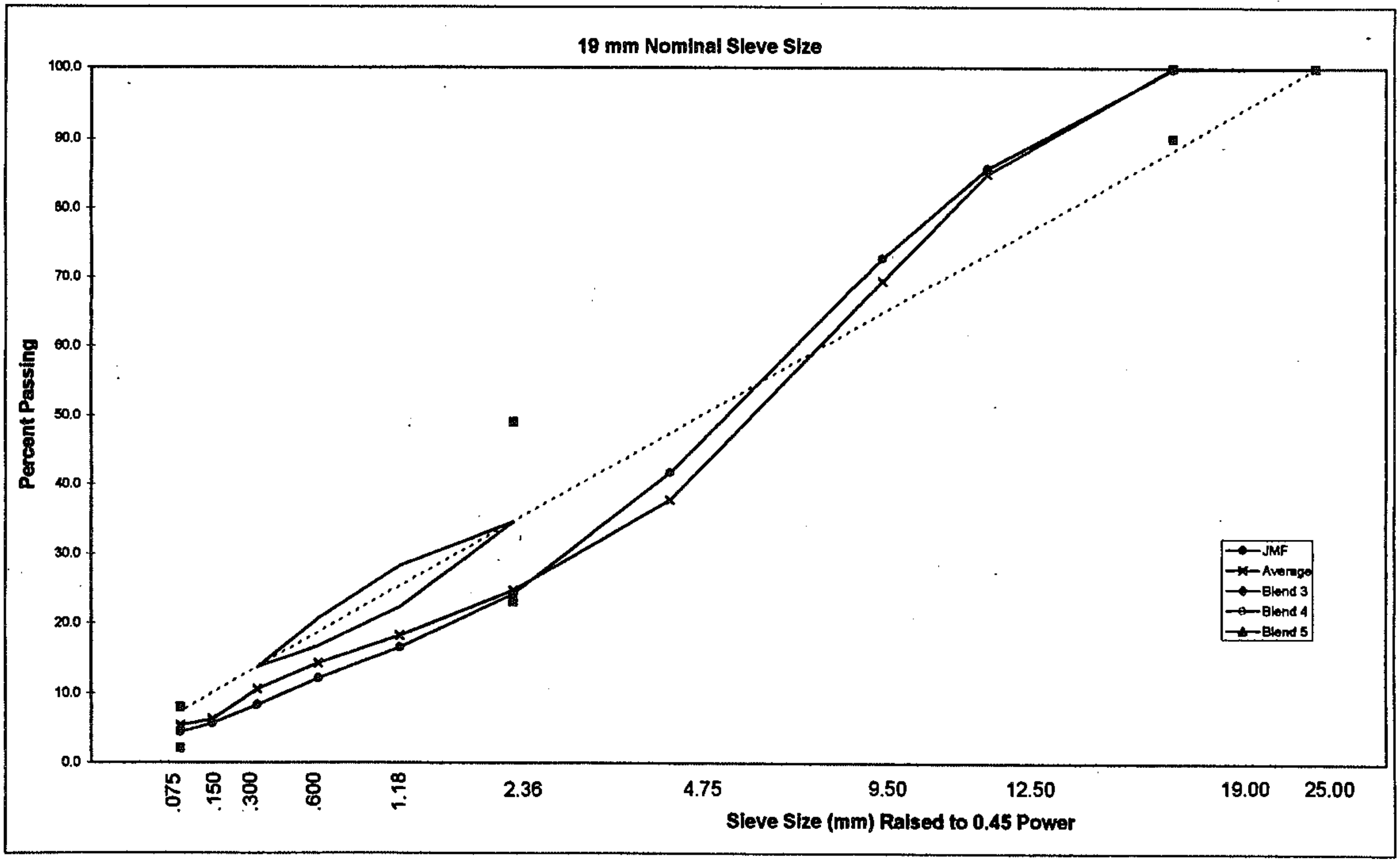
Film Thickness Table 3E10 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	99.8	100	100
12.5	85.7	82.7	82.9
9.5	72.7	68.6	66.8
4.75	41.7	39.1	36.9
2.36	24.2	24	23.1
1.18	16.5	17.6	17.7
0.6	12.1	13.75	13.4
0.3	6.4	10.2	10.1
0.15	5.7	6.4	6.8
0.075	4.4	5.1	5.4
% AC	5.8	5.66	5.25
Film Thick.	0.00119	0.00100	0.00088

Aggregate Gradation Trials

Project Name: US-12
Technician: Doug
Date: 1/0/00

Filename: US12-3E1.XLS
Description: 3E10
Nominal Sieve Size: 19 mm



NOTE TO TMI: Eliminate the Degradation & increase the 31A to 30%.

FILE 300 ___

REPORT OF TEST

BITUMINOUS MIX DESIGN

1931 (N9/91)

Control Section: NH 82061
Job Number: 38075A
Mix Design No.: 97MD-225
Date: SEPTEMBER 17, 1997

Sample Of: BITUMINOUS MIXTURE NO. 4E10 --Recycled
Date Tested: SEPTEMBER 18, 1997 Specification: 4.00 MOD, 1996 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	MARATHON		1.025
1	COARSE GRADED	3/8"	PIT # 82-02	12.0%	
2	COARSE GRADED	26A	PIT # 58-08	17.0%	
3	COARSE GRADED	31 A	PIT # 81-93	27.3%	
4	FINE GRADED	MFG SAND	PIT # 58-08	33.0%	
5	RAP		YARD	10.0%	
6	DEGRADATION		PLANT	0.7%	

NOTE: The Nmax is at maximum specification.

MIX DESIGN

Asphalt @ Optimum= 6.0 Air Voids = 4.0
Density lb/cu.ft = 147.6*
(kg/cu.m) =(2364.1) V.M.A. = 15.0
Theo.Max. Density= 153.8
(kg/cu.m) =(2463.2) V.F.A. = 73.2

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
3/4 IN (19.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
1/2 IN (12.5mm)	98.0	91.0	100.0	100.0	95.0	100.0	97.7	90-100
3/8 IN (9.5mm)	50.0	68.0	98.5	100.0	89.0	100.0	87.1	90 MAX
No. 4 (4.75mm)	4.0	18.0	41.5	84.0	71.0	100.0	50.4	
No. 8 (2.36mm)	3.0	3.0	13.6	52.0	56.0	100.0	28.0	28-58
No. 16 (1.18mm)	3.0	2.0	7.0	38.0	44.0	100.0	20.3	
No. 30 (600µm)	3.0	2.0	4.7	22.0	34.0	100.0	13.3	
No. 50 (300µm)	3.0	2.0	3.8	15.0	23.0	95.0	9.7	
No. 100 (150µm)	2.0	2.0	3.2	8.0	12.0	85.0	5.9	
No. 200 (75µm)	1.4	2.0	2.6	6.2	8.0	75.0	4.6	2-10
A.W.I.	340.0	244.0	296.0	244.0	220.0		281.6	260 Min.
½ sided crush ret 4.75mm	100/100	100/100	100/99.8	100/100	96.3/82.7		99/99	85/80 min.

Materials submitted by: ANGELO IAFRATE CONSTR. CO. Plant # 035-01 --(Contractor Furnished)
RAP CONTAINS 3.9% ASPHALT - 5.6% NEW ASPHALT ADDED TO THE MIXTURE
PG 58-28 GRADE ASPHALT REQUIRED FOR THE PROJECT
* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 45.4
EFFECTIVE SPECIFIC GRAVITY = 2.707

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: SANFORD, J. (PE)	(2)	CONTRACTOR	
FIELD ENGINEER		BIT. FILE	
TED HANLON	(2)		
D. ANDREWS	(4)		

Bituminous Unit - Supervising Engineer

NOTE: The 2.36mm sieve is at minimum specification.

1931A (N9/91)

REPORT OF TEST

BITUMINOUS MIX DESIGN

Control Section: NH 82061
Job Number: 38075A
Mix Design No.: 97MD-225
Mix Type: 4E10 RP

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
6	2.365	147.6	2.464	153.8	4.0	15.0	73.2	0.97
REGRESSION EVERY 0.1%								
5.5	2.343	146.2	2.483	154.9	5.6	15.4	63.3	1.08
5.6	2.348	146.5	2.479	154.7	5.3	15.3	65.4	1.06
5.7	2.353	146.8	2.475	154.4	4.9	15.2	67.5	1.03
5.8	2.358	147.1	2.472	154.3	4.6	15.1	69.4	1.01
5.9	2.362	147.4	2.468	154.0	4.3	15.0	71.4	0.99
6.0	2.365	147.6	2.464	153.8	4.0	15.0	73.2	0.97
6.1	2.368	147.8	2.461	153.6	3.8	15.0	74.8	0.95
6.2	2.371	148.0	2.457	153.3	3.5	15.0	76.6	0.93
6.3	2.374	148.1	2.453	153.1	3.2	15.0	78.5	0.91
6.4	2.376	148.3	2.450	152.9	3.0	15.0	79.8	0.89
6.5	2.377	148.3	2.446	152.6	2.8	15.0	81.2	0.87
6.6	2.378	148.4	2.442	152.4	2.6	15.1	82.6	0.86
6.7	2.379	148.4	2.439	152.2	2.5	15.2	83.8	0.84
6.8	2.379	148.4	2.435	151.9	2.3	15.2	84.9	0.83
6.9	2.379	148.4	2.432	151.8	2.2	15.3	85.8	0.81
7.0	2.379	148.4	2.428	151.5	2.0	15.4	86.9	0.80
SPECIFICATIONS =					4%	14.0	65-78	0.6-1.2

- (PG 52-28 – MARATHON OIL) SP. GR. = 1.025

- EFFECTIVE SPECIFIC GRAVITY = 2.707

BULK AGGREGATE SPECIFIC GRAVITY = 2.616

DESIGN ESAL'S = <10.0

DESIGN TEMPERATURE = 38 degrees C

MIXING TEMPERATURE = 148 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 8 %Gmm = 84.4 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 96

MAXIMUM GYRATIONS = 152 %Gmm = 98.0 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M·DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 82061	38075A	J. Hanson Consultant RE W. Sanford	9-22-98

CONTRACTOR	PLANT LOCATION	PLANT NO.
Angelo Iafrate Construction Co.	Taylor	035-01

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	~~MARSHALL~~ bulk DENSITY	THEORETICAL MAX. DENSITY
4E10	97MD-225	15.0	4.0	2364.1 kg/m³	2463.2 kg/m³

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
III	2.707	8-21-97	[X] YES [ ] NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	6.0	Coarse agg 3/8"	82-02	12.0
P 37.5 mm		" " 26A	58-08	17.0
P 25.0 mm		" " 31A	81-93	30.0
P 19.0 mm	100.0	Fine " Mfg sand	58-08	33.0
P 12.5 mm	97.7			
P 9.5 mm	87.1			
P 4.75 mm	50.4			
P 2.36 mm	28.0			
P 1.18 mm	20.3	RECLAIMED: Cont yard	035-01	10.0
P 600 μm	13.3	FILLER		
P 300 μm	9.7	ASPHALT: Marathon Oil, Det	PG 58-28	5.6
P 150 μm	5.9	AWI (Spec.) 260 / AWI (Actual) 281.6	ANGULARITY INDEX 45.4	
P 75 μm	4.6	TYPE OF TESTING: [X] QUALITY ASSURANCE TESTING [ ] REGULAR TESTING	DUST CORRECTION —	
CRUSHED	1/2: 99/99	[ ] BATCH PLANT [X] DRUM PLANT		

REMARKS: VFA = 73.2, Gb = 1.025, Gsb = 2.616, Compaction temp = 135°
F/Eff. Asphalt = 0.97, Mix production scheduled for 9-24

TRAVELLING MIX INSPECTOR (TMI) - Signature: Theodore L. Hanlon

DATE 9/22/97

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M·DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
NH 82061	38075A	J. Hanson (HRC) / R.E J. Sanford	11-5-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
Angelo Iafrate	Taylor	035-01

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY kg/m³	THEORETICAL MAX. DENSITY kg/m³
4E10	97MD 225 MOD.	15.0	4.0	2364.1 1476	2463.2 153

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
III	2.707	8-21-97	☒ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	**PERCENT**	**MATERIAL/PRODUCER**	**PIT NO.**	**PERCENT**
ASPHALT, %	6.0	Coarse Agg. 3/8"	82-02	12.0
P 37.5 mm		" " 26A	58-08	17.0
P 25.0 mm		" " 31A	81-93	30.0
P 19.0 mm	100	Fine "	58-08	33.0
P 12.5 mm	97.7			
P 9.5 mm	87.1			
P 4.75 mm	50.4			
P 2.36 mm	28.0			
P 1.18 mm	20.3	RECLAIMED: YARD 035-01		10.0
P 600 µm	13.3 ~~9.7~~	FILLER		
P 300 µm	9.7 ~~5.9~~	ASPHALT: MARATHON PG. 58-28		5.6
P 150 µm	5.9	AWI (Spec.) 260	AWI (Actual) 281.6	ANGULARITY INDEX 45.4
P 75 µm *	5.2	TYPE OF TESTING: ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	99/99	☐ BATCH PLANT ☒ DRUM PLANT		DUST. CORRECTION —

REMARKS: VFA = 73.2 * Change From 4.6 TO 5.2
Gb = 1.025
GSb = 2.616 * Change effective LOT # 2 Sublot # 7
Compaction Temp = 135°C
F/EFF Asphalt = .97

TRAVELLING MIX INSPECTOR (TMI) - Signature: L. O'Neill

DATE: 11-8-97

US-12 Wayne Co.
Contractors Quality Control Test Data

4E10 Mixture

G_b =1.025		G_{se} =2.707		G_{sb} =2.616		Absorb. =1.317		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	2487.3	2335.6	6.1	60.90	15.6	5.4	4.15	1.20
2	2466	2342.7	5	68.35	15.8	5.96	4.72	1.03
3	2473.7	2415	4.22	71.16	14.63	5.75	4.51	1.28
4	2453.1	2421	2.9	80.27	14.7	6.31	5.08	1.18
5	2455.1	2423.1	3	79.59	14.7	6.26	5.03	1.21
6	2465.2	2421.1	3.7	74.83	14.7	5.98	4.74	1.24
7	2466.1	2349.36	4.73	69.56	15.54	5.95	4.71	1.14
8	2464.5	2350.16	4.62	70.29	15.55	6	4.76	1.08
9	2461.1	2322.1	3.41	76.76	14.67	6.09	4.85	1.24
10								
11	2465.6	2376.7	3.6		14.56	5.97		
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
Average	2465.77	2375.68	4.13	72.41	15.05	5.97	4.73	1.18
STD	9.5727	40.5812	1.0011	6.1369	0.5036	0.2557	0.2748	0.0798

US-12 Wayne Co.

Contractors Quality Control Test Data 4E10 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm
1	4.97	6.2	8.8	12.16	16.63	24.61	45.15	83.27	95.02	100
2	4.87	6.03	8.47	11.61	16.07	24.59	46.17	85.95	97.8	100
3	5.78	7.2	10.17	14.06	19.69	30.35	53.16	89.87	97.41	100
4	5.98	7.99	11.1	15.3	21.31	31.87	53.87	87.51	97.39	100
5	6.06	7.29	10.01	13.89	19.78	30.9	54.42	87.64	98.46	100
6	5.87	7.1	9.72	13.31	18.5	27.88	50.03	87.01	98.43	100
7	5.39	6.6	9.06	12.17	16.77	25.59	46.33	84.04	96.13	100
8	5.16	6.38	8.95	12.21	17.07	26.5	47.61	84.54	96.18	100
9	6.02	7.32	11.2	15.76	21.86	33.16	57.08	90.64	98.08	100
10										
11	5.46	7.16	9.99	13.63	18.76	28.19	49.36	86.06	96.32	100
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
average	5.56	6.93	9.75	13.41	18.64	28.36	50.32	86.65	97.12	100.00
STD	0.4478	0.6068	0.9359	1.3978	2.0149	3.0811	4.1014	2.3959	1.1530	0

US-12 Wayne Co.
Contractors Quality Control Test Data

4E10 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1		82.3	95.8	100		
2		82.9	97	100		
3		83.8	97.6	100		
4		85.2	98.7	100		
5		84.8	98.7	100		
6		84.2	98.2	100		
7		83.9	97.2	100		
8		83.9	97.2	100		
9		85.4	98.3	100		
10		84.6	97.9	100		
11		84.3	98.3	100		
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
Avg.		84.12	97.72	100.00		
STD		0.9239	0.8727			

US-12 Wayne Co.

Contractors In Place Density Table 4E10 Mixture

Sublot	core #1	Core #2	core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	91.41	89.17	92.52	91.033						
2	93.91	93.69	96.12	94.573						
3	96.1	94.27	92.56	94.310						
4	94.58	91.84	93.28	93.233						
5	95.1	94.96	93.71	94.597	93.55	60.00	66.67	60.00	3.00	1.00
6	93.2	94.91	91.21	93.107	93.96					
7	93.59	93.41	89.76	92.253	93.50					
8	92	95.87	95.63	94.500	93.54					
9	95.71	93.92	93.1	94.243	93.74					
10					93.53	60.00	60.00	40.00	2.00	1.00
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
Specification			93.538							
STD			1.8298							
Bonus Lots						1	0	0		
Bonus Lots									0	0

US-12 Wayne Co.
Contractors Mixture Price Adjustment Table 4E10 Mixture

	TMD				VMA				VOIDS			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	153.8	Avg.	Dev.	Dev.	15.0	Avg.	Dev.	Dev.	4.0	Avg.	Dev.	Dev.
1	1.407				0.6				2.1			
2	0.078				0.8				1			
3	0.558				0.37				0.22			
4	0.726				0.3				1.1			
5	0.601	153.94	0.674	0.143	0.3	15.086	0.474	0.086	1	4.244	1.084	0.244
6	0.028				0.3				0.3			
7	0.084				0.54				0.73			
8	0.015				0.55				0.62			
9	0.227				0.33				0.59			
10		153.76	0.088	0.032		15.115	0.43	0.115		4.115	0.56	0.115
11	0.053				0.44				0.4			
12												
Specification			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			1				2				0	
Deduct Lots				0				0				0

US-12 Wayne Co.
Contractors Mixture Price Adjustment Table 4E10 Mixture

	% A.C.				75um				Crushed			
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	6	Avg.	Dev.	Dev.	5.2	Avg.	Dev.	Dev.	99.0	Avg.	Dev.	Dev.
1	0.6				0.23				1			
2	0.04				0.33				1			
3	0.25				0.58				1			
4	0.31				0.78				1			
5	0.26	5.936	0.292	0.064	0.86	5.532	0.556	0.332	1	100	1	1
6	0.02				0.67				1			
7	0.05				0.19				1			
8	0				0.04				1			
9	0.09				0.82				1			
10		6.005	0.04	0.005		5.61	0.43	0.41	1	100	1	1
11	0.03				0.26				1			
12												
Specification			0.3	0.3			0.7	0.7			10	10
Bonus Lots			2				2				2	
Deduct Lots				0				0				0.

US-12 Wayne Co.

MDOT Verification Test Data — 4E10 Mixture

Sublot	TMD	BULK	AIR VOID	VMA	%AC	Eff. AC	VFA	Fines/AC
2	2464.18	2391.4	5	15.9	6	4.76		0.979
10	2466.35	2371.79			5.9	4.66		1.287
Average	2465.265	2381.60	5	15.90	5.95	4.71		1.13
STD	1.5344	13.8664			0.0707	0.0716		0.2184

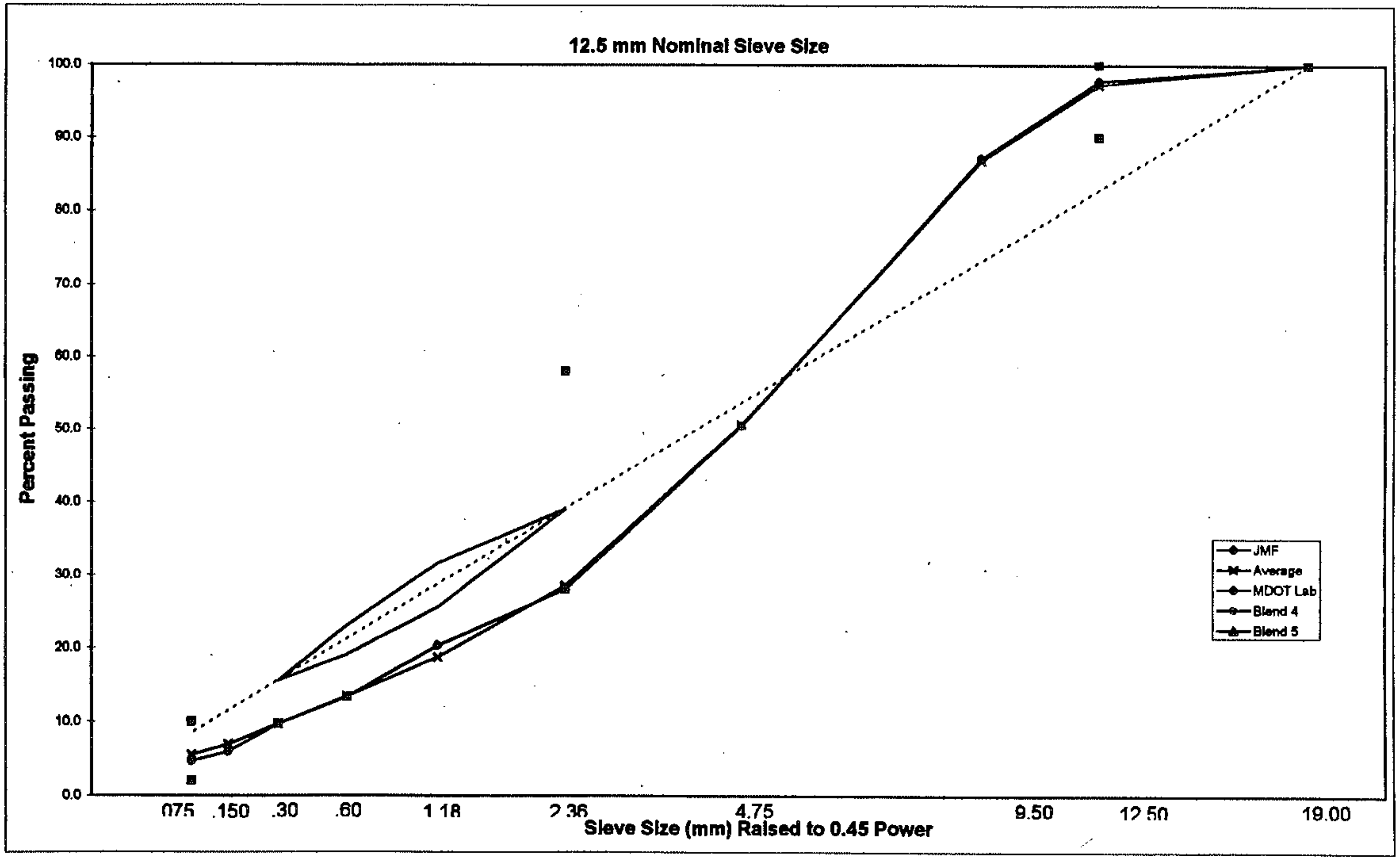
MDOT Central Lab Test Data

	Specification AC PG58-28		AC Used	PG58-28 + 10% RAP		
Date		%AC	%AC	Orig. Pen	Rec. Pen	Fines/AC
9/24/1997		5	3.75	120	80	1.387
9/25/1997				110		
10/16/97		5.8	4.56	100	65	1.294
10/21/97		5.6	4.36	95	61	1.469
11/13/97				101		
11/17/97				99		
Average		5.47	4.22	104.17	68.67	1.38
STD		0.41633	0.42181	9.19601	10.01665	0.08753

Aggregate Gradation Trials

Project Name: US-12
Technician: Doug
Date: 11/11/97

Filename: US12-4E.XLS
Description: 4E10
Nominal Sieve Size: 12.5 mm



Appendix D8

QC/QA Test Data

I-275 Monroe Co.

<10 Million ESAL

2E10 and 3E10 Mixtures

FILE 300 ______

1931 (N9/91)

REPORT OF TEST

BITUMINOUS MIX DESIGN

Control Section: IM 58171
Job Number: 34113A
Mix Design No.: 97MD-196
Date: AUGUST 27, 1997

Sample Of: BITUMINOUS MIXTURE NO. 2E10 --Recycled
Date Tested: AUGUST 25, 1997 Specification: 4.00 MOD, 1996 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Source	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	AMOCO		1.021
1	COARSE	3/4 CLEAR	PIT # 95-05	26.0%	
2	COARSE	3/4X1/2	PIT # 95-05	10.0%	
3	COARSE	#8'S	PIT # 93-03	27.5%	
4	FINE	MFG SAND	PIT # 95-10	16.0%	
5	RAP		YARD	20.0%	
6	BREAKDOWN		PLANT	0.5%	

MIX DESIGN

Asphalt @ Optimum= 4.5 Air Voids = 4.0
Density lb/cu.ft = 155.4*
(kg/cu.m) =(2488.5) V.M.A. = 13.6
Theo.Max. Density= 161.9
(kg/cu.m) =(2592.8) V.F.A. = 70.5

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	AGG.#6	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2	RESTRICTED ZONE
1 IN (25.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90-100	
3/4 IN (19.0mm)	61.0	100.0	100.0	100.0	100.0	100.0	89.9	90 MAX	
1/2 IN (12.5mm)	5.0	49.0	100.0	100.0	96.8	100.0	69.6		
3/8 IN (9.5mm)	5.0	10.0	90.0	100.0	92.1	100.0	62.0		
No. 4 (4.75mm)	5.0	4.6	17.0	99.0	76.2	100.0	38.0		39.5
No. 8 (2.36mm)	5.0	3.2	3.0	65.0	61.5	100.0	25.6	19-45	26.8 - 30.8
No. 16 (1.18mm)	4.0	2.8	2.0	36.0	49.0	100.0	17.9		18.1 - 24.1
No. 30 (600µm)	4.0	2.4	2.0	24.0	37.3	100.0	13.6		13.6 - 17.6
No. 50 (300µm)	4.0	2.2	1.5	14.0	24.0	98.0	9.2		11.4
No. 100 (150µm)	2.0	2.2	1.0	8.0	13.0	85.0	5.3		
No. 200 (75µm)	2.0	2.0	1.0	4.0	9.6	75.0	3.9	1-7	
½ SIDE CRUSH RET. 4.75mm	100/100	100/100	100/100	100/100	88/85		99/99	60/0 Min.	

Materials submitted by: Plant # 020-07 --(Contractor Furnished)
RAP CONTAINS 4.6% ASPHALT - 3.6% NEW ASPHALT ADDED TO THE MIXTURE
PG 58-28 GRADE ASPHALT REQUIRED FOR THE PROJECT
* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 46.7
EFFECTIVE SPECIFIC GRAVITY = 2.797

The bitumen content and aggregate characteristics are based on the submitted material with the gradation and blend ratios indicated. Variation in materials or field conditions may require adjustments of this mix design (see T.M.I. for form 1911 for field application). This laboratory design is valid for two years from date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TESTED FOR INFORMATION.

CC: SHULTZ, T. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
TED HANLON (2)
D. ANDREWS (4)

____
Bituminous Unit - Supervising Engineer

1931A (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: IM 58171
Job Number: 34113A
Mix Design No.: 97MD-196
Mix Type: 2E10 RP

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
4.5	2.49	155.4	2.594	161.9	4.0	13.6	70.5	0.99
REGRESSION EVERY 0.1%								
3.5	2.464	153.8	2.636	164.5	6.5	13.6	52.0	1.33
3.6	2.467	153.9	2.632	164.2	6.3	13.6	53.8	1.29
3.7	2.469	154.1	2.628	164.0	6.1	13.6	55.5	1.25
3.8	2.472	154.3	2.624	163.7	5.8	13.6	57.4	1.21
3.9	2.474	154.4	2.619	163.4	5.5	13.6	59.3	1.17
4.0	2.476	154.5	2.615	163.2	5.3	13.6	61.0	1.14
4.1	2.479	154.7	2.611	162.9	5.1	13.6	62.9	1.11
4.2	2.482	154.9	2.607	162.7	4.8	13.6	64.7	1.07
4.3	2.484	155.0	2.602	162.4	4.5	13.6	66.7	1.05
4.4	2.487	155.2	2.598	162.1	4.3	13.6	68.6	1.02
4.5	2.490	155.4	2.594	161.9	4.0	13.6	70.5	0.99
4.6	2.492	155.5	2.590	161.6	3.8	13.6	72.2	0.97
4.7	2.495	155.7	2.586	161.4	3.5	13.6	74.1	0.94
4.8	2.498	155.9	2.581	161.1	3.2	13.6	76.3	0.92
4.9	2.501	156.1	2.577	160.8	2.9	13.6	78.3	0.90
5.0	2.504	156.2	2.573	160.6	2.7	13.6	80.2	0.88
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2

- (PG 58-28 – AMOCO OIL) SP. GR. = 1.021

- EFFECTIVE SPECIFIC GRAVITY = 2.797

BULK AGGREGATE SPECIFIC GRAVITY = 2.752

DESIGN ESAL'S = <10.0

DESIGN TEMPERATURE = 35 degrees C

MIXING TEMPERATURE = 143 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 8 %Gmm = 85.5 SPECIFICATION = 89% MAX.

DESIGN GYRATIONS = 96

MAXIMUM GYRATIONS = 152 %Gmm = 97.3 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M·DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
IM 58171	34113A	T. SHULTZ	9-5-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
~~Ajax Paving Industries~~	Romulus	020-07

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	~~MARSHALL~~ GYRATORY DENSITY	THEORETICAL MAX. DENSITY
2E10(R)	97MD-196	13.6	4.0	1554 ~~2488.5~~ kg/m³	1618 2592.8 kg/m³

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
111 *	2.797	8-19-97	☒ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	4.5	Coarse agg 3/4" Clear	95-05	26.0
P 37.5 mm		" " 3/4 x 1/2	95-05	10.0
P 25.0 mm	100.0	" " #8's	93-03	28.0
P 19.0 mm	89.9	Fine agg Mfg sand	95-10	16.0
P 12.5 mm	69.6			
P 9.5 mm	62.0			
P 4.75 mm	38.0			
P 2.36 mm	25.6			
P 1.18 mm	17.9	RECLAIMED: Contr. yard	20-07	20.0
P 600 μm	13.6	FILLER		
P 300 μm	9.2	ASPHALT: AMOCO Oil, Det.	PG 58-28	3.6
P 150 μm	5.3	AWI (Spec.) N/A; AWI (Actual) —	ANGULARITY INDEX 46.7	
P 75 μm	3.9	TYPE OF TESTING: ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	99/99	☐ BATCH PLANT ☒ DRUM PLANT	DUST. CORRECTION N/A	

REMARKS:
Contractor will use calculated AC% & Ignition furnace for combined aggregate gradation.
Gsb = 2.752, Design temp. = 35°C, Mixing temp = 143°C, Compaction temp = 135°C (Gyrations, int = 8, design = 96, max = 152)
Gb = 1.021. Restricted zone 4.75 mm = 39.5, 2.36 ~~mm~~ = 26.8 – 30.8, 1.18 mm = 18.1 – 24.1, 600 μm = 13.6 – 17.6 & 300 μm = 11.4

TRAVELLING MIX INSPECTOR (TMI) Signature	DATE
[signature]	9/5/97

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M-DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
IM 58171	34113A	T. SCHULTZ	9/5/97
CONTRACTOR		PLANT LOCATION	PLANT NO.
Ajax Paving Industries		Romulus	20-07

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY kg/m³	THEORETICAL MAX. DENSITY kg/m³
2E-10	97MD-196(Mod)				

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER ☐ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	see previous 1911 (9/5/97)			
P 37.5 mm				
P 25.0 mm				
P 19.0 mm				
P 12.5 mm				
P 9.5 mm				
P 4.75 mm				
P 2.36 mm				
P 1.18 mm		RECLAIMED		
P 600 μm		FILLER		
P 300 μm		ASPHALT: *AMOCO, DET. PG52-28		3.6
P 150 μm		AWI (Spec.) / AWI (Actual) / ANGULARITY INDEX		
P 75 μm		TYPE OF TESTING ☐ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED		☐ BATCH PLANT ☐ DRUM PLANT	DUST. CORRECTION	

REMARKS: * Mix design 97MD-196 calls for PG 58-28, however Contractor reconsidered and opted to use PG 52-28 to meet required recovered pen of PG 58-28

TRAVELLING MIX INSPECTOR (TMI) Signature: K. Hanlon DATE: 9/18/97

D8-4

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF) BITUMINOUS FIELD COMMUNICATION

M·DOT METRIC

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
IM 58171	34113A	T. SHULTZ	9/26/97
CONTRACTOR		PLANT LOCATION	PLANT NO.
AJAX PAVING INDUSTRIES		ROMULUS	20-07

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY	THEORETICAL MAX. DENSITY
3E10(B)*	FIELD	13.6	4.0	2488.5 kg/m³ 155.3	2592.8 kg/m³ 161

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
111	2.797	8-19-97	☒ YES ☐ NO

ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	4.5	Coarse Agg 3/4" Clear	95-05	10.0
P 37.5 mm		" " 3/4" x 1/2"	95-05	26.0
P 25.0 mm	100.0	" " #8's	93-03	28.0
P 19.0 mm	96.0	fine agg Mfg sand	95-10	16.0
P 12.5 mm	74.0			
P 9.5 mm	65.0			
P 4.75 mm	38.0			
P 2.36 mm	25.6			
P 1.18 mm	17.9	RECLAIMED: Contr yard 20-07		20.0
P 600 µm	13.6	FILLER		
P 300 µm	9.2	ASPHALT: AMOCO Det. PG 52-28		3.6
P 150 µm	5.3	AWI (Spec.) N/A; AWI (Actual) ——	ANGULARITY INDEX 46.7	
P 75 µm	3.9	TYPE OF TESTING: ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	99/99	☐ BATCH PLANT ☒ DRUM PLANT	DUST. CORRECTION ——	

REMARKS: * This mixture will be used for base course only. Gsb = 2.752, Gb = 1.025, Compaction temp = 135°C. These changes to 97MD-196 are authorized by the PE & agreed with by the "Superpave Review team" representatives at meeting on 9/25/97. Contractor will use PG 52-28 to meet specified PG 58-28 recovered penetration.

TRAVELLING MIX INSPECTOR (TMI) - Signature: [signature]

DATE: 9/26/97

I-275 Monroe Co.

Contractors Quality Control Testing 2E10 Mixture

G_b =1.021		G_{se} =2.797		G_{sb} =2.752		Absorb =0.597		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff. AC	FINE/AC
1	2602.8	2475.49	4.89	64.82	13.9	4.3	3.73	1.28
2	2575.8	2484.6	3.54	74.98	14.15	4.95	4.38	1.02
3	2598.28	2492.28	4.08	69.55	13.4	4.41	3.84	1.13
4	2595.4	2524.8	2.72	77.96	12.34	4.48	3.91	1.12
5	2604.6	2515.51	3.42	72.53	12.45	4.25	3.68	1.30
6	2597.5	2489.17	4.01	70.38	13.54	4.44	3.87	1.09
7	2605.4	2493.1	4.32	67.40	13.25	4.24	3.67	1.21
8	2605.4	2493.1	4.32	67.40	13.25	4.24	3.67	1.11
9	2602.7	2526.7	2.95	75.68	12.13	4.3	3.73	1.20
10	2628.9	2524.6	4	65.64	11.64	3.68	3.11	1.57
11	2610.9	2470.7	5.36	61.30	13.85	4.11	3.54	1.07
12	2602.7	2500.18	3.93	69.82	13.02	4.3	3.73	1.21
13	2585.8	2502.57	3.21	75.88	13.31	4.71	4.14	0.99
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
Average	2601.24	2499.45	3.90	70.26	13.09	4.34	3.77	1.18
STD	12.4279	18.5849	0.7444	4.9672	0.7503	0.2978	0.2996	0.1503

I-275 Monroe Co.

Contractors Quality Control Test Data 2E10 Mixture

Sublot	75um	150mm	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	4.77	6.38	9.07	12.79	17.27	25.00	37.50	68.66	82.28	99.31	100
2	4.46	6.17	8.87	12.59	17.08	24.89	38.42	69.42	79.87	96.06	100
3	4.33	6.02	8.78	12.61	17.03	23.92	35.78	63.67	77.86	98.56	100
4	4.39	6.12	8.91	12.86	17.72	25.57	39.32	66.41	74.39	95.78	100
5	4.78	6.49	9.38	13.45	18.24	26.07	38.78	69.13	83.4	99.18	100
6	4.23	5.72	8.21	11.68	15.91	22.98	34.52	64.47	79.55	99.2	100
7	4.44	6.1	8.83	12.64	17.2	24.68	37.36	66.62	79.02	97.76	100
8	4.08	5.6	8.16	11.78	16.07	22.91	33.83	61.99	73.94	98.04	100
9	4.47	6.14	8.96	12.75	17.04	24.32	36.6	65.41	75.12	97.33	100
10	4.87	6.91	10.29	14.86	20.06	28.56	42.77	69.81	76.72	96.73	100
11	3.79	5.33	7.84	11.29	15.28	21.86	33.6	62.45	74.11	98.4	100
12	4.52	6.25	9.06	12.93	17.63	25.59	38.7	68.39	78.64	99.33	100
13	4.09	5.81	8.64	12.58	17.4	25.2	40.03	68.97	79.53	97.66	100
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											
46											
47											
48											
Average	4.40	6.08	8.85	12.68	17.23	24.73	37.48	66.57	78.03	97.95	100
STD	0.3088	0.4071	0.6068	0.8767	1.1708	1.6750	2.6260	2.7501	3.0517	1.2140	0.000

I-275 Monroe Co.

Contractors Quality Control test Data 2E10 Mixture

Sublot	Marshall A.V.	% G_{mm} @ N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed
1		84.7	96.7	99.0	
2		86.0	98.0	98.6	
3		85.5	97.5	99.3	
4		85.7	98.9	97.5	
5		86.2	98.1	97.3	
6		85.3	97.5	99.1	
7		96.6	98.5	100	
8		85.2	97.3	98.7	
9		86.7	98.6	98.9	
10		86.4	97.4	97.8	
11				100	
12				100	
13				100	
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
Average		86.83	97.85	98.94	
STD		3.4852	0.6867	0.9526	

I-275 Monroe Co.

Contractors In Place Density Results 2E10 Mixture

Sublot	Core #1	Core #2	Core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	92.89	90.12	91.86	91.623						
2	92.97	93.46	92.73	93.053						
3	94.11	92.71	93.37	93.397						
4	96.59	93.52	94.87	94.993						
5	94.31	92.17	95.65	94.043	93.42	80.00	53.33	40.00	2.00	1.00
6	93.1	96.61	92.5	94.070	93.91					
7	92.34	94.35	92.13	92.940	93.89					
8	94.83	94.35	92.13	93.770	93.96					
9	90.7	92.9	93.13	92.243	93.41					
10	95.84	91.72	91.77	93.110	93.23	53.33	46.67	33.33	3.00	1.00
11	93.26	89.92	93.58	92.253	92.86					
12	93.47	93.2	94.9	93.857	93.05					
13	91.13	92.84	93.71	92.560	92.80					
14				#DIV/0!	92.95					
15				#DIV/0!	92.89	46.67	40.00	20.00	2.00	1.00
16				#DIV/0!	93.21					
17				#DIV/0!	92.56					
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
Average			93.2241							
STD			1.5561							
Bonus Lots						1	0	0		
Deduct Lots									0	0

I-275 Monroe Co.

Contractors Price Incentive and Deduction Table 2E10 Mixture

	TMD				VMA				VOIDS			
Sublot	JMF 161.9	Lot Avg.	Abs. Dev.	Dev.	JMF 13.6	Lot Avg.	Abs. Dev.	Dev.	JMF 4	Lot Avg.	Abs. Dev.	Dev.
1	0.51				0.3				0.89			
2	1.17				0.55				0.46			
3	0.23				0.2				0.08			
4	0.05				1.26				1.28			
5	0.63	161.95	0.519	0.051	1.15	13.248	0.692	0.352	0.58	3.73	0.658	0.27
6	0.18				0.06				0.01			
7	0.68				0.35				0.32			
8	0.68				0.35				0.32			
9	0.51				1.47				1.05			
10	2.14	162.73	0.837	0.837	1.96	12.762	0.838	0.838	0	3.92	0.34	0.08
11	1.02				0.25				1.36			
12	0.51				0.58				0.07			
13	0.55	162.62	0.945	0.726	0.29	12.79	0.91	0.81	0.79	3.89	0.654	0.11
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
Spec			0.6	0.6			0.6	0.6			0.5	0.5
Bonus Lots			1				0				1	
Deduct Lots				2				2				0

I-275 Monroe Co.

Contractors Price Incentive and Deduction Table

2E10 Mixture

	% A.C.				75um				Crushed			
Sublot	JMF 4.5	Lot Avg.	Abs. Dev.	Dev.	JMF 3.9	Lot Avg.	Abs. Dev.	Dev.	JMF 99	Lot Avg.	Abs. Dev.	Dev.
1	0.2				0.87				0			
2	0.45				0.56				0.4			
3	0.09				0.43				0.3			
4	0.02				0.49				1.5			
5	0.25	4.478	0.20	0.022	0.88	4.546	0.646	0.646	1.7	98.34	0.78	0.66
6	0.06				0.33				0.1			
7	0.26				0.54				1			
8	0.26				0.16				0.3			
9	0.2				0.57				0.1			
10	0.82	4.18	0.32	0.32	0.97	4.414	0.514	0.514	1.2	98.9	0.54	0.1
11	0.39				0.11				1			
12	0.2				0.62				1			
13	0.21	4.22	0.36	0.28	0.19	4.348	0.492	0.448	1	99.34	0.86	0.34
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
Spec			0.3	0.3			0.7	0.7			10	10
Bonus Lots			1				3				3	
Deduct Lots				1				0				0

I-275 Monroe Co.

MDOT Verification Test Data

2E10 Mixture

MDOT Sublot	I-275 TMD	25mm BULK	AIR VOID	Volumetics VMA	%AC	EFF. AC	FINES/AC	VFA
3	2592.5	2527	4.1	13.8	4.57	3.973	1.115	70.290
10	2630.3	2567.1	3.84	11.47	3.67	3.073	1.497	66.521
11	2610	2502	5.8	14.3	4.1	3.503	1.279	59.441
16	2589.8	2569.8	2.33	12.32	4.6	4.003	1.154	81.088
Average	2605.65	2541.48	4.0175	12.97	4.24	3.64	1.26	69.33
STD	18.7144	32.7961	1.4217	1.3077	0.4408	0.4408	0.1719	9.0343

MDOT Central Lab Test Data

2E10 Mixture

LAB	Specification AC	PG58-28 Fines/AC	Eff. AC	AC Used %AC	PG52-28 Orig. Pen	20%RAP Rec. Pen
9/14/1997		1.688	2.903	3.5	234	66
9/15/1997		1.324	4.003	4.6	229	85
9/16/1997					240	
9/18/1997		1.236	3.803	4.4	237	89
9/19/1997					245	
9/22/1997		1.485	3.703	4.3	245	78
10/8/1997				3.8	203	77
10/9/1997					233	
Average		1.43	3.60	4.12	233.25	79.00
STD		0.1987	0.4830	0.4550	13.4669	8.8034

I-275 Monroe Co.

MDOT Verification Test Data — 2E10 Mixture

MDOT Sublot	I-275 75um	150um	25mm 300um	600um	Gradation 1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
3	4.43	6.12	8.97	12.42	16.76	23.79	38.42	66.34	77.81	96.5	100
10	4.6	6.74	10.33	14.73	19.9	27.56	42.07	66.42	72.2	95.25	100
11	4.48	6.22	9.04	12.35	16.35	22.21	33.62	59.18	74.84	98.17	100
16	4.62	6.7	10.4	14.89	20.3	28.17	43.03	70.13	83.02	98.33	100
Average	4.53	6.45	9.69	13.60	18.33	25.43	39.29	65.52	76.97	97.06	100.00
STD	0.0922	0.3206	0.7862	1.4019	2.0600	2.8927	4.2670	4.5800	4.6403	1.4645	0.0000

MDOT Central Lab Test Data — 2E10 Mixture

LAB	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
9/14/97	4.9	5.7	8.3	11.5	14.8	20.1	30.7	61.2	77.8	97.5	100
9/15/97	5.3	6.9	9.8	13.9	18.4	26.2	42.6	72.8	87.5	97.8	100
9/18/97	4.7	6.1	9.1	12.5	16.9	23.3	36.7	67.1	82.7	97.1	100
9/22/97	5.5	7.1	10.1	13.9	18.5	25.8	39.1	65.9	74.8	93.7	100
10/8/97	4.2	5.7	8.3	11.5	16.3	20.9	33.2	60.7	75.6	97.1	100
10/9/97											
Average	4.92	6.30	9.12	12.66	16.98	23.26	36.46	65.54	79.68	96.64	100.00
STD	0.5119	0.6633	0.8319	1.2033	1.5450	2.7682	4.7046	4.9379	5.3448	1.6697	0.0000

I-275 Monroe Co.

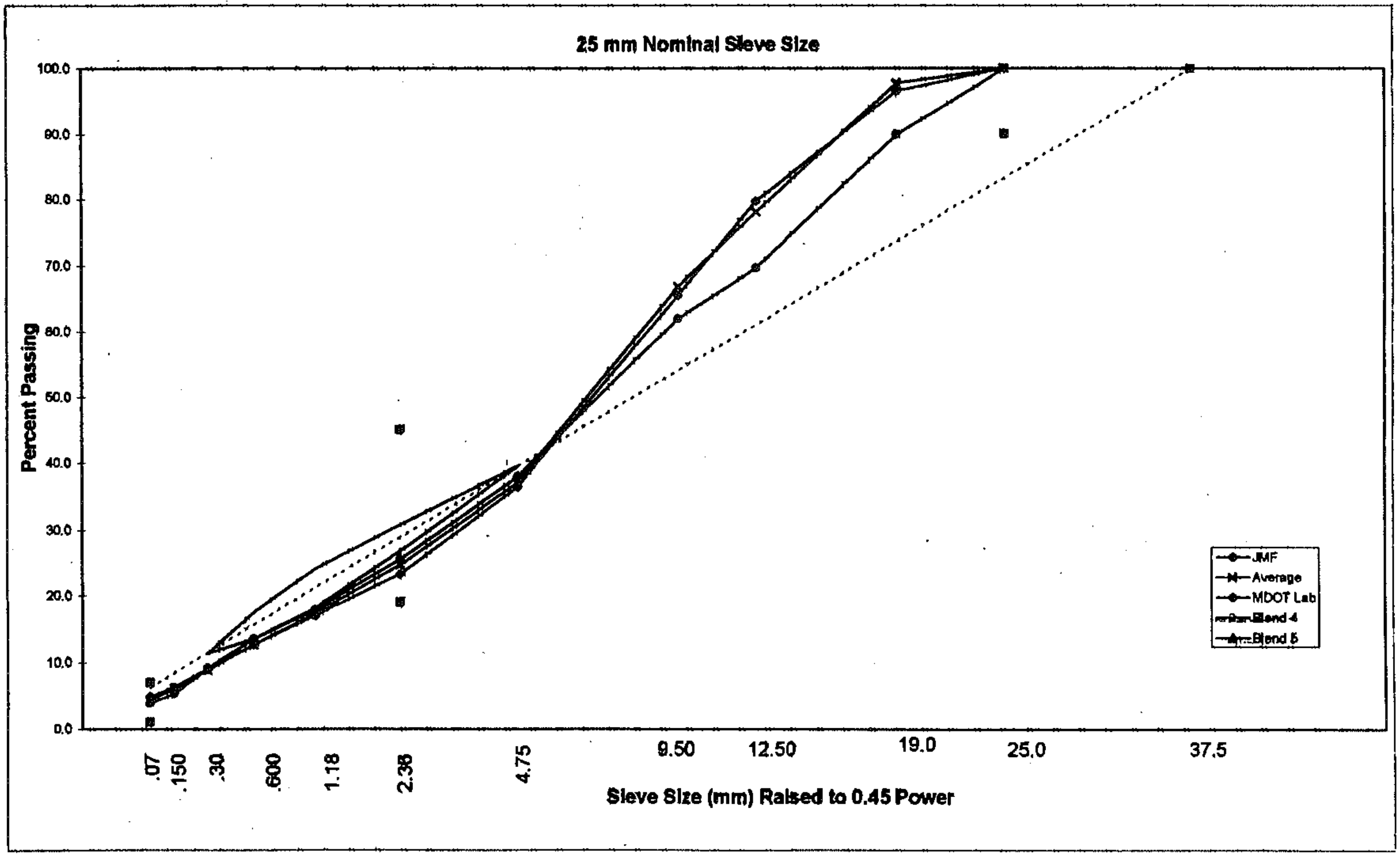
Film Thickness Table 2E10 Mixture

Gradation	DESIGN % Pass	PLANT % Pass	MDOT LAB % Pass
37.5	100	100	100
25	100	100	100
19	89.9	98	96.6
12.5	69.6	78	79.7
9.5	62	66.6	65.5
4.75	38	37.5	36.5
2.36	25.6	24.7	23.3
1.18	17.9	17.2	17
0.6	13.6	12.7	12.7
0.3	9.2	8.9	9.1
0.15	5.3	6.1	6.3
0.075	3.9	4.4	4.9
% AC	4.5	4.34	4.1
Film Thick.	0.00114	0.00102	0.00090

Aggregate Gradation Trials

Project Name: I-275
Technician: Doug
Date: 1/0/00

Filename: I-275-2E.XLS
Description: JMF/prod
Nominal Sieve Size: 25 mm



Control ·ction: IM 58171
Job Num ·: 34113A
REPORT OF TEST Mix Des ı No.: 97MD-226
Date: OCTOBER 9, 1997

1931 (N9/91) BITUMINOUS MIX DE: 3N

Sample Of: BITUMINOUS MIXTURE NO. 3E10 --Recycled
Date Tested: SEPTEMBER 17, 1997 Specificati(: 4.00 MOD, 1996 STD. SPECS.

MATERIALS USED

Agg.#	Material	Type	Sourc(	Percent	SP.GR.
	ASPHALT CEMENT	PG 58-28	AMOCO		1.021
1	COARSE	3/4X1/2	PIT # 95-(	21.0%	
2	COARSE	#8'S	PIT # 93-(	30.0%	
3	FINE	MFG SNAD	PIT # 95-]	28.5%	
4	RAP		YARD	20.0%	
5	BKDOWN		PLANT	0.5%	

MIX DESIGN

Asphalt @ Optimum= 5.1 Air Voids 4.0
Density lb/cu.ft = 154.3*
(kg/cu.m) =(2470.9) V.M.A. 14.8
Theo.Max. Density= 160.7
(kg/cu.m) =(2574.3) V.F.A. 72.9

SIEVE SIZE	AGG.#1	AGG.#2	AGG.#3	AGG.#4	AGG.#5	COMBINED GRADATION	MASTER GRAD. RANGE 7.10-2
1 IN (25.0mm)	100.0	100.0	100.0	100.0	100.0	100.0	100
3/4 IN (19.0mm)	80.0	100.0	100.0	100.0	100.0	95.8	90-100
1/2 IN (12.5mm)	6.7	100.0	100.0	96.8	100.0	79.8	90 MAX
3/8 IN (9.5mm)	4.7	90.0	100.0	92.1	100.0	75.4	
No. 4 (4.75mm)	3.3	17.0	99.0	76.2	100.0	49.7	
No. 8 (2.36mm)	2.7	3.0	65.0	61.5	100.0	32.8	23-49
No. 16 (1.18mm)	2.7	2.0	36.0	49.0	100.0	21.7	
No. 30 (600µm)	2.3	2.0	24.0	37.3	100.0	15.9	
No. 50 (300µm)	2.3	1.5	14.0	24.0	98.0	10.2	
No. 100 (150µm)	2.3	1.0	8.0	13.0	85.0	6.1	
No. 200 (75µm)	2.0	1.0	4.0	9.6	75.0	4.2	2-8
CRUSH RET.#4	100.0	100.0	100.0	88.0	100.0	98.9	Min.

Materials submitted by: AJAX PAVING INDUSTRIES, INC. Plant #)20-07
RAP CONTAINS 4.6% ASPHALT - 4.2% NEW ASPHALT ADDED TO THE MIXTURE
PG 58-28 GRADE ASPHALT REQUIRED FOR THE PROJECT
* RECOMMENDED FIELD CONTROL DENSITY
ANGULARITY INDEX NUMBER = 46.4
EFFECTIVE SPECIFIC GRAVITY = 2.805

The bitumen content and aggregate characteristics are based on the subm :ed material with the gradation and blend rati indicated. Variation in materials or field conditions may require adjus ents of this mix design (see T.M.I. for form 1 for field application). This laboratory design is valid for two years f a date reported and should not be applied or adjusted without written approval of the Bituminous Services Unit. TES ı FOR INFORMATION.

CC: SHULTZ, T. (PE) (2) CONTRACTOR
FIELD ENGINEER BIT. FILE
TED HANLON (2)
D. ANDREWS (4)

tuminous Unit - Supervising Engineer

1931A (N9/91)

REPORT OF TEST
BITUMINOUS MIX DESIGN

Control Section: IM 58171
Job Number: 34113A
Mix Design No.: 97MD-226
Mix Type: 3E10 RP

A.C. BY WT	BULK S.G.	BULK DENSITY	MAX THEO. S.G.	T.M.D.	AIR VOIDS	VMA	VFA	FINES/EFF. ASPHALT RATIO
@ OPTIMUM								
5.1	2.472	154.3	2.575	160.7	4.0	14.8	72.9	0.95
REGRESSION EVERY 0.1%								
4.5	2.447	152.7	2.601	162.3	5.9	15.1	60.7	1.10
4.6	2.451	152.9	2.596	162.0	5.6	15.0	62.8	1.07
4.7	2.455	153.2	2.592	161.7	5.3	15.0	64.7	1.04
4.8	2.459	153.4	2.588	161.5	5.0	14.9	66.6	1.02
4.9	2.464	153.8	2.584	161.2	4.6	14.9	68.7	0.99
5.0	2.468	154.0	2.580	161.0	4.3	14.8	70.7	0.97
5.1	2.472	154.3	2.575	160.7	4.0	14.8	72.9	0.95
5.2	2.476	154.5	2.571	160.4	3.7	14.7	74.9	0.93
5.3	2.481	154.8	2.567	160.2	3.4	14.6	77.1	0.91
5.4	2.485	155.1	2.563	159.9	3.0	14.6	79.1	0.89
5.5	2.489	155.3	2.559	159.7	2.7	14.5	81.2	0.87
5.6	2.493	155.6	2.555	159.4	2.4	14.5	83.2	0.85
5.7	2.498	155.9	2.551	159.2	2.1	14.4	85.6	0.83
5.8	2.502	156.1	2.547	158.9	1.8	14.4	87.7	0.82
5.9	2.506	156.4	2.543	158.7	1.5	14.3	89.8	0.80
6.0	2.511	156.7	2.539	158.4	1.1	14.2	92.3	0.79
SPECIFICATIONS =					4%	13.0	65-78	0.6-1.2

- (PG 52-28 – AMOCO OIL) SP. GR. = 1.021

- EFFECTIVE SPECIFIC GRAVITY = 2.805

BULK AGGREGATE SPECIFIC GRAVITY = 2.~~572~~ 752

DESIGN ESAL'S = <10.0

DESIGN TEMPERATURE = 38 degrees C

MIXING TEMPERATURE = 143 degrees C

COMPACTION TEMPERATURE = 135 degrees C

INITIAL GYRATIONS = 8 %Gmm = 86.3 SPECIFICATION = 8 % MAX.

DESIGN GYRATIONS = 96

MAXIMUM GYRATIONS = 152 %Gmm = 97.3 SPECIFICATION = 98% MAX.

Michigan Department of Transportation
1911 (3/97)

JOB MIX FORMULA (JMF)
BITUMINOUS FIELD COMMUNICATION

DISTRIBUTION: WHITE - Testing Lab. GREEN - District YELLOW - Project Engineer PINK - Inspector GOLD - TMI

This form applies only to the project listed below and is not transferable to other projects.

CONTROL SECTION	JOB NO.	PROJECT ENGINEER	DATE EFFECTIVE
IM 58171	34113I	T. Shultz	10-13-97

CONTRACTOR	PLANT LOCATION	PLANT NO.
Ajax Paving Industries Inc.	Romulus	20-07

TYPE OF MIXTURE	MIX DESIGN NO.	VMA %	AIR VOIDS %	MARSHALL DENSITY kg/m³	THEORETICAL MAX. DENSITY kg/m³
* 3E10(L)(R)	97MD-226	14.8	4.0	2470.9 (154.2)	2574.3 (160.7)

TESTING OPTION	MIX DESIGN EFFECTIVE SPECIFIC GRAVITY	PLANT CERTIFICATION DATE	CONTRACTOR'S QC PLAN TO PROJECT ENGINEER
III	2.805	8-19-97	☒ YES ☐ NO

MIX/AGG. GRADATION, %		MIX/AGG. BLEND PROPORTION, %		
ITEM	PERCENT	MATERIAL/PRODUCER	PIT NO.	PERCENT
ASPHALT, %	5.1	Coarse agg 3/4 x 1/2	95-05	21.0
P 37.5 mm		" " #8's	93-03	30.0
P 25.0 mm	100.0	fine " Mfg sand	95-10	29.0
P 19.0 mm	95.8			
P 12.5 mm	79.8	Gsb = 2.752		
P 9.5 mm	75.4	Design temp = 58°C, Mix temp = 143°C		
P 4.75 mm	49.7	Compaction temp = 135°C VFA = 72.9		
P 2.36 mm	32.8	Absorbed binder = 0.7%		
P 1.18 mm	21.7	RECLAIMED: Contr. yard, 20-07		20.0
P 600 μm	15.9	FILLER		
P 300 μm	10.2	ASPHALT: AMOCO, Det. PG 52-28		4.2 **
P 150 μm	6.1	AWI (Spec.) N/A; AWI (Actual) —; ANGULARITY INDEX 4.6.4		
P 75 μm	4.2	TYPE OF TESTING: ☒ QUALITY ASSURANCE TESTING ☐ REGULAR TESTING		
CRUSHED	98.9	☐ BATCH PLANT ☒ DRUM PLANT; DUST. CORRECTION —		

REMARKS:

* This mix to be used for leveling course on above project.

** Contr. will use PG 52-28 to meet the recovered penetration requirement for PG 58-28 binder.

Contr. to use calculated binder % and ignition furnace for combined agg gradation.

TRAVELLING MIX INSPECTOR (TMI) - Signature: [illegible]

DATE: 10/13/97

I-275 Monroe Co.

Contractors Quality Control Test Data — 3E10 Mixture

G_b =1.021		G_{se} =2.805		G_{sb} =2.752		Absorp. =0.701		
SUBLOT	TMD	BULK	AIR VOID	VFA	VMA	%AC	Eff AC	FINE/AC
1	2589.4	2530.39	2.27	81.48	12.26	4.62	3.95	1.10
2	2599.1	2521.77	2.97	75.97	12.36	4.39	3.72	1.25
3	2602	2523.7	3	75.45	12.22	4.32	3.65	1.22
4	2614.3	2511.15	3.94	68.20	12.39	4.03	3.36	1.17
5	2609.7	2509.09	3.85	69.37	12.57	4.14	3.47	1.22
6	2608.2	2516.68	3.5	71.61	12.33	4.17	3.50	1.27
7	2591.3	2491.3	3.85	71.65	13.58	4.58	3.91	1.10
8	2607.4	2485.4	4.67	65.25	13.44	4.19	3.52	1.21
9	2596.8	2542.81	2.07	82.22	11.64	4.41	3.74	1.22
10	2610.4	2501.3	4.18	67.45	12.84	4.11	3.44	1.28
11	2600.96	2498.39	3.66	71.47	12.83	4.3	3.63	1.10
12	2615.4	2485.6	3.66	71.47	12.83	4	3.33	1.23
13	2615.2	2498.6	4.46	65.26	12.84	4	3.33	1.20
14	2608.03	2501.85	4.07	68.40	12.88	4.17	3.50	1.21
15	2606.1	2508.6	3.74	70.50	12.68	4.21	3.54	1.32
16	2598.9	2505.1	3.61	72.12	12.95	4.38	3.71	1.20
17	2596.7	2504.8	3.54	72.81	13.02	4.44	3.77	1.13
18	2591.4	2502.5	3.43	74.03	13.21	4.56	3.89	1.11
19	2600.83	2496.8	4	69.72	13.21	4.34	3.67	1.11
20	2595.88	2492.56	3.98	70.43	13.46	4.45	3.78	1.17
21	2593.2	2505.1	3.4	74.05	13.1	4.52	3.85	1.13
22	2608.03	2501.85	4.07	68.40	12.88	4.17	3.50	1.21
23	2588.35	2502.93	3.3	75.19	13.3	4.63	3.96	1.05
24	2587.8	2507.58	3.1	78.62	14.5	4.65	3.98	1.16
25	2605.42	2507.98	3.74	70.64	12.74	4.23	3.56	1.30
26	2620.49	2467.45	5.84	57.71	13.81	3.87	3.20	1.21
27	2588.63	2512.53	2.94	77.26	12.93	4.63	3.96	1.12
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								
46								
47								
Average	2601.85	2504.96	3.66	71.73	12.92	4.32	3.64	1.19
STD	9.3805	14.7938	0.7311	5.1379	0.5682	0.2216	0.2232	0.0688

I-275 Monroe Co.

Contractors Quality Control Test Data 3E10 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.36mm	4.75mm	9.5mm	12.5mm	19mm	25mm
1	4.36	6.55	10.27	15.70	22.74	33.07	47.76	75.32	79.88	96.17	100.00
2	4.64	6.87	10.63	15.97	22.94	34.28	53.69	78.23	81.21	96.22	100
3	4.45	6.84	10.31	15.55	22.3	33.29	49.73	73.95	78.32	93.28	100
4	3.94	5.97	9.24	13.91	20.05	29.81	43.89	71.94	76.9	94.69	100
5	4.22	6.24	9.6	14.39	20.78	31.41	46.45	74.5	79.11	94.51	100
6	4.44	6.51	9.9	14.76	21.41	32.65	49.63	76.27	80.41	94.81	100
7	4.31	6.11	8.97	12.85	17.57	25.74	40	68.24	80.4	100	100
8	4.26	5.87	8.47	11.99	16.12	23.27	36.35	64.74	74.43	97.09	100
9	4.56	6.57	9.84	14.4	19.64	28.06	41.81	66.51	78.37	96.56	100
10	4.41	6.17	9.06	13.01	17.84	26.08	41.85	69.95	82.48	97.88	100
11	4	5.7	8.6	12.4	17	24.6	38.1	64.1	75.4	97.6	100
12	4.1	5.8	8.6	12.3	16.7	24.4	38.2	62.8	75.2	97.4	100
13	3.98	5.78	8.7	12.61	17.04	24.16	36.52	62.7	75.03	95.97	100
14	4.25	6.08	9.09	13	17.76	25.98	40.44	66.61	78.07	98.41	100
15	4.66	6.47	9.39	13.28	18.01	25.8	41.05	70.42	80.84	98.21	100
16	4.46	6.22	9.02	12.78	17.44	25.39	39.17	68.28	77.12	95.58	100
17	4.27	6.03	8.89	12.68	17.17	24.52	37.21	67.95	79.19	97.67	100
18	4.32	6.04	8.75	12.32	16.52	23.28	35.51	63.65	72.91	99.3	100
19	4.06	5.89	8.35	11.94	16.13	23.26	35.12	63.39	75.06	95.37	100
20	4.41	6.11	8.87	12.6	16.99	24.46	37.18	66.9	77.55	95.11	100
21	4.35	6.07	8.97	12.86	17.49	25.27	37.77	67.87	74.96	95.85	100
22	4.25	6.08	9.09	13	17.76	25.98	40.44	66.61	78.07	98.41	100
23	4.14	5.83	8.62	12.36	16.83	24.14	37.53	66.12	73.36	97.03	100
24	4.6	6.36	9.24	13.16	18.15	26.74	40.51	69.22	78.91	97.84	100
25	4.63	6.46	9.42	13.37	18.37	27.27	44.17	74.22	82.29	96.58	100
26	3.86	5.39	7.9	11.22	15.11	21.97	34.3	61.52	70.09	94.06	100
27	4.45	6.23	9.13	13.14	18.16	26.55	41.22	70.07	77.96	98.15	100
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											
46											
47											
Average	4.31	6.14	9.15	13.24	18.30	26.72	40.95	68.60	77.54	96.66	100.00
STD	0.222	0.3394	0.6304	1.1865	2.0992	3.4416	4.9266	4.5508	3.0137	1.6577	0

I-275 Monroe Co.

Contractors Quality Control Test Data 3E10 Mixture

Sublot	Marshall A.V.	% G_{mm} at N_{ini}	% G_{mm} at N_{max}	1 face Crushed	2 face Crushed	FAA
1				98.6		
2				98.7		
3				97.7		
4				97.9		
5				97.4		
6				99.6		
7				98.3		
8				98.6		
9				97.6		
10				98.4		
11				98.9		
12				99.4		
13				98.9		
14				99.1		
15				98.8		
16				97.5		
17				98.3		
18				99.1		
19				98.8		
20				98.8		
21				98.9		
22				99.1		
23				99.3		
24				98.6		
25				99.1		
26				99.4		
27				99.3		
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
Average				98.67		
STD				0.6106		

I-275 Monroe Co.

Contractors In Place Density Results 3E10 Mixture

Sublot	Core #1	Core #2	Core #3	Sublot Avg.	Lot Avg.	+2%	+4%	+6%	-10%	-25%
1	93.56	93.17	94.13	93.620						
2	93.9	96.59	96.4	95.630						
3	93.19	92.38	92.12	92.563						
4	91.28	91.06	93.39	91.910						
5	93.28	94.76	91.94	93.327	93.41	66.67	66.67	40.00	3.00	0.00
6	95.43	93.16	93.58	94.057	93.50					
7	91.13	92.84	93.71	93.280	92.88					
8	93.74	91.69	93.05	92.827	92.94					
9	91.46	93.43	92.49	92.460	93.05					
10	91.63	95.16	93.76	93.517	93.08	66.67	60.00	40.00	4.00	0.00
11	92.27	94.22	93.88	93.457	92.96					
12	91.49	94.27	93.34	93.033	93.06					
13	94.01	92.46	92.61	93.027	93.10					
14	93.45	91.86	92.65	92.653	93.14	66.67	53.33	40.00	3.00	0.00
15				#DIV/0!	93.04					
16				#DIV/0!	92.90					
17				#DIV/0!	92.84					
18				#DIV/0!	92.65					
19				#DIV/0!	#DIV/0!					
20				#DIV/0!	#DIV/0!	0.00	0.00	0.00		
21				#DIV/0!	#DIV/0!					
22				#DIV/0!	#DIV/0!					
23				#DIV/0!	#DIV/0!					
24				#DIV/0!	#DIV/0!					
25				#DIV/0!	#DIV/0!	0.00	0.00	0.00		
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
Average			93.1885							
STD			1.30796							
Bonus Lots						0	0	0		
Deduct Lots									1	0

I-275 Monroe Co.
Contractors Mixture Price Adjustments Table 3E10

	TMD				VMA					VOIDS		
	JMF	Lot	Abs.		JMF	Lot	Abs.		JMF	Lot	Abs.	
Sublot	160.7	Avg.	Dev.	Dev.	14.8	Avg.	Dev.	Dev.	4	Avg.	Dev.	Dev.
1	0.8785				2.54				1.73			
2	1.4838				2.44				1.03			
3	1.6648				2.58				1			
4	2.4323				2.41				0.06			
5	2.1452	162.42	1.72	1.72	2.23	12.36	2.44	2.44	0.15	3.206	0.794	0.794
6	2.0516				2.47				0.5			
7	0.9971				1.22				0.15			
8	2.0017				1.36				0.67			
9	1.3403				3.16				1.93			
10	2.1889	162.41	1.71	1.71	1.96	12.766	2.034	2.034	0.18	3.654	0.686	0.346
11	1.5999				1.97				0.34			
12	2.5009				1.97				0.34			
13	2.4884				1.96				0.46			
14	2.0410				1.92				0.07			
15	1.9206	162.81	2.11	2.11	2.12	12.812	1.988	1.988	0.26	3.918	0.294	0.082
16	1.4713				1.85				0.39			
17	1.3340				1.78				0.46			
18	1.0033				1.59				0.57			
19	1.5917				1.59				0			
20	1.2829	162.03	1.33	1.33	1.34	13.17	1.63	1.63	0.02	3.712	0.288	0.288
21	1.1156				1.7				0.6			
22	2.0410				1.92				0.07			
23	0.8130				1.5				0.7			
24	0.7787				0.3				0.9			
25	1.8782	162.02			2.06	13.304			0.26	3.522		
26	2.8185				0.99				1.84			
27	0.8305	162.12	1.42	1.42	1.87	13.456	1.344	1.344	1.06	3.784	0.952	0.216
28												
SPEC			0.6	0.6			0.6	0.6			0.5	0.5
Bonus			0				0				2	
Deduct				5				5				1

I-275 Monroe Co.

Contractors Price Adjustment Table 3E10

	% A.C.				75um				Crushed			
Sublot	JMF 5.1	Lot Avg.	Abs. Dev.	Dev.	JMF 4.2	Lot Avg.	Abs. Dev.	Dev.	JMF 98.9	Lot Avg.	Abs. Dev.	Dev.
1	0.48				0.16				0.3			
2	0.71				0.44				0.2			
3	0.78				0.25				1.2			
4	1.07				0.26				1			
5	0.96	4.3	0.8	0.8	0.02	4.322	0.226	0.122	1.5	98.06	0.84	0.84
6	0.93				0.24				0.7			
7	0.52				0.11				0.6			
8	0.91				0.06				0.3			
9	0.69				0.36				1.3			
10	0.99	4.292	0.808	0.808	0.21	4.396	0.196	0.196	0.5	98.5	0.68	0.4
11	0.8				0.2				0			
12	1.1				0.1				0.5			
13	1.1				0.22				0			
14	0.93				0.05				0.2			
15	0.89	4.136	0.964	0.964	0.46	4.198	0.206	0.002	0.1	99.02	0.16	0.12
16	0.72				0.26				1.4			
17	0.66				0.07				0.6			
18	0.54				0.12				0.2			
19	0.76				0.14				0.1			
20	0.65	4.434	0.666	0.666	0.21	4.304	0.16	0.104	0.1	98.5	0.48	0.4
21	0.58				0.15				0			
22	0.93				0.05				0.2			
23	0.47				0.06				0.4			
24	0.45				0.4				0.3			
25	0.87	4.44			0.43	4.394			0.2	99		
26	1.23				0.34				0.5			
27	0.47	4.402	0.698	0.698	0.25	4.336	0.296	0.136	0.4	99.14	0.36	0.24
SPEC			0.3	0.3			0.7	0.7			10	10
Bonus			0				5				5	
Deduct				5				0				0

I-275 Monroe Co.

MDOT Verification Test Data   3E10 Mixture

Sublot	TMD	BULK	%AC	Eff. AC	Fines/AC
2	2602.6	2560.6	4.45	3.749	1.216
11	2608.02	2530	4.19	3.489	1.253
8	2604.3	2521	4.32	3.619	1.119
Average	2604.973	2537.20	4.32	3.62	1.20
STD	2.7720	20.7586	0.1300	0.1300	0.0690

MDOT Central Lab Test Data   3E10 Mixture

Specification AC PG58-28 LAB	AC Used %AC	PG52-28 Orig. Pen	20% RAP Rec. Pen
10/13/1997	4.7		78
10/14/1997		201	
10/15/1997	4.8	210	78
10/17/1997		245	
10/18/1997	4.1	244	79
10/24/1997	4	249	80
10/16/1997	4.9	244	69
Average	4.50	232.17	76.80
STD	0.4183	20.9324	4.4385
MIN			69
MAX			80

I-275 Monroe Co.

MDOT Verification Test Data 3E10 Mixture

Sublot	75um	150um	300um	600um	1.18mm	2.35mm	4.75mm	9.5mm	12.5mm	19mm	25mm
2	4.56	6.72	10.67	15.58	22.17	32.4	50.28	73.84	77.99	93.77	100
11	4.37	6.24	9.42	13.11	17.89	25.9	41.87	69.2	77.85	97.97	100
8	4.05	5.75	8.68	12.03	16.17	22.46	34.68	63.77	75.72	98.42	100
Average	4.33	6.24	9.59	13.57	18.74	26.92	42.28	68.94	77.19	96.72	100.00
STD	0.2577	0.4850	1.0058	1.8198	3.0897	5.0479	7.8079	5.0402	1.2721	2.5647	0.0000

MDOT Central Lab Test Data

LAB	75um	150um	300um	600um	1.18mm	2.35mm	4.74mm	9.5mm	12.5mm	19mm	25mm
10/13/97	4.8	6.5	10.8	16	22.5	32.4	43.4	70.2	82.3	96.3	100
10/14/97											
10/15/97	5	7	10.3	14.6	19.9	29	47.4	78.3	88.7	98.1	100
10/17/97											
10/18/97	4.3	5.9	8.9	12.7	17.1	23.6	38.3	65.1	80.4	97	100
10/24/97	4.7	6.5	9.5	13.3	19	24.9	40.6	66.7	75.5	97.2	100
10/16/97	4.7	6.5	10	14.7	20	27.7	43.4	70.2	84.9	99.3	100
Average	4.70	6.48	9.90	14.26	19.70	27.52	42.62	70.10	82.36	97.58	100.00
STD	0.2549	6.48	0.7314	1.2934	1.9506	3.4737	3.4208	5.0946	4.9384	1.1562	0

I-275 Monroe Co.

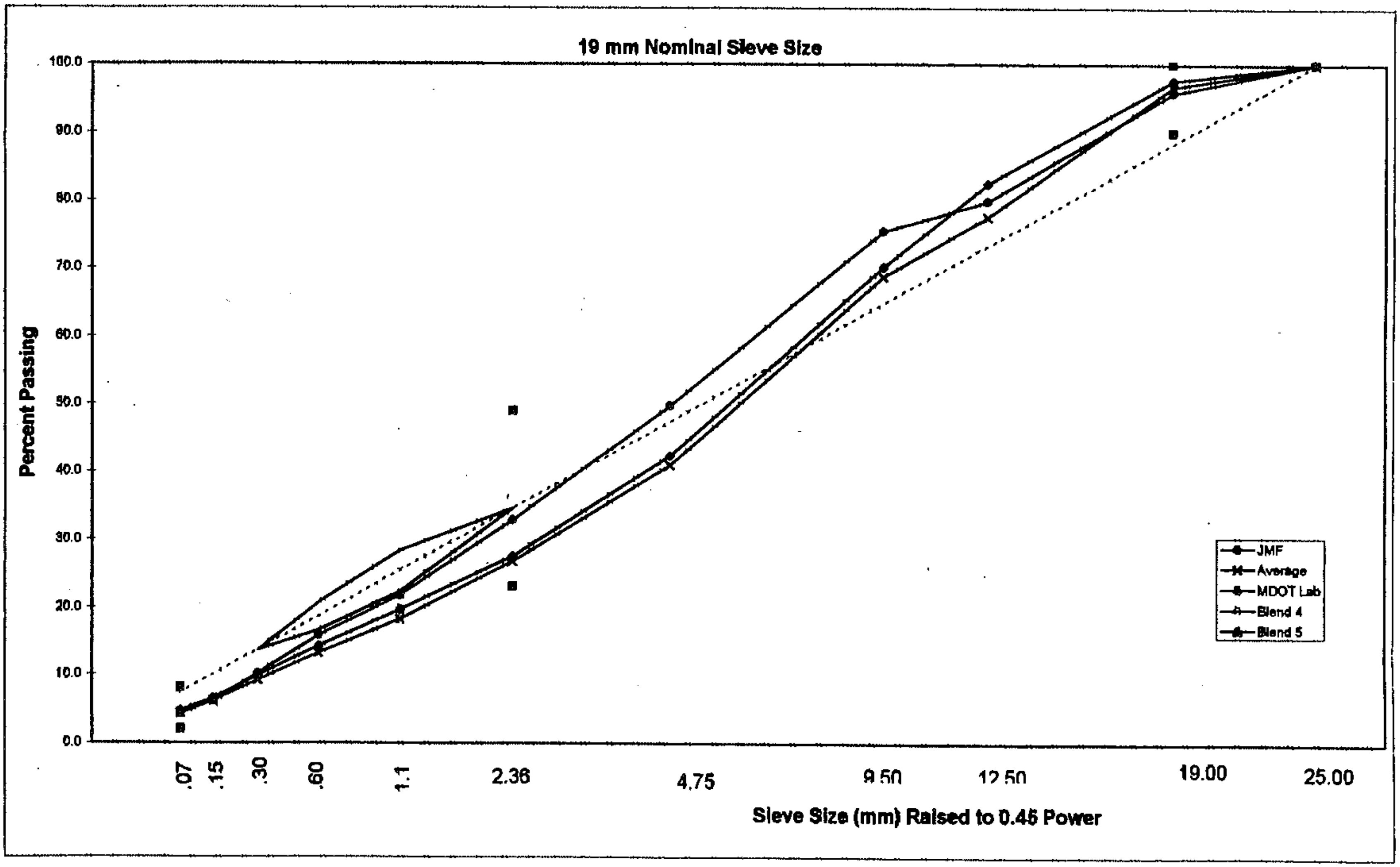
Film Thickness Table 3E10 Mixture

	DESIGN	PLANT	MDOT LAB
Gradation	% Pass	% Pass	% Pass
37.5	100	100	100
25	100	100	100
19	95.8	96.7	97.6
12.5	79.8	77.5	82.4
9.5	75.4	68.6	70.1
4.75	49.7	41	42.6
2.36	32.8	26.7	27.5
1.18	21.7	18.3	19.7
0.6	15.9	13.2	14.3
0.3	10.2	9.2	9.9
0.15	6.1	6.1	6.5
0.075	4.2	4.3	4.7
% AC	5.1	4.32	4.5
Film Thick.	0.00115	0.00098	0.00095

Aggregate Gradation Trials

Project Name: I-275
Technician: Doug
Date: 1/0/00

Filename: I275-3E.XLS
Description: JMF/PROD
Nominal Sieve Size: 19 mm



Appendix D9

MDOT Central Lab
PG Binder Test Data

PG 46-34

PG46-34						PG46-34 Recovered				
	Orig.	RTFO	PAV				PAV			Rec.
Lab. No.	DSR	DSR	DSR	Stiffness	M	DSR	DSR	stiffness	m	Pen
29	1.34	3	3725	194	0.336					
1147	1.47	3.45	3607	198	0.339					
1807	1.62	3.84	4846	228	0.317					
59	1.32	3.02	3566	204	0.358					
338	2.75		5602	261	0.302					
359	2.9		6986	336	0.29					
400	2.54	6.07	5518	278	0.3					
659	2.51	6.13	5163	275	0.3					
763	1.78	3.61	4570	232	0.321					
Average	2.026	4.160	4843	245.111	0.318					
Spec.	1.0 Min.	2.2 Min.	5000 Max	300 Max.	.300 Min					
STD	0.641	1.359	1129.7	46.737	0.023					
MAX	2.9	6.13	6986	336	0.358					
MIN	1.32	3	3566	194	0.29					
						PG46-34 with RAP to meet aPG46-34				
1147						4.61	6665	253	0.3	
659						9.98	7043	320	0.285	
763						8.24	9126	343	0.259	
Average						7.61	7611.33	305.33	0.28	
STD						2.74	1325.29	46.76	0.02	
MAX						9.98	9126	343	0.3	
MIN						4.61	6665	253	0.259	

PG 52-34

PG52-34						PG52-34 Recovered				
	Orig. DSR	RTFO DSR	PAV			DSR	PAV			Rec. Pen
Lab. No.			DSR	Stiffness	m		DSR	stiffness	m	
126	0.95	2.3	3274	213	0.324					
127	1.57	3.34	2953	195	0.324					
86	0.92	1.92	4862	248	0.31					
218	1.01	2.31	5227	310	0.29					
80	1.16	2.87	3997	291	0.304					
215	1.38	3.32	3818	286	0.3					
27	1.36	3.25	3577	365	0.265					
116	1	2.44	3339	258	0.332					
471	1.22	2.91	3438	314	0.302					
Average	1.174	2.740	3832	275.556	0.306					
Spec.	1.0 Min.	2.2 Min.	5000 Max	300 Max.	.300 Min					
STD	0.226	0.518	756.8	53.012	0.020					
MAX	1.57	3.34	5227	365	0.332					
MIN	0.92	1.92	2953	195	0.265					

PG 52-28

PG52-28

Lab. No.	Orig. DSR	RTFO DSR	PAV DSR	PAV Stiffness	PAV M	DSR	PAV DSR	PAV stiffness	PAV m	Rec. Pen
30	1.16	2.93	2932	152	0.367					
714	1.24	2.83	3260	146	0.378					
625	1.36	3.15	2725	162	0.366	2.55	3356	143	0.353	123
707	1.29	3.36	3226	136	0.354	22.9	3938	136	0.34	105
878	1.32	3.73	2875	148	0.356	2.39	3234	141	0.362	116
1320	1.28	2.94	2928	144	0.35	2.37	2555	132	0.363	125
1231	1.67	3.86	3528	168	0.334	4.92	4645	170	0.324	77
115	1.62	4	2563	126	0.383					
478	1.54	3.59	2567	157	0.36					
501	1.55	3.71	2696	152	0.358	3.1	3383	134	0.362	
634	1.65	3.97	3219	141	0.368	2.81	2955	130	0.385	109
864	1.66	3.84	3122	144	0.376					
53	1.59	3.93	4858	195	0.312					
214	1.49	3.57		123	0.385					
381	1.99	4.69	4945	228	0.313					
407	1.99	4.86	5651	197	0.325					
482	1.91	4.46	4665	198	0.323					
485	1.97	4.72	4883	190	0.324					
903	2.45	6.13	4949	202	0.316	5.61	5895	207	0.308	78
1198	1.44	3.27	3842	208	0.322					
Average	1.609	3.877	3654	165.850	0.350	3.331	3326	149.12	0.350	104.71
Spec.	1.0 Min.	2.2 Min.	5000 Max	300 Max.	.300 Min					65-135
STD	0.322	0.796	999.545	30.318	0.024	1.23	170.68	26.589	0.025	19.88
MAX	2.45	6.13	5651	228	0.385	5.61	5895	207	0.385	125
MIN	1.16	2.83	2563	123	0.313	2.37	3383	130	0.308	77
						PG 52-28 with RAP to meet a PG52-28				
714						3.51	4476	168	0.334	
475						4.68	4577	181	0.338	77
477						3.88	4116	170	0.35	89
407						5.27	5422	239	0.298	70
						PG46-34 with RAP to meet a PG52-28				
1807						2.63	3449	133	0.358	
338						3.72	4396	194	0.306	82
Average						4.036	4392	183.4	0.33	79.5
STD						1.005	717.734	38.501	0.027	8.021
MAX						5.27	5422	239	0.358	89
MIN						2.63	3449	133	0.298	70

PG 58-28

PG58-28						PG58-28 Recovered				
	Orig.	RTFO	PAV				PAV			Rec.
Lab. No.	DSR	DSR	DSR	Stiffness	M	DSR	DSR	stiffness	m	Pen
31	1.02	2.58	3704	248	0.31					
791	1.41	3.39	4057	272	0.311	2.65	4550	218	0.326	96
793	1.14	2.67	4559	243	0.314	1.95	4082	213	0.308	81
433	1.19	2.85	2881	227	0.316	2.4	2474	223	0.317	75
1464	1.38	3.25	4589	246	**0.298**					
28	1.2	3.56	3431	188	0.329					
297	1.41	3.81	4447	216	0.312					
117	1.54	3.83	3789	224	0.315					
737	1.41	3.55	4615	222	0.323	2.69	2463	252	0.321	73
857	1.12	2.64	3379	203	0.318	2.91	2812	206	0.32	85
67	**0.91**	2.38	3835	231	0.304					
219	**0.96**	2.32	3383	214	0.304					
95	1.42	3.94	**5085**	286	0.302					
55	1.29	3.21	3818	261	0.307					
216	1.35	3.46	3627	212	0.312					
436	1.24	2.97	4314	280	**0.296**	2.33	3853	280	0.305	86
769	1.36	3.1	**5627**	196	0.301	2.69	**6042**	284	**0.271**	
1200						2.57	**6517**	296	**0.272**	60
1209						2.31	3912	256	**0.299**	73
Average	1.256	3.148	4067	233.471	0.310	2.500	4078	247.556	0.304	78.625
Spec.	1.0 Min.	2.2 Min.	5000 Max	300 Max.	.300 Min					55-115
STD	0.180	0.515	696.467	28.983	0.009	0.284	1453.048	33.942	0.020	10.862
MAX	1.54	3.94	5627	286	0.329	2.91	6517	296	0.326	96
MIN	0.91	2.32	2881	188	0.296	1.95	2463	206	0.271	60

PG52-28 with RAP to meet a PG58-28

Lab. No.	DSR	PAV DSR	PAV stiffness	m	Rec. Pen
478	2.46	3585	228	0.317	74
864	1.72	3064	170	0.331	
482	3.02	4222	268	**0.276**	60
Average	2.4	3624	222	0.308	67
STD	0.652	579.968	49.275	0.029	9.899
MAX	3.02	4222	268	0.331	74
MIN	1.72	3064	170	0.276	60

PG 58-22

PG58-22						PG58-22 Recovered				
	Orig.	RTFO	PAV				PAV	PAV	PAV	Rec.
Lab. No.	DSR	DSR	DSR	Stiffness	m	DSR	DSR	stiffness	m	Pen
750	1.51	3.66	4121	120	0.358	3.02	3150	128	0.354	70
751	1.42	3.7	3496	136	0.362	2.87	4216	138	0.346	67
523	1.55	3.57	2923	142	0.338	3.48	3067	122	0.36	57
323	1.2	2.95	4457	140	0.328	2.59	4356	138	0.321	62
424	1.16	2.77								
895	1.38	3.36	3655	144	0.344	2.47	3497	140	0.352	
976						3.2	3339	131	0.364	61
Average	1.370	3.335	3730	136.40	0.346	2.938	3604	132.833	0.350	63.40
Spec.	1.0 Min.	2.2 Min.	5000 Max	300 Max.	.300 Min					65-135
STD	0.160	0.390	590.135	9.633	0.014	0.378	550.674	7.055	0.015	5.128
MAX	1.55	3.7	4457	144	0.362	3.48	4356	140	0.364	70
MIN	1.16	2.77	2923	120	0.328	2.47	3067	122	0.321	57
						PG58-22 with RAP to meet a PG58-22				
381						3.34		126	0.346	62
400						3.89	4067	171	0.324	87
1198						1.99	3881	151	0.327	89
Average						3.07	3974.00	149.33	0.33	79.33
STD						0.98	131.52	22.55	0.01	15.04
MAX						3.89	4067	171	0.346	89
MIN						1.99	3881	126	0.324	62

PG64-28						PG64-28 Recovered				
	Orig.	RTFO	PAV				PAV			Rec.
Lab. No.	DSR	DSR	DSR	Stiffness	M	DSR	DSR	stiffness	m	Pen
32	1.02	2.3	2835	220	0.3					
1626	1.12	3.34	2764	168	0.267	4.25	2177	164	0.257	42
1629	0.9	2.77	2331	106	0.27	3.96	3395	173	0.263	44
2329	1.14	3.63	2917	241	0.271	2.26	3075	175	0.287	54
524	1.05	2.58	3695	244	0.293	2.1	2283	199	0.315	64
1233	1.12	2.75	2994	266	0.279	2.11	3048	240	0.294	60
1235	1.09	2.34	3694	258	0.292	2.23	2840	246	0.292	61
1384	1.17	2.79	3474	288	0.283	2.18	3311	253	0.282	60
1385	1.15	2.64	2794	307	0.275	2	2678	246	0.294	60
1386	1.16	2.67	3406	263	0.278					
1485	1.22	2.8	2938	234	0.286	2.39	2509	229	0.303	56
2430	1.15	2.81	3069	158	0.274					
119	0.96	2.48	3629	236	0.304					
2318	1.12	2.83	2791	248	0.295	1.93	2270	310	0.273	68
2319	1.1	2.91	3055	269	0.29	2	3311	210	0.31	65
57	2	4.05	2357	210	0.307	3.28	3044	260	0.279	49
911	0.92	2.05	2528	211	0.302	2.3	3330	206	0.312	53
920	1.14	2.56	2905	212	0.314	2.22	2231	210	0.31	57
954	1.19	2.68	1753	233	0.304					
955	1.19	2.69	2250	224	0.3					
1080	1.19	2.73	2583	200	0.313					
1042	1.22	2.8	2656	215	0.294					
1043	1.21	2.64	2550	204	0.306					
1068	1.24	2.73	3011	219	0.305					
1079	1.25	2.75	3350	203	0.317					
1365	1.39	3.09	2942	219	0.296					
1366	1.37	3.03	3685	227	0.295					
1367	1.4	3	3543	231	0.307					
1494	1.39	3.01	3111	246	0.296					
1496	1.19	2.6	2401	206	0.306					
1497	1.2	2.64	2423	206	0.302					
1498	1.15	2.57	2235	194	0.306					
1499	1.19	2.61	1814	204	0.307					
1500	1.19	2.5	2449	205	0.309					
1501	1.19	2.56	2761	208	0.307					
1246						2.85	2739	190	0.269	40
1247						3.36	3022	200	0.264	42
1838						3.64	2947	178	0.278	45
Average	1.191	2.769	2848	222.371	0.296	2.651	2836	217.00	0.287	54.12
Spec.	1.0 Min.	2.2 Min.	5000 Max	300 Max.	.300 Min					65-135
STD	0.182	0.359	508.296	36.600	0.014	0.753	415.91	38.519	0.019	8.936
MAX	2	4.05	3695	307	0.317	4.25	3395	310	0.315	68
MIN	0.9	2.05	1753	106	0.267	1.93	2177	164	0.257	40

PG 64-28 From RAP

	DSR	PAV DSR	PAV Stiffness	PAV m
	PG58-28 with RAP to meet a PG64-28			
1705	3.49	3004	258	0.3
2136	3.93	3099	275	0.287
2153	2.28	3409	273	0.289
	PG64-28 with RAP to meet a PG64-28			
912	2.35	2649	207	0.296
920	2.55	2936	241	0.288
954	2.51	3739	211	0.3
955	2.55	3760	255	0.287
1080	2.49	2259	223	0.297
1043	2.86	2937	244	0.293
1365	3.15	2053	240	0.302
1367	2.99	2795	253	0.279
1494	2.9	4728	246	0.284
1495	2.78	2737	271	0.293
1497	2.32	2609	248	0.289
1498	2.49	3733	226	0.301
1500	2.56	3733	231	0.297
Average	2.714	3145	242.933	0.292
STD	0.423	701.373	20.964	0.007
MAX	3.93	4728	275	0.302
MIN	2.28	2053	207	0.279