

Evaluation of Rubblized Pavement Sections in Michigan Constructed between 1988 and 2002

Final Report

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EVALUATION OF RUBBLIZED PAVEMENT SECTIONS IN MICHIGAN – FINAL REPORT

Introduction

Antigo Construction, Inc. (Antigo) has been involved in portland cement concrete (PCC) pavement rehabilitation since the 1980s, specializing in concrete pavement rubblization, cracking and seating, and breaking for removal. In response to the need for improved methods of rubblizing and breaking deteriorated concrete pavements, Antigo developed the MHB Badger Breaker® (referred to herein as the multi-head breaker [MHB]) in the mid 1990s and has used this device successfully on hundreds of rubblization projects.

The Michigan Department of Transportation (MDOT) began using rubblization of PCC pavement followed by the application of a hot-mix asphalt (HMA) overlay as a rehabilitation method for deteriorated PCC pavements in 1988. Early projects used resonant frequency breakers (RFB) and, on one occasion, a modified whip hammer (MWH), to rubblize the pavement. However, in 1997, MDOT conducted its first rubblization project using the MHB. Over the years, MDOT has completed numerous rubblization projects using both the MHB and RFB equipment, with mixed performance results. Because of the concern over the performance of rubblization projects that needed rehabilitation after less than 12 years of service, MDOT initiated a study in 1999 to identify the causes for underperforming rubblized concrete pavement projects. That study included investigations of trenches excavated in the rubblized pavements, evaluation of pavement surface conditions, and destructive and nondestructive testing of pavements rubblized using the MHB and RFB.

A final report on the project states that the prime distresses contributing to the underperformance of rubblized pavement sections are top-down cracking, joint reflective cracking, and raveling, with the majority of the top-down cracking and raveling found in areas of segregated HMA (Baladi, Svasdisant, and Chatti 2002). The report also found that the majority of rubblized sections had segregation in the HMA due to poor construction quality. Therefore, the cause of the underperforming rubblized pavements may be more related to asphalt laydown procedures and mixture design than the actual rubblization process itself.

Antigo requested assistance from Applied Pavement Technology, Inc. (APTech) to not only review the performance of the pavement sections rubblized using the MHB and RFB, but also to determine if a relationship exists between the categorized uniformity of rubblized pavement (as determined in the study conducted by Baladi, Svasdisant, and Chatti [2002]) and the actual performance of the pavement sections. This report has been prepared to summarize the relevant findings regarding the performance of the pavement sections rubblized using the MHB between 1997 and 2002 in Michigan and the performance of pavement sections rubblized using the RFB between 1988 and 2000.

Background

This section presents background information on pavement rubblization technology and a general description of the performance of rubblized pavement sections across the United States. This is followed by a summary of the details of the pavement sections rubblized using the MHB and RFB in Michigan that are included in the study and general information regarding the pavement condition data collection procedures used by MDOT (which serve as the basis for the performance data evaluated under this study).

Pavement Rubblization Technology

The rubblization process involves mechanically breaking the existing PCC slabs into smaller-sized pieces prior to the application of an HMA overlay as a means of preventing or reducing reflection cracking. The rubblization technique has evolved since its introduction in the late 1980s and has seen more widespread use in the United States in recent years. In the rubblization process, the existing PCC slabs are broken into extremely small pieces (varying from a few inches up to a maximum size of 6 to 15 inches, depending on the specifications for the given state), and this is followed by a rolling process to “seat” the pieces into the subbase. The rubblized pavement then effectively serves as a dense aggregate base layer for the new HMA overlay.

Rubblization is a particularly appropriate treatment for existing PCC pavements that exhibit moderate to severe materials-related distresses (MRD), such as aggregate durability (e.g., D-cracking) or alkali-silica reactivity (ASR) deterioration, because there simply are no other treatments (other than complete reconstruction) that effectively address these conditions. Moreover, since the existing PCC is left in place, rubblization helps facilitate the overall construction process by eliminating the need for hauling and disposal of old paving materials (Decker and Hansen 2006).

The modulus of the fractured PCC slab is an important parameter for the performance of rubblized projects. As the PCC modulus decreases (the slab becomes more fractured), the likelihood of having reflection cracking decreases; however, as the PCC modulus decreases, the likelihood of having insufficient structural capacity increases (Decker and Hansen 2006). Therefore, PCC slabs should be broken to a point to eliminate reflective cracking without sacrificing structural capacity.

General Performance of Rubblized Pavement Sections

A variety of studies have indicated the performance potential of rubblization as a rehabilitation strategy, and the performance of rubblized pavement projects throughout the U.S. has generally been good (NAPA 1991; Galal et al. 1999; Ksaibati, Miley, and Armaghani 1999). For example, a study of fractured slab techniques in Wisconsin showed that after 7 years, rubblized pavements exhibit less reflective cracking compared to crack and seat pavements and conventional HMA overlays (Owusu-Ababio and Nelson 1999). Similarly, an Illinois study of 6- and 8-inch HMA overlays of 10-inch rubblized jointed reinforced concrete pavement (JRCP) showed that both sections were exhibiting excellent performance after 8 years of service and 7.5 million ESAL

applications (Thompson 1999). Several other studies evaluating rubblization projects across the state of Illinois indicated that the treatment provided good performance on both Interstate and non-Interstate projects, and using both the RFB and MHB devices (Heckel 2002; Weinrank and Lippert 2006). Also, a study in Nevada on I-80 showed positive behavior for rubblized pavements, with the FWD data confirming that sections had retained their structural capacity and integrity after 4 years of service (Bemanian and Sebaaly 1999). Finally, a review of the performance of rubblization projects constructed with the MHB indicates generally excellent performance from the constructed projects (Thompson 2006). No transverse cracking was observed on 75 percent of the projects, and little or no apparent reflection cracking was observed on any of the projects (Thompson 2006).

Despite the generally good performance associated with rubblization projects, there have been some performance concerns as well. As previously mentioned, Baladi, Svasdisant, and Chatti (2002) report that some MDOT rubblization projects from the late 1980s and early 1990s showed reduced service lives due to the occurrence of various distress, including top-down cracking, joint reflective cracking, and raveling. In addition, some difficulty in effectively rubblizing pavements on soft subgrades has been periodically encountered (Decker and Hanson 2006).

Analysis Database

To evaluate the performance of the rubblized pavement sections in Michigan, a database was created using condition data files provided by MDOT for all pavement sections in the Michigan road network that are monitored in the MDOT pavement management system. The data for this particular study were obtained by extracting from the original MDOT data set only those pavements rubblized using the MHB between 1997 and 2002 and those pavements rubblized using the RFB between 1988 and 2002. These data are described in the following sections, along with information on the condition data collection procedures and rating system used in Michigan.

Pavement Sections Rubblized in Michigan with the MHB

In 1997, Michigan began conducting rubblization projects using the MHB. Between 1997 and 2002, the MHB was used to construct 20 rubblization projects on Interstate, U.S., and state trunk highway projects in Michigan that are discussed in this report. Details regarding these projects are included in tables 1 through 3. Some of the pavement sections in tables 1 through 3 are noted as non-continuous because of a break in the rubblized pavement project due to issues such as bridge locations, railroad crossings, and control sections. For a few of these pavement sections, data did not exist for each portion of the project in each survey year. Therefore, the pavement data were aggregated based upon the available data.

Table 1. General information for the pavement sections rubblized using the MHB in Michigan between 1997 and 2002.

Control Section(s)	Location	Direction (Increasing/Decreasing)	Year Rubblized	Route Type	Length, miles
81076	USH 23 NB/SB, Washtenaw County	I	1997	4-In divided highway	6.076
		D			5.887
46082	M-50, Lenawee County ¹	I	1997	2-In highway	4.656
46082/58041			1998		7.820
58171	I-275 NB/SB, Monroe County	I	1997	4-In divided highway	1.497
		D			1.975
21031	M-35, Delta County ¹	I	1998	2-In highway	3.409
25042	I-69 EB/WB, Genesee County	I	1998	4-In divided highway	5.892
		D			5.892
38061	M-60 EB/WB, Jackson County ²	I	1998	4-In divided highway	3.395
25092	M-15, Genesee County	I	1998	2-In highway	0.908
67021/67022	USH 10, Osceola County ^{1,3}	I	1998	2-In highway	2.213
26011	M-18, Gladwin County	I	1999	2-In highway	7.140
67022	USH 10, Osceola County	I	1999	2-In highway	2.430
05011	USH 31, Antrim County ¹	I	1999	2-In highway	1.647
10032	USH 31, Benzie County ⁴	I	1999	2-In highway	2.910
25081	M-21, Genesee County	I	1999	4-In highway	2.304
58042	M-50, Monroe County	I	1999	2-In highway	4.386
44031	M-53, Lapeer County ¹	I	1999	2-In highway	5.372
35032	USH 23, Iosco County	I	2000	2-In highway	2.887
37011/37013/37014	USH 27 NB/SB, Isabella County ¹	I	2000	4-In divided highway	1.931
37013/37014		D			1.435
65041	I-75 NB/SB, Ogemaw County	I	2001	4-In divided highway	4.826
		D			4.655
58042	M-50 EB/WB, Monroe County ²	I	2001	4-In divided highway	2.377
51012	USH 31, Manistee County ¹	I	2002	2-In highway	2.791

¹ Non-continuous section.

² No decreasing direction data reported in MDOT database.

³ 1999 data reported for decreasing direction.

⁴ 2001 RQI and IRI data reported for decreasing direction.

Table 2. Original concrete pavement data for the sections rubblized using the MHB in Michigan between 1997 and 2002.

Control Section(s)	Location	Direction (Increasing/Decreasing)	Original Concrete Pavement Data		
			Type	Thickness (in)	Width (ft)
81076	USH 23 NB/SB, Washtenaw County	I	JRCP	9	24
		D	JRCP	9	24
46082	M-50, Lenawee County ¹	I	JRCP	8	22
46082/58041					
58171	I-275 NB/SB, Monroe County	I	CRCP	9	24
		D	CRCP	9	24
21031	M-35, Delta County ¹	I	JRCP	8	22
25042	I-69 EB/WB, Genesee County	I	JRCP	9	24
		D	JRCP	9	24
38061	M-60 EB/WB, Jackson County ²	I	JRCP	9	24
25092	M-15, Genesee County	I	JPCP	8	22
67021/67022	USH 10, Osceola County ^{1,3}	I	JPCP	9	24
26011	M-18, Gladwin County	I	JRCP	9-7-9	22
67022	USH 10, Osceola County	I	JPCP	9-7-9	24
05011	USH 31, Antrim County ¹	I	JRCP	8	22
10032	USH 31, Benzie County ⁴	I	JPCP	9-7-9	20
25081	M-21, Genesee County	I	JRCP	8	54-59
58042	M-50, Monroe County	I	JRCP	8	24
44031	M-53, Lapeer County ¹	I	JRCP	7-10	20-24
35032	USH 23, Iosco County	I	JRCP	9-6-9	20
37011/37013/37014	USH 27 NB/SB, Isabella County ¹	I	JRCP	9	24
		D	JRCP	9	24
65041	I-75 NB/SB, Ogemaw County	I	JRCP	9	24-36
		D	JRCP	9	24-36
58042	M-50 EB/WB, Monroe County ²	I	JRCP	8	24
51012	USH 31, Manistee County ¹	I	JRCP	8	24

¹ Non-continuous section.

² No decreasing direction data reported in MDOT database.

³ 1999 data reported for decreasing direction.

⁴ 2001 RQI and IRI data reported for decreasing direction.

Table 3. Overlay and drainage data for the pavement sections rubblized using the MHB in Michigan between 1997 and 2002.

Control Section(s)	Location	Direction (Increasing/Decreasing)	Overlay and Drainage Data	
			Total HMA Thickness (in)	Drainage System (Type)
81076	USH 23 NB/SB, Washtenaw County	I	7.000-10.625	Drained (PDS)
		D	7.000-10.625	
46082	M-50, Lenawee County ¹	I	7.000	Drained (PDS)
46082/58041		D	7.000	
58171	I-275 NB/SB, Monroe County	I	7.000	Drained (PDS)
		D	7.000	
21031	M-35, Delta County ¹	I	5.500	Drained (PDS)
25042	I-69 EB/WB, Genesee County	I	8.750	Partially Drained (Underdrain)
		D	8.750	
38061	M-60 EB/WB, Jackson County ²	I	7.625	Drained (PDS)
25092	M-15, Genesee County	I	5.500	Partially Drained (Open graded drainage course)
67021/67022	USH 10, Osceola County ^{1,3}	I	5.500	Drained (Leaching Trench)
26011	M-18, Gladwin County	I	5.500	Partially Drained (Open graded drainage course)
67022	USH 10, Osceola County	I	5.250-5.830	Drained (Leaching Trench)
05011	USH 31, Antrim County ¹	I	6.875	Drained (Underdrain/Leaching Trench)
10032	USH 31, Benzie County ⁴	I	5.500-7.000	Drained (Leaching Trench)
25081	M-21, Genesee County	I	6.000	Drained (Underdrain)
58042	M-50, Monroe County	I	6.500-8.000	Drained (Underdrain)
44031	M-53, Lapeer County ¹	I	6.000	Drained (Underdrain)
35032	USH 23, Iosco County	I	6.500	Not Drained
37011/37013/37014	USH 27 NB/SB, Isabella County ¹	I	6.500	Drained (Underdrain)
37013/37014		D	6.500	
65041	I-75 NB/SB, Ogemaw County	I	6.625-7.370	Drained (Underdrain/Leaching Trench)
		D	6.625-7.370	
58042	M-50 EB/WB, Monroe County ²	I	6.500	Drained (Underdrain)
51012	USH 31, Manistee County ¹	I	6.500	Drained (Leaching Trench)

¹ Non-continuous section.

² No decreasing direction data reported in MDOT database.

³ 1999 data reported for decreasing direction.

⁴ 2001 RQI and IRI data reported for decreasing direction.

PDS = Prefabricated Drainage System

Because of the way MDOT conducts its network-level condition surveys (some surveys are broken out by direction on divided highways), it should be noted that the actual analysis database consists of data from 42 construction sections. The direction designation is indicated in tables 1 through 3 based upon the increasing (I) versus decreasing (D) mileposts. Therefore, the majority of 4-lane divided highways have data associated with both directions of travel unless rubblization was only conducted for one direction of travel while the 2-lane highways have data collected primarily in the increasing milepost direction. Appendix A summarizes the mileposts associated with each individual pavement section prior to combination into summarized project details.

Table 1 includes details of the route type and length of each MHB project section that was included in the analysis. Table 2 shows design details on the original PCC pavement while table 3 provides overlay and drainage system information. The overlay data includes the total thickness of the HMA overlay. The drainage system information provides details of the general type of system utilized for the project. Based upon a review of drainage details provided by MDOT, an examination of the construction documents, and an evaluation of final pay quantities for work items on each project, the drainage systems used on each MHB project were classified as *drained*, *partially drained*, or *not drained*. Those pavement sections classified as *drained* were constructed with either geocomposite drains (prefabricated drainage systems [PDS]), subgrade underdrains, or leaching trenches along the entire or at least the majority of the length of the project. The pavement sections that had a drainage system (PDS, subgrade underdrain, leaching trench, or open-graded drainage course placed to act as a leaching trench) installed on less than half the length but in most cases only in isolated areas along the length of the project were classified as *partially drained*. Finally there was one project that did not receive any type of drainage system installation and it was classified as *not drained*. While tables 1 through 3 provide some applicable construction details for each pavement section, specific information regarding the base, subbase and subgrade is not available.

It should be noted that two rubblization projects were excluded from the analysis. A rubblization project performed using the MHB in 1997 (located on USH 131, Manton in Wexford County) was excluded from the analysis because the construction of a bypass a few years after rubblization altered control section values and mile point designations, making it difficult to accurately map the performance data over time. In addition, because of missing DI condition information for USH 27, Clare in Clare County, this pavement section, which was rubblized in 2002, was also excluded from the analysis.

Pavement Sections Rubblized in Michigan with the RFB

Prior to the use of the MHB, MDOT was rubblizing pavement with the RFB and MWH followed by the placement of an HMA overlay as a method of rehabilitation since 1988. The RFB was used for the majority of projects but the MWH was also used in 1996 on one project, USH 12 EB/WB; Control Section 81063. The MWH was used on a few rubblization projects in the mid-1990s before being removed from the market. Given the fact that the MWH was used on only one pavement section in the study and that it provides a different impact energy compared to the RFB, it was excluded from the analysis.

Between 1988 and 2002, a total of 34 rubblization projects using the RFB were constructed on Interstate, U.S., and state trunk highway projects in Michigan that are included in this analysis. It should be noted that no sections were rubblized using the RFB in 2001 and 2002. The details regarding the constructed RFB projects are provided in tables 4 through 6. As with the MHB sections, some of the pavement sections in tables 4 through 6 are noted as non-continuous because of a break in the rubblized pavement project, again due to issues such as bridge locations, railroad crossings, and control sections. Therefore, the analysis database of sections rubblized using the RFB contains data for 87 construction subsections. For a few of these pavement sections, data did not exist for each portion of the project in each survey year. Therefore, the pavement data were aggregated based upon the available data. Appendix B provides a summary of the milepost associated with each individual pavement section prior to combination into summarized project details.

The information presented in tables 4 through 6 for the RFB pavement sections mimic the information presented for the MHB sections in tables 1 through 3, respectively. Table 4 includes details of the route type and length of each project section that was included in the analysis. Design details on the original PCC pavement are detailed in table 5, while table 6 provides overlay and drainage system information. It should be noted that the drainage details provided in table 6 are not as comprehensive as the data available for the sections rubblized using the MHB. Only the sections rubblized with the RFB in 1999 and 2000 had information regarding final pay quantities of amount of drainage used available. Therefore, the same designations of *drained*, *partially drained*, or *not drained* as used on the MHB sections were applied to these three sections based upon the available pay quantities. For the remaining RFB sections that were without pay quantities, sections were classified as *drained* if MDOT job reports specified any type of drainage was used and *not drained* if no drainage was listed. This analysis resulted in only one section being classified as *partially drained*, another section being classified as *not drained*, and the remaining 32 sections being classified as *drained*, as shown in table 6.

It should be noted that one RFB rubblization project was excluded from the analysis. A rubblization project using the RFB in 2000 (located on US-10, Mason County) was excluded from the analysis because of missing DI condition information.

Table 4. General information for the pavement sections rubblized using the RFB in Michigan between 1988 and 2002.

Control Section Number	Location	Direction (Increasing/Decreasing)	Year Rubblized	Route Type	Length (miles)
13081	I-94 EB/WB, Calhoun County	I	1988	4-In divided highway	3.176
		D			3.176
16092	I-75 NB/SB, Cheboygan County	I	1988	4-In divided highway	2.032
		D			2.032
17062	M-28, Brimley, Chippewa County	I	1989	2-In highway	3.603
34031/34032	M-66 NB/SB, Ionia County ¹	I	1989	4-In highway	0.758
		D			0.758
09101/09042	US-10 EB / M-25 EB, Bay County ¹	I	1989	4-In divided highway	9.882
					9.882
41131	US-131 NB/SB, Kent County	I	1990	4-In divided highway	3.670
		D			3.854
16032	M-27, Cheboygan County ^{1,2}	I	1990	2-In highway	3.553
20014	I-75 SB, Crawford County	D	1990	4-In divided highway	3.730
16021	M-68, Cheboygan County ³	I	1990	2-In highway	7.481
41033	M-37 NB/SB, Kent County ¹	I	1992	4-In divided highway	5.440
		D			5.345
47013/47014	US-23 NB/SB, Livingston County ¹	I	1992	4-In divided highway	8.622
		D			8.622
37013	US-27 NB/SB, Isabella County ¹	I	1993	4-In divided highway	2.706
		D			2.611
03112	US-131 NB/SB, Allegan County ¹	I	1993	4-In divided highway	5.492
		D			5.251
33084	I-96 EB/WB, Ingham County	I	1993	4-In divided highway	8.512
		D			8.641
13033	I-194/M-66 NB/SB, Calhoun County	I	1993	4-In divided highway	1.187
		D			1.187
41013	M-44 EB/WB, Kent County	I	1993	4-In divided highway	1.970
		D			1.970
33083/33084	I-96 EB/WB, Ingham ¹	I	1994	4-In divided highway	2.654
		D			1.976
25092	M-15, Genesee County ⁴	I	1994	2-In highway	0.294
56021	M-20 WB, Midland County	D	1994	4-In highway	4.536
74012	M-53, Sanilac County ⁵	I	1995	2-In highway	4.000
41033	M-37 NB/SB, Kent County ¹	I	1995	4-In divided highway	7.738
		D			7.698

Table 4. General information for the pavement sections rubblized using the RFB in Michigan between 1988 and 2002 (continued).

Control Section Number	Location	Direction (Increasing/Decreasing)	Year Rubblized	Route Type	Length (miles)
01052	US-23, Alcona County	I	1996	2-In highway	1.979
70024	I-196 EB, Ottawa County	I	1996	4-In divided highway	3.002
03111/03112	US-131 NB/SB, Allegan County ¹	I	1997	4-In divided highway	4.183
		D			3.892
70024	I-196 EB, Ottawa County	I	1997	4-In divided highway	3.994
13033	I-194/M-66 NB/SB, Calhoun County	I	1997	4-In divided highway	0.435
		D			0.470
70013	US-31 NB, Ottawa County ¹	I	1997	4-In divided highway	11.125
37014	US-27 NB/SB, Isabella County ¹	I	1997	4-In divided highway	7.276
		D			7.303
		I	1998	4-In divided highway	5.471
		D			5.566
74073	M-25, Sanilac County	I	1998	2-In highway	4.454
41026/41131	I-96 & I-296 EB/WB, Kent County ¹	I	1998	4-In divided highway	1.320
		D			1.520
41029	I-196 EB/WB, Kent County	I	1998	4-In divided highway	5.518
		D			5.544
01052/04031	US-23, Alpena County ¹	I	1999	2-In highway	5.243
41133/59012	US-131 NB/SB, Kent & Montcalm Counties	I	1999	4-In divided highway	9.719
		D			9.719
41033/61171	M-37/M-46, Kent & Muskegon Counties ¹	I	2000	2-In highway	1.953

¹ Non-continuous section.

² 1992 DI data and 1994, 1996, and 2000 RQI and IRI data reported for decreasing direction.

³ 1996 and 1998 DI data, 1994 and 1998 RQI data, and 1994 IRI data reported for decreasing direction.

⁴ 1996 and 1998 DI and RQI data and 1996 IRI data reported for decreasing direction.

⁵ 1996 DI, RQI, and IRI data reported for decreasing direction.

Table 5. Original concrete pavement data for the sections rubblized using the RFB in Michigan between 1988 and 2002.

Control Section Number	Location	Direction (Increasing/Decreasing)	Original Concrete Pavement Data		
			Type	Thickness (in)	Width (ft)
13081	I-94 EB/WB, Calhoun County	I	JRCP	9	24
		D			
16092	I-75 NB/SB, Cheboygan County	I	JRCP	9	24
		D			
17062	M-28, Brimley, Chippewa County	I	JRCP	8	20
34031/34032	M-66 NB/SB, Ionia County ¹	I	JRCP	9	Variable
		D			
09101/09042	US-10 EB / M-25 EB, Bay County ¹	I	JRCP	9	24
41131	US-131 NB/SB, Kent County	I	JRCP	9	24
		D			
16032	M-27, Cheboygan County ^{1,2}	I	JRCP	8	20-22
20014	I-75 SB, Crawford County	D	JRCP	9	24
16021	M-68, Cheboygan County ³	I	JRCP	8	20
41033	M-37 NB/SB, Kent County ¹	I	JRCP	9	24
		D			
47013/47014	US-23 NB/SB, Livingston County ¹	I	JRCP	9	24
		D			
37013	US-27 NB/SB, Isabella County ¹	I	JRCP	9	24
		D			
03112	US-131 NB/SB, Allegan County ¹	I	JRCP	9	24
		D			
33084	I-96 EB/WB, Ingham County	I	JRCP	9	24
		D			
13033	I-194/M-66 NB/SB, Calhoun County	I	JRCP	9	24
		D			
41013	M-44 EB/WB, Kent County	I	JRCP	9	22
		D			
33083/33084	I-96 EB/WB, Ingham ¹	I	JRCP	9	24
		D			
25092	M-15, Genesee County ⁴	I	JRCP	8	24
56021	M-20 WB, Midland County	D	JRCP	8 & 9-7-9	20-24
74012	M-53, Sanilac County ⁵	I	JRCP	9-7-9	24
41033	M-37 NB/SB, Kent County ¹	I	JRCP	9	24
		D			

Table 5. Original concrete pavement data for the sections rubblized using the RFB in Michigan between 1988 and 2002 (continued).

Control Section Number	Location	Direction (Increasing/Decreasing)	Original Concrete Pavement Data		
			Type	Thickness (in)	Width (ft)
01052	US-23, Alcona County	I	JRCP	8	20
70024	I-196 EB, Ottawa County	I	CRCP	9	24
03111/03112	US-131 NB/SB, Allegan County ¹	I	JRCP	9	24
		D			
70024	I-196 EB, Ottawa County	I	CRCP	8	24
13033	I-194/M-66 NB/SB, Calhoun County	I	JRCP	9	24
		D			
70013	US-31 NB, Ottawa County ¹	I	JRCP	9	22
37014	US-27 NB/SB, Isabella County ¹	I	JRCP	9	24
		D			
74073	M-25, Sanilac County	I	JRCP	9-7-9	22
41026/41131	I-96 & I-296 EB/WB, Kent County ¹	I	JRCP	9	24-36
		D			
41029	I-196 EB/WB, Kent County	I	CRCP	9	24-36
		D			
01052/04031	US-23, Alpena County ¹	I	JRCP	9	20
41133/59012	US-131 NB/SB, Kent & Montcalm Counties	I	JRCP	9	24
		D			
41033/61171	M-37/M-46, Kent & Muskegon Counties ¹	I	JRCP	9	24

¹ Non-continuous section.

² 1992 DI data and 1994, 1996, and 2000 RQI and IRI data reported for decreasing direction.

³ 1996 and 1998 DI data, 1994 and 1998 RQI data, and 1994 IRI data reported for decreasing direction.

⁴ 1996 and 1998 DI and RQI data and 1996 IRI data reported for decreasing direction.

⁵ 1996 DI, RQI, and IRI data reported for decreasing direction.

Table 6. Overlay and drainage data for the pavement sections rubblized using the RFB in Michigan between 1988 and 2002.

Control Section Number	Location	Direction (Increasing/Decreasing)	Overlay and Drainage Data	
			Total HMA Thickness (in)	Drainage System (Type)
13081	I-94 EB/WB, Calhoun County	I	6.000	Drained (PDS)
		D		
16092	I-75 NB/SB, Cheboygan County	I	4.250	Drained (PDS)
		D		
17062	M-28, Brimley, Chippewa County	I	3.500	Drained (Underdrain)
34031/34032	M-66 NB/SB, Ionia County ¹	I	4.750 – 10.500	Drained (PDS)
		D		
09101/09042	US-10 EB / M-25 EB, Bay County ¹	I	7.000	Drained (PDS)
41131	US-131 NB/SB, Kent County	I	6.000	Drained (PDS)
		D		
16032	M-27, Cheboygan County ^{1, 2}	I	4.000	Drained (Underdrain/Leaching Trench)
20014	I-75 SB, Crawford County	D	4.250	Drained (Leaching Trench)
16021	M-68, Cheboygan County ³	I	3.750	Drained (Underdrain/Leaching Trench)
41033	M-37 NB/SB, Kent County ¹	I	5.750	Drained (PDS)
		D		
47013/47014	US-23 NB/SB, Livingston County ¹	I	5.250	Drained (PDS)
		D		
37013	US-27 NB/SB, Isabella County ¹	I	5.500	Drained (PDS)
		D		
03112	US-131 NB/SB, Allegan County ¹	I	7.250	Drained (PDS)
		D		
33084	I-96 EB/WB, Ingham County	I	5.500 – 11.000	Drained (PDS)
		D		
13033	I-194/M-66 NB/SB, Calhoun County	I	6.250	Drained (PDS)
		D		
41013	M-44 EB/WB, Kent County	I	5.500	Drained (PDS)
		D		
33083/33084	I-96 EB/WB, Ingham ¹	I	6.000 – 13.250	Drained (PDS)
		D		
25092	M-15, Genesee County ⁴	I	5.500	Drained (PDS)
56021	M-20 WB, Midland County	D	6.500	Drained (PDS)
74012	M-53, Sanilac County ⁵	I	5.000	Drained (Underdrain)
41033	M-37 NB/SB, Kent County ¹	I	5.330	Drained (PDS)
		D		

Table 6. Overlay and drainage data for the pavement sections rubblized using the RFB in Michigan between 1988 and 2002 (continued).

Control Section Number	Location	Direction (Increasing/Decreasing)	Overlay and Drainage Data	
			Total HMA Thickness (in)	Drainage System (Type)
01052	US-23, Alcona County	I	5.000	Drained (PDS)
70024	I-196 EB, Ottawa County	I	8.000	Drained (PDS)
03111/03112	US-131 NB/SB, Allegan County ¹	I	6.000 – 8.125	Drained (PDS)
		D		
70024	I-196 EB, Ottawa County	I	5.625	Drained (PDS)
13033	I-194/M-66 NB/SB, Calhoun County	I	5.500 – 6.250	Drained (Underdrain)
		D		
70013	US-31 NB, Ottawa County ¹	I	6.500 – 8.000	Drained (Leaching Trench)
37014	US-27 NB/SB, Isabella County ¹	I	5.500	Drained (PDS)
		D		
74073	M-25, Sanilac County	I	4.813	Not drained
41026/41131	I-96 & I-296 EB/WB, Kent County ¹	I	6.000	Drained (PDS)
		D		
41029	I-196 EB/WB, Kent County	I	6.500 – 12.000	Drained (PDS)
		D		
01052/04031	US-23, Alpena County ¹	I	5.000	Partially Drained (PDS)
41133/59012	US-131 NB/SB, Kent & Montcalm Counties	I	6.000	Drained (Leaching Trench)
		D		
41033/61171	M-37/M-46, Kent & Muskegon Counties ¹	I	6.500 – 8.500	Drained (PDS)

¹ Non-continuous section.

² 1992 DI data and 1994, 1996, and 2000 RQI and IRI data reported for decreasing direction.

³ 1996 and 1998 DI data, 1994 and 1998 RQI data, and 1994 IRI data reported for decreasing direction.

⁴ 1996 and 1998 DI and RQI data and 1996 IRI data reported for decreasing direction.

⁵ 1996 DI, RQI, and IRI data reported for decreasing direction.

PDS = Prefabricated Drainage System

Condition Data Collection in Michigan

As part of their network pavement monitoring, MDOT determines a variety of condition information on their pavement sections, including distress index (DI), distress types, international roughness index (IRI), and ride quality index (RQI). The DI and RQI are indexes specific to MDOT. The pavement distress data and longitudinal profile measurements collected by MDOT are obtained on 0.1-mile sections throughout the state network on a 2-year cycle.

However, from 1992 to 1997, longitudinal profile data was often collected yearly. The distress data are collected to determine the DI, and the longitudinal profile measurements are taken to determine ride quality (Lee, Chatti, and Baladi 2002).

The DI is determined by collecting surface condition data through analyzing videotape surveys to summarize the primary distress and associated secondary distresses present on each 0.1-mile pavement section. Each combination of primary and secondary distress has an associated distress point (DP). The final DI for a pavement section is determined as the summation of all DPs along a pavement section divided by the length of the pavement section in terms of the number of 0.1-mile sections. A pavement that shows no signs of distress has a DI of zero, and that value increases as the amount of distress present increases. The DI is divided into three general categories: low ($DI < 20$), medium ($20 < DI < 40$) and high ($DI > 40$). When a pavement reaches a DI of 50, it is considered to have exhausted its service life and it is ready for rehabilitation because its remaining service life (RSL) is considered to be zero (Bausano, Chatti, and Williams 2002).

One of the most commonly used measures for quantifying road roughness is the IRI, and this index is also used by MDOT. However, in addition to the IRI, MDOT also reports pavement roughness in terms of the RQI. The RQI was developed by MDOT in the 1970s to provide a smoothness statistic that correlates ride quality to the subjective opinions of highway users. RQI measurements between 0 and 30 describe excellent ride quality; values between 31 and 54 reflect good ride quality; values between 55 and 70 indicate fair ride quality; and values greater than 70 reflect poor ride quality (Lee, Chatti, and Baladi 2002).

To investigate the performance of the rubblized pavement sections in this study, Antigo requested from MDOT condition information for the pavement sections that have been rubblized in Michigan. A variety of highway section data was requested from MDOT including DI, distress types, IRI, RQI, traffic data, overlay thickness, year of last resurfacing, and pavement maintenance activities recorded for the pavement section. Data were provided to Antigo in December 2005 and January 2006.

Analysis Approach

The following three work tasks were conducted to evaluate the performance of the 20 pavement projects rubblized in Michigan using the MHB from 1997 to 2002 and the 34 pavement projects rubblized using the RFB from 1998 to 2002:

- Task 1: Data Selection and File Formatting.
- Task 2: Data Compilation.
- Task 3: Data Analysis.

A summary of the work conducted under each of these tasks is presented in the following sections.

Task 1: Data Selection and File Formatting

MDOT provided Antigo with extensive condition data and associated information for nearly all pavement sections in the Michigan pavement network as extracted from their electronic pavement condition data files. Due to the very large volume of data, Antigo and APTech jointly sorted through the data and located the sections that were needed for the analysis and identified the associated information to compile for the data analysis. The desired data elements needed for the condition analysis included the following:

- Distress index (DI).
- Distress types.
- International roughness index (IRI).
- Ride quality index (RQI).
- Traffic data.
- Overlay thickness.
- Year of last resurfacing.
- Maintenance activity recorded for the pavement section.

Data exploration was conducted jointly by APTech and Antigo to locate the final data elements to include in the data summary.

Task 2: Data Compilation

Reviews of the electronic data provided by MDOT revealed that the data needed to assess the condition of the rubblized pavement sections were in a variety of files and file formats, making the compilation of the data a potentially time-consuming task. Because of the programming ability of personnel at Antigo to develop code to extract data from these files, Antigo took the lead on compiling the data summary to provide the data needed for the data analysis. The data provided by Antigo included a summary of DI, RQI, IRI, and distress code information for the rubblized pavement sections, all presented in Microsoft® Excel format. APTech reviewed approximately 5 percent of the data for consistency with the initial data files provided by MDOT. All data proved to be consistent with the expected results so the provided data were used for the data analysis task.

Condition data were provided in 0.1-mile increments and in summarized form for each project. As previously mentioned, some projects had more than one record because of the occurrence of divided roadways. General project information was also provided for each pavement section in Microsoft® Excel format, which included original PCC pavement data, overlay data information, and drainage system data, as provided in tables 1 through 3 for the pavement sections rubblized using the MHB and tables 4 through 6 for the pavement sections rubblized using the RFB. A listing of the DI information used for the MHB section analysis is provided in Appendix C, and the DI information for the RFB sections is provided in Appendix D. In addition, the RQI and IRI information used in the study are summarized in Appendices E and F, respectively, for the MHB pavement sections, and in Appendices G and H, respectively, for the RFB pavement sections.

The summarized MDOT condition data for the MHB pavement sections and the RFB pavement sections are presented in tables 7 through 10, respectively. These are area-weighted values of DI and RQI, which provide an overall condition value for each pavement section by weighing the condition of subsections of the project according to their area; in this way, the condition of subsections of a project could be combined to provide a single condition value representative of the entire project.

It should be noted that seventeen pavement subsections that were rubblized using the RFB received maintenance or resurfacing during the timeframe of data collection (prior to 2004). Of these seventeen pavement sections, twelve sections received capital preventive maintenance treatments while the remaining five sections were resurfaced. Therefore, the condition data that were collected for the sections after they received these treatments were removed from the summary of condition information presented in tables 7 through 10 because they are no longer in their initial rubblization performance period. The post-treatment condition data were also removed from the summary of condition data for the RFB pavement sections presented in Appendices D, G, and H. A summary of these pavement sections is provided in table 11 including the age of the section at the time of treatment. The data for control section 47013/47014, US NB/SB, Livingston County is presented at an age of 7 years because the 47014 portion of the section received preventive maintenance at 8 years of age while the remaining portion of the section did not receive work.

Table 7. DI area-weighted summary for MHB sections.

Year Rubblized	Location	Control Section(s)	Direction (Increasing/Decreasing)	Area-Weighted Average DI at Age:					
				1	2	3	4	5	6
1997	USH 23 NB/SB, Washtenaw County	81076	I	0.058	0.000		0.045		7.701
			D	0.074	0.021		0.308		2.712
1997	M-50, Lenawee County ¹	46082	I	0.101			5.851	7.524	
1998		46082/58041				1.094	0.194		2.170 ²
1997	I-275 NB/SB, Monroe County	58171	I		0.067		0.000		3.034
			D		0.000				2.488
1998	M-35, Delta County ¹	21031	I		0.513		0.556		4.327
1998	I-69 EB/WB, Genesee County	25042	I	0.093		0.265		11.418	
			D	0.017		0.145		17.104	
1998	M-60 EB/WB, Jackson County	38061	I				4.757		
1998	M-15, Genesee County	25092	I			1.984	1.513		10.395
1998	USH 10, Osceola County ¹	67021/67022	I	0.106 ³		0.033		3.101	
1999	M-18, Gladwin County	26011	I		4.357	0.195		21.539	
1999	USH 10, Osceola County	67022	I		0.008		3.379		
1999	USH 31, Antrim County ¹	05011	I		0.073		1.976		
1999	USH 31, Benzie County	10032	I				2.191		
1999	M-21, Genesee County	25081	I		0.125	0.000			
1999	M-50, Monroe County	58042	I		0.054	0.062			
1999	M-53, Lapeer County ¹	44031	I		0.375	0.121			
2000	USH 23, Iosco County	35032	I			1.932			
2000	USH 27 NB/SB, Isabella County ¹	37011/37013/37014	I	1.769 ²	0.500 ²	0.605 ²	4.480 ²		
		37013/37014	D	2.535		4.045 ²			
2001	I-75 NB/SB, Ogemaw County	65041	I		0.153				
			D		0.221				
2001	M-50 EB/WB, Monroe County	58042	I	0.009					
2002	USH 31, Manistee County ¹	51012	I	0.041					

¹ Non-continuous section.² Value represents area-weighted DI for the section length based upon available data for the given survey year.³ Data reported for decreasing direction.

Table 8. RQI area-weighted summary for MHB sections.

Year Rubblized	Location	Control Section	Direction (Increasing/ Decreasing)	Area-Weighted Average RQI at Age:							
				1	2	3	4	5	6	7	8
1997	USH 23 NB/SB, Washtenaw County	81076	I	23.831	22.283		34.733		29.000		34.050
			D	20.328	18.017		34.448		27.448		32.224
1997	M-50, Lenawee County ¹	46082	I	27.256		45.146		32.243		36.839	
1998		46082/58041			44.385		32.442		35.002		
1997	I-275 NB/SB, Monroe County	58171	I		28.286		44.000		31.429		34.833
			D		30.316				33.526		37.000
1998	M-35, Delta County	21031	I		48.873		36.838		37.685		
1998	I-69 EB/WB, Genesee County	25042	I	27.000		35.655				34.793	
			D	25.828		35.379				34.517	
1998	M-60 EB/WB, Jackson County	38061	I				30.029		35.935		
1998	M-15, Genesee County	25092	I		44.750		39.000		38.500		
1998	USH 10, Osceola County ¹	67021/67022	I	37.654 ²		35.064		32.054		36.337	
1999	M-18, Gladwin County	26011	I	39.648		26.729		32.871			
1999	USH 10, Osceola County	67022	I		33.435		25.478		32.609		
1999	USH 31, Antrim County ¹	05011	I		46.377		36.513		40.363		
1999	USH 31, Benzie County	10032	I		48.750 ²		31.857		36.321		
1999	M-21, Genesee County	25081	I	47.364		38.500		38.682			

¹ Non-continuous section.² Data reported for decreasing direction.³ Value represents area-weighted RQI for the section length based upon available data for the given survey year.

Table 8. RQI area-weighted summary for MHB sections (continued).

Year Rubblized	Location	Control Section	Direction (Increasing/ Decreasing)	Area-Weighted Average RQI at Age:							
				1	2	3	4	5	6	7	8
1999	M-50, Monroe County	58042	I	34.860		24.395		31.186			
1999	M-53, Lapeer County ¹	44031	I	39.083		28.867		34.179			
2000	USH 23, Iosco County	35032	I	24.069		22.000		29.414			
2000	USH 27 NB/SB, Isabella County ¹	37011/37013/37014	I	37.377 ³	31.000 ³	26.724 ³	35.000 ³	32.392 ³			
		37013/37014	D	41.157		24.929		32.066			
2001	I-75 NB/SB, Ogemaw County	65041	I		26.213						
			D		27.326		29.675				
2001	M-50 EB/WB, Monroe County	58042	I	23.909		31.727					
2002	USH 31, Manistee County ¹	51012	I	33.891		35.453					

¹ Non-continuous section.² Data reported for decreasing direction.³ Value represents area-weighted RQI for the section length based upon available data for the given survey year.

Table 9. DI area-weighted summary for RFB sections.

Year Rubbled	Location	Control Section	Direction	DI at age						
				1	2	3	4	5	6	7
1988	I-94 EB/WB, Calhoun County	13081	I					61.915		18.475
			D					7.968		9.919
1988	I-75 NB/SB, Cheboygan County	16092	I					2.115		20.925
			D					6.403		16.290
1989	M28, Brimley, Chippewa County	17062	I			1.251	3.681		20.595	
1989	M-66 NB/SB, Ionia County ¹	34031/34032	I			3.621		58.933		41.908
			D			2.875		21.496		32.091
1989	US-10 EB / M-25 EB, Bay County ¹	09101/09042	I				2.490	7.644	23.378	12.834
1990	US-131 NB/SB, Kent County ¹	41131	I			4.244		5.026		11.970
			D			0.918		2.959		8.055
1990	M-27, Cheboygan County ¹	16032	I		0.744 ²		1.328		5.256	
1990	I-75 SB, Crawford County	20014	D			4.760		9.262		9.153
1990	M-68, Cheboygan County	16021	I		5.371		0.368		1.914 ²	
1992	M-37 NB/SB, Kent County ¹	41033	I		0.780		2.769		3.318	
			D		1.030		1.819			
1992	US-23 NB/SB, Livingston County ¹	47013/47014	I	3.767		8.071		8.922		6.537
			D	2.153		6.115		8.360		2.738
1993	US-27 NB/SB, Isabella County ¹	37013	I		0.118		8.663			
			D		4.178		10.766			
1993	US-131 NB/SB, Allegan County ¹	03112	I		2.799		4.227		2.983	
			D		1.065		2.300		3.437	
1993	I-96 EB/WB, Ingham County	33084	I		5.220		13.310		6.719	
			D		0.564		5.083		6.613	
1993	I-194/M-66 NB/SB, Calhoun County	13033	I		1.438		19.516		14.863	
			D		0.491		12.805		15.762	
1993	M-44 EB/WB, Kent County	41013	I	2.789		9.309		1.022		6.913
			D	1.074		0.467		0.877		

¹ Non-continuous section.² Data reported for decreasing direction.

Table 9. DI area-weighted summary for RFB sections (continued).

Year Rubblized	Location	Control Section	Direction	DI at age							
				8	9	10	11	12	13	14	15
1988	I-94 EB/WB, Calhoun County	13081	I		61.665		44.701				
			D		12.952		4.847				
1988	I-75 NB/SB, Cheboygan County	16092	I		18.212		12.136		33.704		31.791
			D		32.452		22.339		19.742		65.278
1989	M28, Brimley, Chippewa County	17062	I	26.816		28.063					
1989	M-66 NB/SB, Ionia County ¹	34031/34032	I		119.824		195.738		116.804		400.000
			D		56.410						
1989	US-10 EB / M-25 EB, Bay County ¹	09101/09042	I	29.031	19.209	31.159					
1990	US-131 NB/SB, Kent County ¹	41131	I		8.940		14.728		6.023		
			D		5.093		4.991		5.493		
1990	M-27, Cheboygan County ¹	16032	I	6.047 ²				12.382			
1990	I-75 SB, Crawford County	20014	D		11.658						
1990	M-68, Cheboygan County	16021	I	1.958		39.774		21.908			
1992	M-37 NB/SB, Kent County ¹	41033	I	24.915		18.040		19.466			
			D								
1992	US-23 NB/SB, Livingston County ¹	47013/47014	I				18.133				
			D		0.555		8.740				
1993	US-27 NB/SB, Isabella County ¹	37013	I								
			D								
1993	US-131 NB/SB, Allegan County ¹	03112	I								
			D								
1993	I-96 EB/WB, Ingham County	33084	I			227.419					
			D	1.287		2.483					
1993	I-194/M-66 NB/SB, Calhoun County	13033	I								
			D								
1993	M-44 EB/WB, Kent County	41013	I								
			D								

¹ Non-continuous section.² Data reported for decreasing direction.

Table 9. DI area-weighted summary for RFB sections (continued).

Year Rubblized	Location	Control Section	Direction	DI at age								
				1	2	3	4	5	6	7	8	9
1994	I-96 EB/WB, Ingham ¹	33083/33084	I	0.032		0.309		4.292		2.023		10.504
1995			D		3.532		0.145		1.121		9.968	
1994	M-15, Genesee County	25092	I		0.731 ²		5.034 ²			16.179		
1994	M-20 WB, Midland County	56021	D		0.031							
1995	M-53, Sanilac County	74012	I	0.160 ²		1.020				8.059	21.420	
1995	M-37 NB/SB, Kent County ¹	41033	I	2.381		5.009		269.180				
			D	0.225								
1996	US-23, Alcona County	01052	I	1.316		2.606						
1996	I-196 EB, Ottawa County	70024	I			0.036		0.929		1.141		
1997	US-131 NB/SB, Allegan County ¹	03111/03112	I		0.958		0.027		3.426			
			D		0.134		0.003		1.699			
1997	I-196 EB, Ottawa County	70024	I		2.910		10.014		5.131			
1997	I-194/M-66 NB/SB, Calhoun County	13033	I		3.635				10.333			
			D		5.767		1.800		12.000			
1997	US-31 NB, Ottawa County ¹	70013	I		0.027				3.881			
1997	US-27 NB/SB, Isabella County	37014	I		0.023		6.262		10.005			
			D		0.000		2.884					
1998	US-27 NB/SB, Isabella County ¹	37014	I	0.015		0.760		6.480				
			D	0.054		0.265						
1998	M-25, Sanilac County	74073	I			0.035	0.035		13.715			
1998	I-96 & I-296 EB/WB, Kent County ¹	41026/41131	I	0.050		0.435		1.799				
			D	0.000		4.621		4.033				
1998	I-196 EB/WB, Kent County	41029	I	1.000				2.131				
			D	0.661		1.402		1.708				
1999	US-23, Alpena County ¹	01052/04031	I		0.178		4.157					
1999	US-131 NB/SB, Kent & Montcalm Counties ¹	41133/59012	I				5.547					
			D		0.966		1.787					
2000	M-37/M-46, Kent & Muskegon Counties ¹	61171	I		0.067		0.014					

¹ Non-continuous section.

² Data reported for decreasing direction.

Table 10. RQI area-weighted summary for RFB sections.

Year Rubbled	Location	Control Section	Direction	RQI at age							
				1	2	3	4	5	6	7	8
1988	I-94 EB/WB, Calhoun County	13081	I				52.516	62.643	33.935	42.323	47.968
			D				39.581	38.345	24.484	30.893	36.161
1988	I-75 NB/SB, Cheboygan County	16092	I				18.667	18.000	18.905	27.952	35.429
			D				21.714	21.524	23.952	34.619	38.714
1989	M28, Brimley, Chippewa County	17062	I			35.057	35.857	38.657	44.143	44.914	
1989	M-66 NB/SB, Ionia County ¹	34031/34032	I				32.743	36.097	44.500	45.843	
			D					37.704	43.763	60.000	
1989	US-10 EB / M-25 EB, Bay County ¹	09101/09042	I			30.511	27.640	29.382	35.877		
1990	US-131 NB/SB, Kent County ¹	41131	I			22.971	26.029	29.200	33.706		
			D			22.243	25.054	30.054	33.270		
1990	M-27, Cheboygan County ¹	16032	I		20.383	21.194	21.979 ²	31.342	31.925 ²		25.802
1990	I-75 SB, Crawford County	20014	D		23.703	25.324	25.667	31.568	38.108		
1990	M-68, Cheboygan County	16021	I		30.681	26.583	27.722 ²	34.571	37.205		31.301 ²
1992	M-37 NB/SB, Kent County ¹	41033	I	22.833	23.944	31.852	35.389		28.396		46.741
			D	23.477	24.907	31.531	36.597		28.276		48.761
1992	US-23 NB/SB, Livingston County ¹	47013/47014	I	34.836	35.643	39.968	41.281			45.326	
			D	33.267	33.952	37.885	39.891			40.116	
1993	US-27 NB/SB, Isabella County ¹	37013	I	27.808	34.769	35.423					
			D	26.180	33.783	37.023					
1993	US-131 NB/SB, Allegan County ¹	03112	I	37.759	45.667	46.623			40.704		
			D	35.856	44.653	45.340			38.925		
1993	I-96 EB/WB, Ingham County	33084	I	21.378	29.753	30.675			33.810		44.167
			D	21.398	34.939	34.553			28.698		35.105
1993	I-194/M-66 NB/SB, Calhoun County	13033	I		35.636	35.636			33.909		
			D		32.909	34.182			39.909		
1993	M-44 EB/WB, Kent County	41013	I	32.263	36.000	36.474		37.632		43.211	
			D	31.789	35.316	38.333		34.474		50.105	

¹Non-continuous section.²Data reported for decreasing direction.

Table 10. RQI area-weighted summary for RFB sections (continued).

Year Rubblized	Location	Control Section	Direction	RQI at age								
				9	10	11	12	13	14	15	16	17
1988	I-94 EB/WB, Calhoun County	13081	I			73.500						
			D			44.548						
1988	I-75 NB/SB, Cheboygan County	16092	I			34.700		51.700		50.400		53.316
			D			36.421		54.850		50.100		51.450
1989	M28, Brimley, Chippewa County	17062	I		63.629							
1989	M-66 NB/SB, Ionia County ¹	34031/34032	I	57.699		62.588		61.403		60.971		
			D	47.000		73.488						
1989	US-10 EB / M-25 EB, Bay County ¹	09101/09042	I	41.364	44.246							
1990	US-131 NB/SB, Kent County ¹	41131	I	38.806		45.306		41.000				
			D	33.395		40.553		46.158				
1990	M-27, Cheboygan County ¹	16032	I		50.395 ²		33.525		37.088			
1990	I-75 SB, Crawford County	20014	D	42.297								
1990	M-68, Cheboygan County	16021	I		53.041		40.270		45.431			
1992	M-37 NB/SB, Kent County ¹	41033	I		35.500		38.151					
			D									
1992	US-23 NB/SB, Livingston County ¹	47013/47014	I			48.000						
			D	62.000		41.077						
1993	US-27 NB/SB, Isabella County ¹	37013	I									
			D									
1993	US-131 NB/SB, Allegan County ¹	03112	I									
			D									
1993	I-96 EB/WB, Ingham County	33084	I		42.576							
			D		31.023							
1993	I-194/M-66 NB/SB, Calhoun County	13033	I									
			D									
1993	M-44 EB/WB, Kent County	41013	I			44.000						
			D									

¹Non-continuous section.²Data reported for decreasing direction.

Table 10. RQI area-weighted summary for RFB sections (continued).

Year Rubblized	Location	Control Section	Direction	RQI at age										
				1	2	3	4	5	6	7	8	9	10	11
1994	I-96 EB/WB, Ingham ¹	33083/33084	I	40.092	13.064			12.582		32.201		26.857		29.216
1995			D	18.462			20.863		34.406		28.264		29.296	
1994	M-15, Genesee County	25092	I	45.500	45.500 ²		37.500 ²		60.000					
1994	M-20 WB, Midland County	56021	D	13.386					33.022					
1995	M-53, Sanilac County	74012	I	27.769 ²		30.425				34.875				
1995	M-37 NB/SB, Kent County ¹	41033	I	34.120		50.000		45.534						
			D	31.460		20.382		47.563						
1996	US-23, Alcona County	01052	I			21.737		36.000						
1996	I-196 EB, Ottawa County	70024	I			23.621		34.414		28.724				
1997	US-131 NB/SB, Allegan County ¹	03111/03112	I		29.031		40.611		34.612		34.598			
			D		27.781		40.436		34.047		34.551			
1997	I-196 EB, Ottawa County	70024	I		34.359		45.513		42.564					
1997	I-194/M-66 NB/SB, Calhoun County	13033	I		31.000		31.333		23.333		32.000			
			D		34.000		37.750		27.500		33.667			
1997	US-31 NB, Ottawa County ¹	70013	I		17.663		26.965		21.819		29.492			
1997	US-27 NB/SB, Isabella County ¹	37014	I		22.153		34.542		27.944		32.380			
			D		22.222		35.528		31.931		36.181			
1998	US-27 NB/SB, Isabella County ¹	37014	I	27.944		35.759		31.463		33.500				
			D	26.836		36.491		32.145		35.811				
1998	M-25, Sanilac County	74073	I		36.227		27.682		33.477					
1998	I-96 & I-296 EB/WB, Kent County ¹	41026/41131	I	36.896		47.014		40.541		35.399				
			D	33.456		43.962		39.200		34.537				
1998	I-196 EB/WB, Kent County	41029	I	44.241		49.870		42.333		38.750				
			D	39.630		48.611		42.130		39.419				
1999	US-23, Alpena County ¹	01052/04031	I		31.866		25.913		31.456					
1999	US-131 NB/SB, Kent & Montcalm Counties ¹	41133/59012	I		29.203		24.625		31.158					
			D		28.487		23.874		31.395					
2000	M-37/M-46, Kent & Muskegon Counties ¹	61171	I		31.301		33.958							

¹ Non-continuous section.² Data reported for decreasing direction.

Table 11. DI and age of sections receiving work prior to 2004.

Control Section(s)	Year Rubblized	Location	Direction	Age	Treatment
13081	1988	I-94 EB/WB, Calhoun County	I	11	Resurfacing
13081	1988	I-94 EB/WB, Calhoun County	D	11	Resurfacing
17062	1989	M28, Brimley, Chippewa County	I	10	Resurfacing
09101/09042	1989	US-10 EB / M-25 EB, Bay County*	I	10	Preventive Maintenance
20014	1990	I-75 SB, Crawford County	D	9	Resurfacing
47013/47014	1992	US-23 NB/SB, Livingston County*	I	7	Preventive Maintenance
47013/47014	1992	US-23 NB/SB, Livingston County*	D	7	Preventive Maintenance
37013	1993	US-27 NB/SB, Isabella County*	I	4	Preventive Maintenance
37013	1993	US-27 NB/SB, Isabella County*	D	4	Preventive Maintenance
03112	1993	US-131 NB/SB, Allegan County*	I	6	Preventive Maintenance
03112	1993	US-131 NB/SB, Allegan County*	D	6	Preventive Maintenance
13033	1993	I-194/M-66 NB/SB, Calhoun County	I	6	Preventive Maintenance
13033	1993	I-194/M-66 NB/SB, Calhoun County	D	6	Preventive Maintenance
25092	1994	M-15, Genesee County	I	7	Preventive Maintenance
74012	1995	M-53, Sanilac County	I	7	Preventive Maintenance
41033	1995	M-37 NB/SB, Kent County*	I	5	Preventive Maintenance
01052	1996	US-23, Alcona County	I	3	Resurfacing

Task 3: Data Analysis

Based upon the summarized data, APTech began the data analysis portion of the project. The analysis of the data included an evaluation of the performance trends of the pavement sections with a focus on the pavement performance measurements used by MDOT, specifically in terms of DI, RQI, and IRI. Specific distress information was also evaluated for the pavement sections in terms of the amount of transverse and longitudinal cracking included in the DI. Finally, a comparison of actual performance of the pavement sections (as measured by the DI and RQI) to the categorized uniformity of the rubblized pavement was conducted. The analysis results are presented first for the MHB pavement sections and then for the RFB pavement sections.

Performance Trends for MHB Pavement Sections

The information compiled from the MDOT database was used to evaluate the MHB pavement sections in terms of their current condition and their performance trends over time. A common modeling technique used to describe pavement performance is the use of family models. The development of family models allows pavements to be grouped together based upon the assumption that their performance will be similar due to their similar characteristics. The final regression model developed for a family, which represents the average deterioration rate for all sections in the family, often uses age as the independent variable. Assuming similar

characteristics for all pavement sections rubblized by using the MHB in Michigan from 1997 to 2002, a performance trend of average DI was created as shown in figure 1.

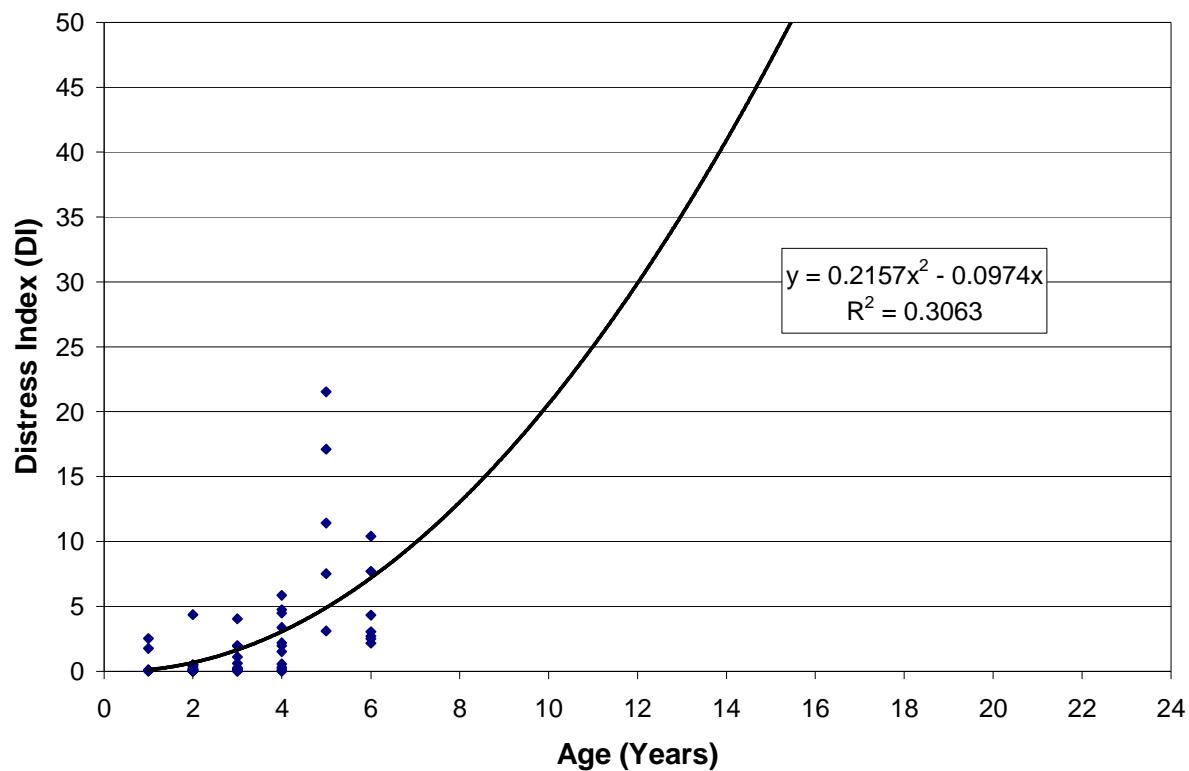


Figure 1. Predicted DI for all pavement sections constructed in Michigan between 1997 and 2002 with the MHB using second order polynomial regression.

The performance data show that all but one pavement section constructed with the MHB in Michigan between 1997 and 2002 have a DI less than 20. Therefore, all of these sections are categorized as being in good condition according to MDOT's condition rating scale.

Other forms of the regression (linear and third order polynomials) were evaluated for the pavement data but the second order equation provided the best fit to the available data, both statistically and visually. Although providing the best fit to the data, the resulting R-squared value for the regression is relatively low (less than 0.5) due to the scatter of the data across the 6 years of the pavement condition data (the R-squared value is a measure of the strength of the correlation between the dependent variable [in this case, DI] and the independent variable [age]). Since data are only available for the first 6 years of pavement life, the performance trend for DI was extrapolated to estimate an expected 15.4-year average service life for the rubblized pavement sections (shown in figure 1 as the extension of the performance curve beyond the 6 years of data and out to a DI of 50, which MDOT defines as having no remaining life).

The developed model does not do a particularly good job of predicting the performance of the rubblization and overlay technique because all of the sections are less than 6 years old and no

long-term performance data are currently available that suggests what the expected service life might actually be. Furthermore, there are other sources of variability that affect the ability to develop accurate performance models, including differences and variability in overlay thicknesses, construction materials, base and subgrade characteristics, construction quality, traffic levels, and environmental conditions. Therefore, the resulting model is limited in its ability to accurately predict the service life of the pavement sections beyond the six years of available data.

With the performance of the rubblized sections categorized based upon the use of DI, the development of a performance trend for RQI was attempted based upon available data aggregated for each pavement section in the analysis. As shown in figure 2, the considerable scatter of the RQI data prevented the development of a meaningful trend of performance. However, figure 2 shows that all data have RQI values less than 50, indicating that based upon an aggregated condition, all pavement sections can be categorized as providing good or excellent ride quality.

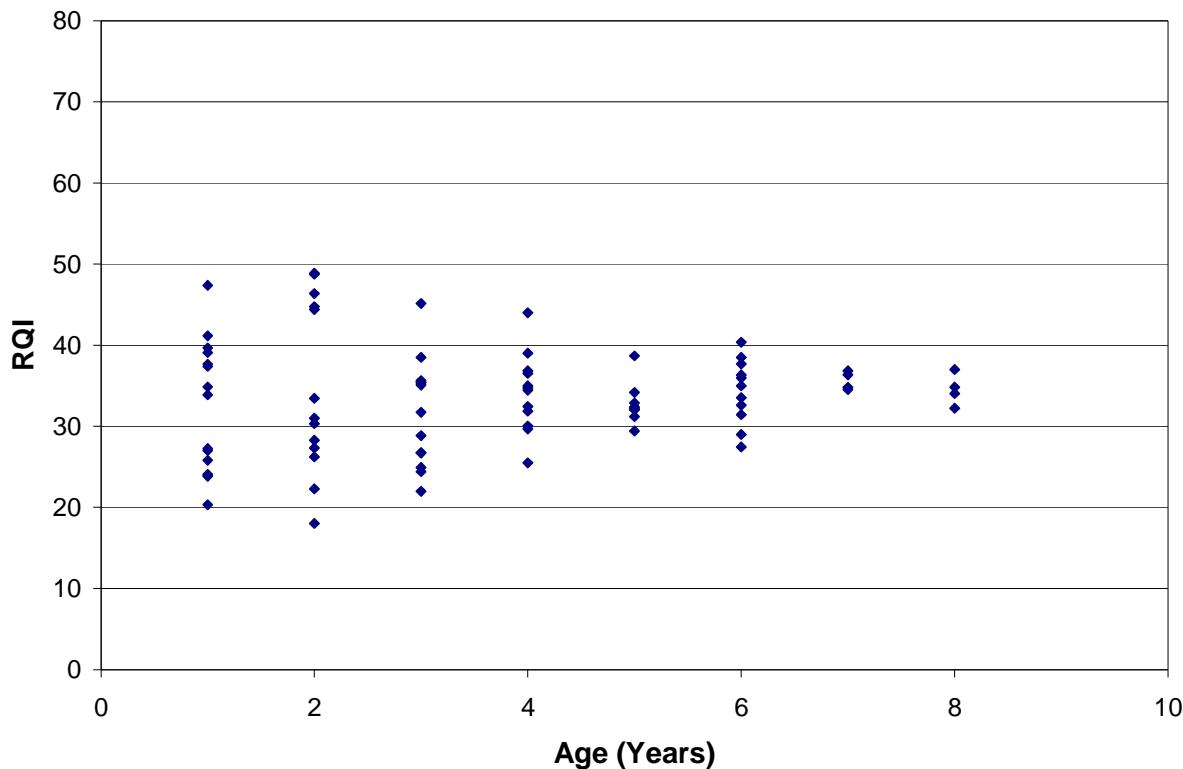


Figure 2. RQI for all pavement sections rubblized in Michigan between 1997 and 2002 using the MHB.

In addition to examining the RQI values for the pavement sections, APTech evaluated the IRI data. As shown in figure 3, the IRI data showed a scatter similar to that observed in the RQI data. Again the scatter was too variable to produce a meaningful regression equation, but all of the aggregated average IRI data values for each project section fall below the 95 in/mile

threshold, which is considered the upper threshold for classifying pavements as having good ride quality (FHWA 2004).

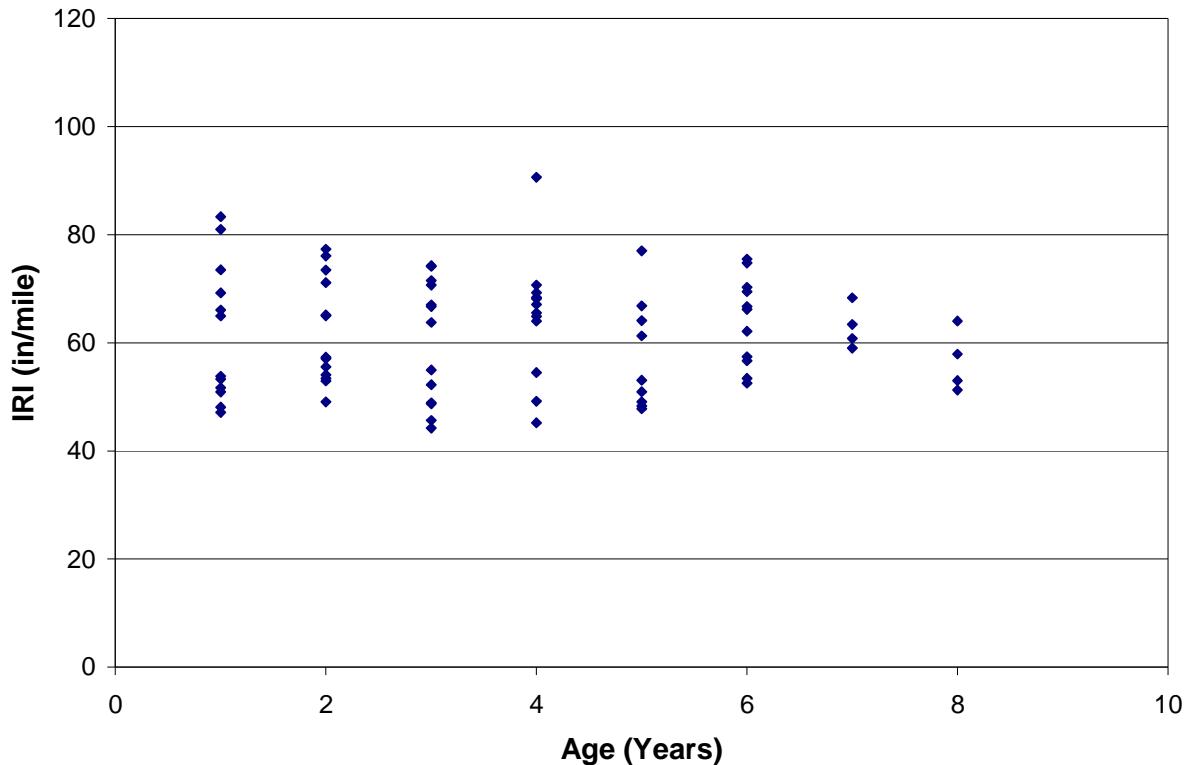


Figure 3. IRI for all pavement sections rubblized in Michigan between 1997 and 2002 using the MHB.

Performance Trends for RFB Pavement Sections

The same performance trend analysis that was conducted for the MHB pavement sections was conducted for all pavement sections rubblized using the RFB. Using the family pavement performance models with age as the independent variable, a performance trend of average DI was created as shown in figure 4. As with the performance trends created for the MHB sections, the resulting R-squared value for the regression is relatively low (0.1978) due to the scatter of the data across the 16 years of the pavement condition data. Based upon this regression, the expected service life for the pavement sections rubblized using the RFB is 11.2 years.

While the majority of the DI condition data is less than 50, the performance data shows that 11 DI measurements exceed a value of 50, which corresponds to 5 sections having recorded DIs indicating an exhaustion of service life. With some DI values more than 8 times the threshold value of service life exhaustion, an analysis of the data for potential outliers that are affecting the slope of the regression equation and corresponding overall correlation is warranted.

The first step of the statistical analysis was to use statistical software, Arc 1.06, which was developed by Drs. R. D. Cook and S. Weisberg at the University of Minnesota in Minneapolis-St. Paul, Minnesota, to test for the outliers. Outliers are defined as atypical, infrequent

observations within a data set that do not follow the model of the rest of the data (Weisburg 2005).

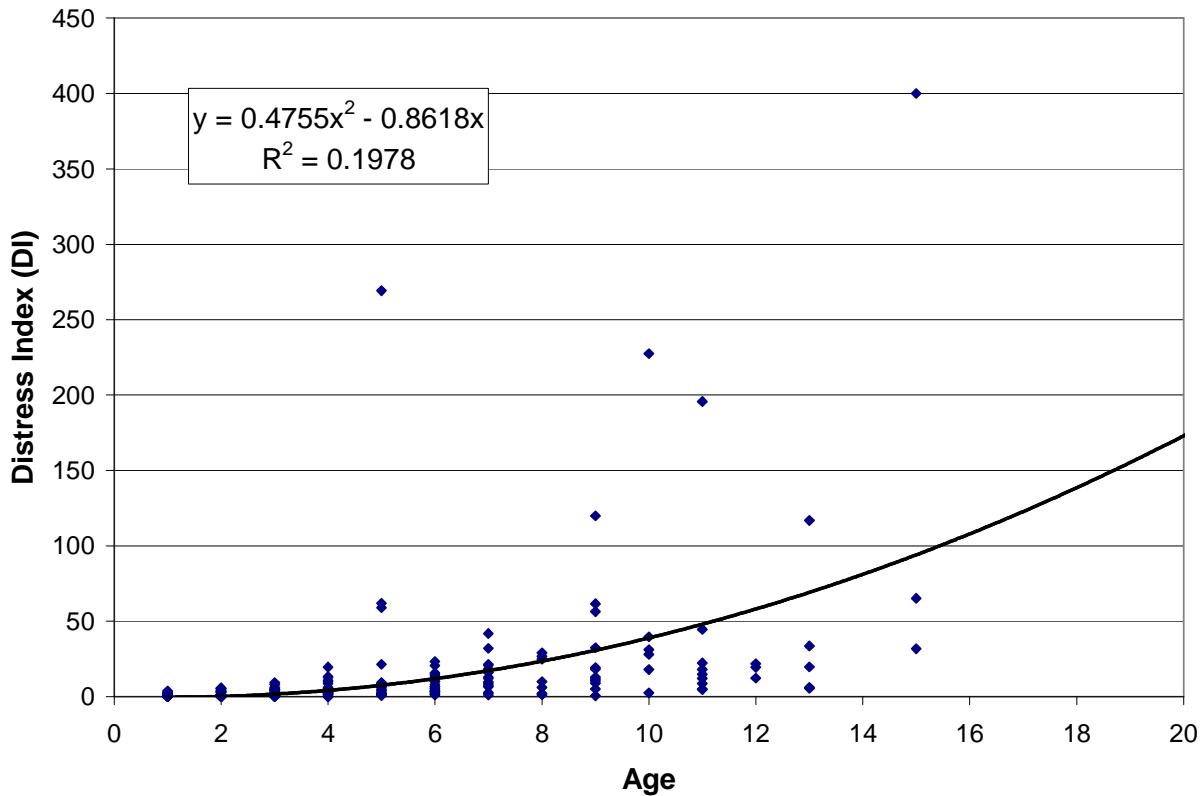


Figure 4. Predicted DI for all pavement sections constructed in Michigan between 1988 and 2002 using the RFB for rubblization based upon a second order polynomial regression.

The data for the RFB sections was checked for their influence on the regression equation by evaluating the Outliers t-test and Cook distances for each data point. The Outliers t-test determines a studentized t-statistic for each data point in the analysis based upon the distance of the point from the fitted regression line in both the x (age) and y (DI) direction. In addition to the determination of the studentized t-statistic, Cook's distance was calculated to determine the influence that each data point has on the regression. Data points with large Cook's Distance measurements can be considered as outliers, and can result in significant changes to the regression model if removed from the analysis.

With each studentized t-statistic and Cook's distance determined, the RFB data points could be reviewed to determine if any should be classified as outliers. Table 12 provides a listing of a portion of the statistical results for several of data points in the RFB data set. The results for all data points are provided in Appendix I.

Table 12. Statistical analysis to determine outliers in RFB project sections.

Control Section	DI	Age	Model Prediction	Residual	T-Statistic from Outlier Test	Cook's Distance	Outlier? (Yes/No)
34031/ 34032	400.000	15	145.362	254.638	11.625	9.158	Yes
16092	31.791	15	145.362	-113.362	-4.338	1.815	Yes
16092	65.278	15	145.362	-80.362	-3.020	0.912	Yes
33084	227.419	10	25.114	201.886	6.927	0.271	Yes
34031/ 34032	195.738	11	31.924	164.076	5.496	0.267	Yes
41033	269.180	5	11.868	257.132	9.272	0.128	Yes
41131	5.493	13	65.136	-60.136	-1.944	0.062	No
41131	6.023	13	65.136	-59.136	-1.944	0.062	No
34031/ 34032	116.804	13	65.136	51.864	1.673	0.046	No
41131	14.728	11	31.924	-16.924	-0.536	0.003	No

The selection of outliers was determined based upon a combination of the studentized t-statistic and the Cook's distance measurement; the values that were selected as outliers are bolded in table 12. The outliers were determined by selecting any data with a t-statistic greater than the critical t-statistic of 1.95, which corresponds to a 99 percent confidence interval. Also, those data points were shown to have Cook's Distance values greater than all other values in the analysis, further indicating the significant influence the data points have on the regression and confirming the validity of removing those data from the RFB performance analysis.

A review of the sections (Control sections: 13081, 16092, 34031/34032, 33084, and 41033) that demonstrated high DI values (greater than 50) and those removed from the data set because they were statistical outliers (Control sections: 34031/34032, 16092, 33084, and 41033) show significant overlap and all have the common characteristic that all sections were rubblized prior to 1996. Based upon this finding and the fact that all of the sections rubblized using the MHB were constructed after 1996, the RFB section data was divided into two data sets for analysis based upon year of rubblization (1988 to 1996 and 1997 to 2002). In dividing the sections, an evaluation of the service lives of each data set could be examined. The decision to divide the data set into time periods was further substantiated by the fact that several changes occurred in asphalt mix designs in the mid to late 1990s. Specifically, in 1997, changes were made to the calculation of Voids in the Mineral Aggregate (VMA) with MDOT switching to the use of bulk aggregate specific gravity from effective aggregate specific gravity with an assumed absorption. This change along with a change in target air voids in the asphalt mixes of 4 percent resulted in mixes with less rutting, less segregation, and overall better performance compared to previous asphalt mixes.

For the pavement sections rubblized with the RFB between 1988 and 1996, and with the outliers still included, the regression analysis using a second order polynomial equation produced the model shown in figure 5, and yielded an average expected service life of 11.2 years. For the

pavement sections rubblized with the RFB between 1997 and 2002, the regression analysis produced the second-order polynomial model shown in figure 6, which yielded an average expected service life of 16.0 years. However, both models exhibit low R-squared values (less than 0.50).

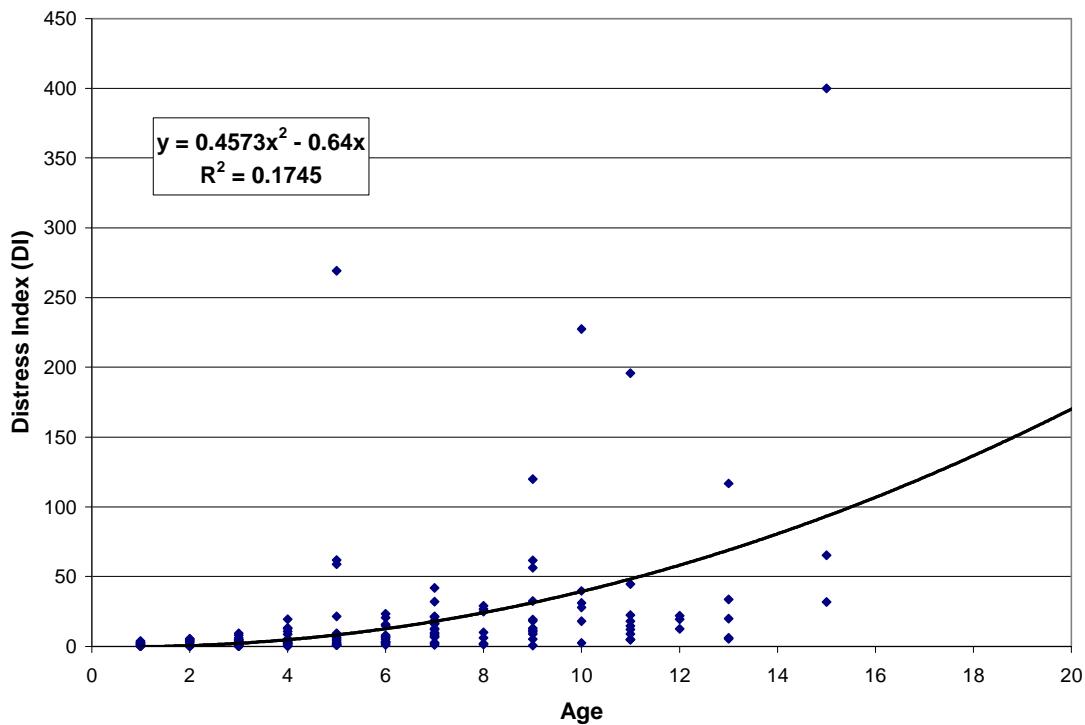


Figure 5. Predicted DI for all pavement sections constructed in Michigan between 1988 and 1996 using the RFB for rubblization based upon a second order polynomial regression.

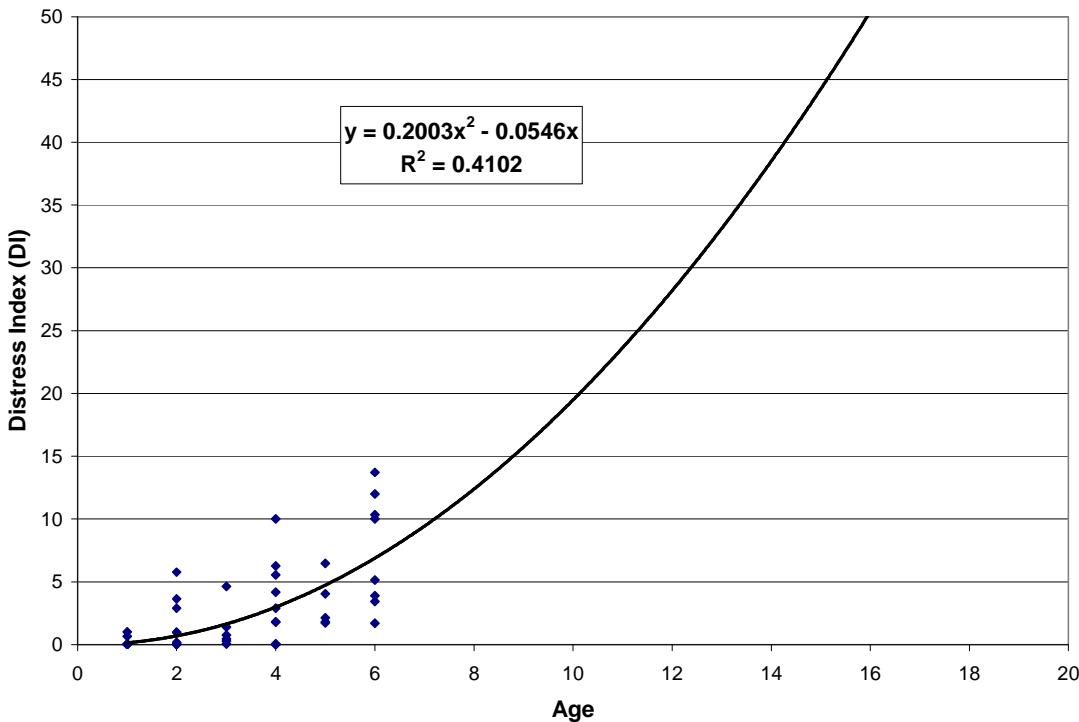


Figure 6. Predicted DI for all pavement sections constructed in Michigan between 1997 and 2002 using the RFB for rubblization based upon a second order polynomial regression.

A regression analysis was then conducted with the outliers removed. All outliers existed in the 1988 to 1996 data set, so a new regression for this data set was obtained and an expected service life of 18.4 years was determined (see figure 7) as compared to the initial 11.2 years. The removal of the statistical outliers resulted in a significant increase in the predicted expected service life, which is now greater than the expected service life for the sections rubblized between 1997 and 2002. Based upon this change, a decision was made to re-evaluate the expected service life of the entire data set with all non-outlier data. This analysis resulted in an expected service life of 17.1 years for all non-outlier RFB sections, as shown in figure 8.

In addition to considering the DI information, a review of the RQI information for all sections rubblized using the RFB was conducted based upon available data aggregated for each pavement section in the analysis (no outliers removed). As shown in figure 9, although scatter of the RQI data exists, an average trend of performance was developed. Only one data point had an RQI greater than 70 indicating that all other pavement sections were in *Excellent*, *Good*, or *Fair* condition based upon the RQI. Furthermore, the regression predicts that on average the pavements are not expected to fall into the *Poor* RQI range until an age of 21.9 years.

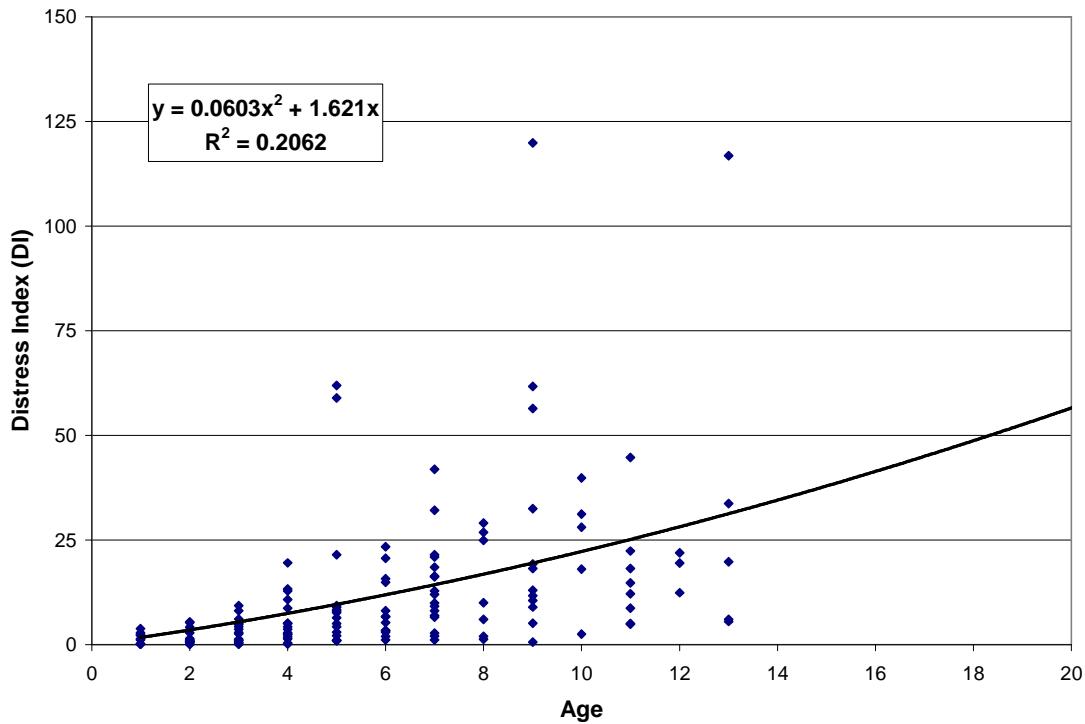


Figure 7. Predicted DI for non-outlier pavement sections constructed in Michigan between 1988 and 1996 using the RFB for rubblization based upon a second order polynomial regression.

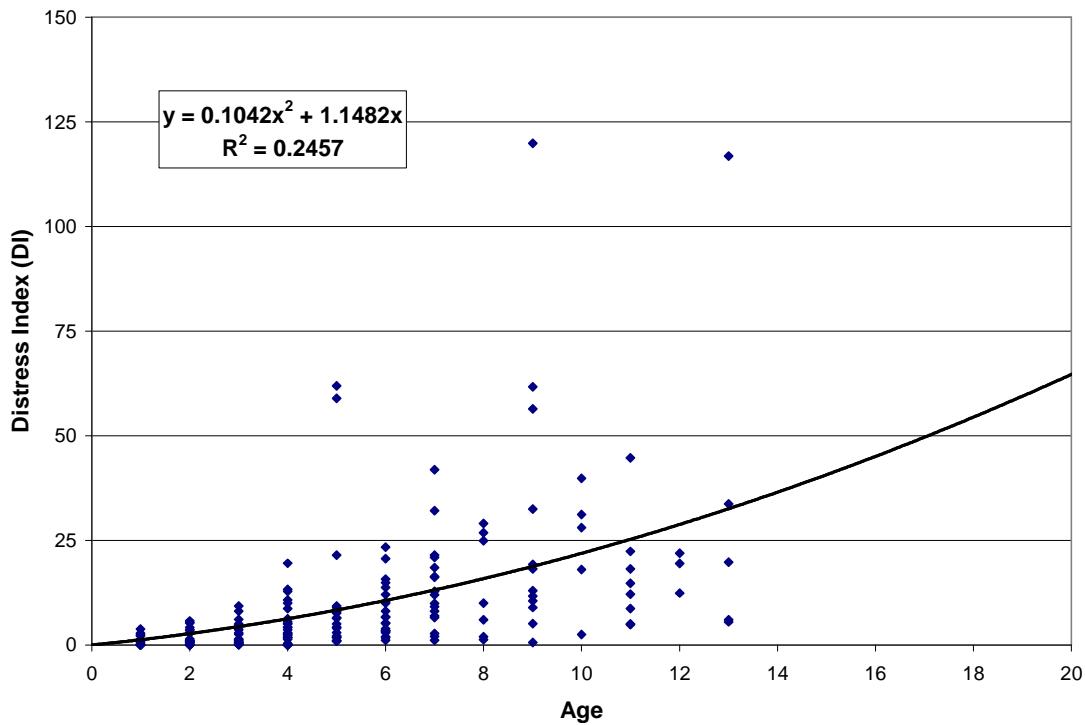


Figure 8. Predicted DI for non-outlier pavement sections constructed in Michigan between 1988 and 2002 using the RFB for rubblization based upon a second order polynomial regression.

In addition to examining the RQI values for the RFB pavement sections, an evaluation of the IRI data was conducted. As shown in figure 10, the IRI data showed a scatter similar to that observed in the RQI data. The scatter resulted in a regression equation with a low R-squared value, but all of the aggregated average IRI data values for each project section fall below the 170 in/mile threshold, which is considered the threshold for classifying pavements as having acceptable ride quality (FHWA 2004). Based upon the regression equation, the service life of the pavement sections (using the 170 in/mile) as a service life threshold is 23.8 years.

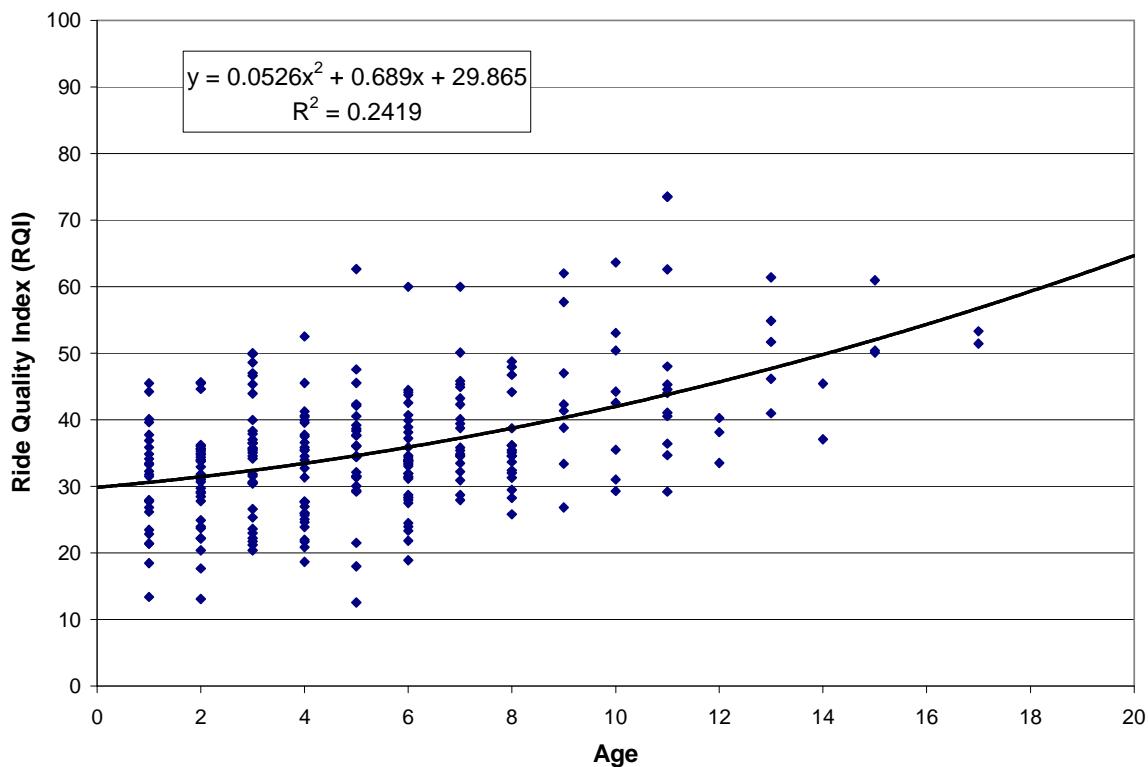


Figure 9. RQI for all pavement sections rubblized using the RFB between 1988 and 2002.

When reviewing the RQI and IRI data for the RFB sections, it is also interesting to note that for those sections that were rubblized since 1997, the maximum RQI value is 49.87 which indicates that all pavement sections have a good ride quality. Also, sixty-five of the sixty-nine IRI measurements for sections rubblized since 1997 have IRI values less than the 95 in/mile threshold, signifying that the pavement sections are providing good ride quality.

In addition to evaluating family modeling techniques, multivariate regression models were evaluated for the entire MHB and RFB pavement sections. Those equations that used age, rubblization method, route type, drainage, average daily traffic, and thickness of the asphalt overlay to predict the behavior of the DI proved that the only variable that was statistically significant at predicting the behavior of DI was age. Therefore, further use of multivariate regression was abandoned and focus turned to the use of distress-specific information to analyze the performance of the pavement sections.

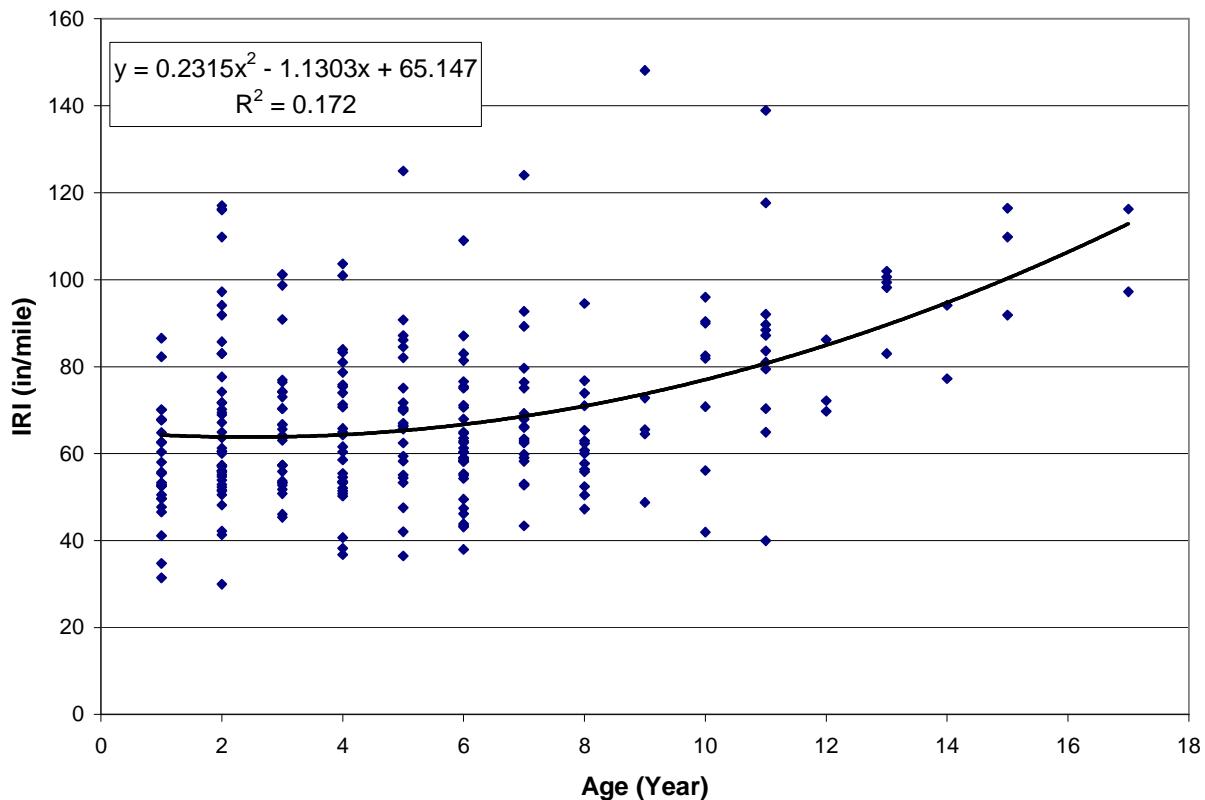


Figure 10. IRI for all pavement sections rubblized using the RFB between 1988 and 2002.

Distress Summary for MHB Pavement Sections

One of the primary reasons for rubblizing a PCC pavement is to reduce reflection cracks that might occur in the HMA overlay due to movements in the underlying slabs. Therefore, assessing the performance of rubblized pavements should include an analysis of the transverse cracking in the HMA surface. This was accomplished by using the distress code data provided by MDOT to extract the amount of transverse cracking reported in the DI. Table 13 provides a summary of the MHB pavement sections evaluated and the corresponding DI for the section and distress index due to transverse cracking.

Table 13. MHB section DIs, showing amount attributed to transverse cracking, longitudinal cracking, and longitudinal cracking at the construction joint/pavement edge from latest survey.

Control Section	Location (Direction-Increasing/Decreasing)	Age at Testing	DI	DI due to Transverse Cracking ²	DI due to Longitudinal Cracking (Total) ²	DI due to Longitudinal Cracking at the Construction Joint/Pavement Edge ²
81076	USH 23 NB/SB, Washtenaw County (I)	6	7.701	0.025	7.676	7.099
81076	USH 23 NB/SB, Washtenaw County (D)	6	2.712	0.091	2.620	2.620
46082	M-50, Lenawee County (I) ¹	5	7.524	4.145	3.380	1.023
46082/58041		6	2.170	0.175	1.994	1.994
58171	I-275 NB/SB, Monroe County (I)	6	3.034	0.103	2.931	2.931
58171	I-275 NB/SB, Monroe County (D)	6	2.488	0.150	2.338	2.338
21031	M-35, Delta County (I) ¹	6	4.327	0.523	3.805	3.649
25042	I-69 EB/WB, Genesee County (I)	5	11.418	0.538	10.792	10.120
25042	I-69 EB/WB, Genesee County (D)	5	17.104	0.703	14.284	14.282
38061	M-60 EB/WB, Jackson County (I)	4	4.757	0.043	4.714	4.714
25092	M-15, Genesee County (I)	6	10.395	3.165	7.231	3.087
67021/ 67022	USH 10, Osceola County (I) ¹	5	3.101	0.501	2.600	2.529
26011	M-18, Gladwin County (I)	5	21.539	6.521	6.631	2.280
67022	USH 10, Osceola County (I)	4	3.379	0.055	3.325	3.222
05011	USH 31, Antrim County (I) ¹	4	1.976	0.012	1.965	1.965
10032	USH 31, Benzie County (I)	4	2.191	0.000	2.191	2.191
25081	M-21, Genesee County (I)	3	0.000	0.000	0.000	0.000
58042	M-50, Monroe County (I)	3	0.062	0.005	0.057	0.057
44031	M-53, Lapeer County (I) ¹	3	0.121	0.004	0.118	0.118
35032	USH 23, Iosco County (I)	3	1.932	0.135	1.797	1.797
37011/37013/ 37014	USH 27 NB/SB, Isabella County (I) ¹	4	4.480	0.000	4.480	4.480
37013/37014	USH 27 NB/SB, Isabella County (D) ¹	3	4.045	0.053	3.992	3.992
65041	I-75 NB/SB, Ogemaw County (I)	2	0.153	0.138	0.008	0.008
65041	I-75 NB/SB, Ogemaw County (D)	2	0.221	0.202	0.019	0.019
58042	M-50 EB/WB, Monroe County (I)	1	0.009	0.009	0.000	0.000
51012	USH 31, Manistee County (I) ¹	1	0.041	0.007	0.033	0.000

¹ Non-continuous section.

² Calculated values based upon calculation using the distress code data provided by MDOT.

In addition to evaluating the amount of DI due to transverse cracking, the distress code information provided by MDOT was further evaluated to determine what other distress types were contributing to the DI values for each pavement section. Therefore, table 13 also includes a summary of the amount of DI due to all longitudinal cracking on the section. As a point of further investigation, the portion of DI due to longitudinal cracking that is occurring at the paving lane joint (construction joint) or pavement edge of the pavement is also provided. This value provides an indication if the longitudinal cracking occurring in the pavement lane is concentrated at the paving lane joint or edge (which may suggest poor compaction of the asphalt mix during placement) or throughout the pavement lane (which may suggest other construction or support condition issues). The values used to determine the amounts of distress at paving lane joint or pavement edge were determined using the MDOT principle distress (PD) codes of PD201 and PD203 for left and right edge longitudinal cracking, respectively.

The values included in table 13 represent the most recent performance evaluation for each of the pavement sections included in the study. It should be noted that the pavement sections included in table 13 are aggregated into area-weighted DI values for the given project when possible. In some cases, some sections were not aggregated because the surveys occurred at different ages.

From table 13, there are only three sections that have DI indexes due to transverse cracking that are greater than 1. It should be noted that a DI of 1 is a very low level of distress. In fact, the majority of the data shows that little to none of the measured DI index is due to the occurrence of transverse cracking, which suggests that the rubblization process has removed a primary mechanism contributing to transverse cracking. However, the summation of the amount of DI due to transverse cracking includes all transverse cracking, whether the cause was due to reflective cracking or other forces (e.g., thermal stresses in the HMA overlay). Therefore, the estimation of amount of distress due to the occurrence of transverse reflective cracking is likely to be less than that indicated in the reported DI due to transverse cracking.

For pavement sections with DI greater than 1, transverse cracking occurs as the predominant distress on only one pavement section, M-50, Lenawee County (Control Section 46082), which was constructed in 1999 with the MHB. After 5 years of service, this pavement section still has low DI of 7.524 (indicating it is in good condition), and an even lower DI due to transverse cracking of 4.145. For all other sections with a DI greater than 1, longitudinal cracking is the prominent distress type and for the majority of the pavement sections longitudinal cracking is concentrated at the construction joint or pavement edge. Only three pavement sections with a DI greater than 1 have greater than 10 percent of the longitudinal cracking occurring within the pavement width: M-50, Lenawee County (I)-Control Section 46082; M-15, Genesee County (I); and M-18, Gladwin County (I).

While table 13 provides an indication of the amount of distress due to transverse and longitudinal cracking, it does not provide an indication of the effect of other surface distress on the final DI. Further review of the DI distress code data showed that only two pavement sections had any major distress other than transverse and longitudinal cracking. The first section was M-18 in Gladwin County from mileposts 4.860 to 12.0. As mentioned previously, this pavement section is the only one rubblized using the MHB that is not categorized as being in good condition. The distress on the section, which has a DI of 21.539, is due to transverse cracking (30 percent),

longitudinal cracking (31 percent), alligator cracking (18 percent), and block cracking (21 percent).

A review of pay quantities for the M-18 project showed that over 4,000 m³ of subgrade undercutting was conducted over the entire project, which was more than four times the original bid quantity for the project. Based upon the available documentation, it is not possible to link the area of undercutting to the exact stations along the length of the project. Therefore, it is unknown whether the undercutting occurred in an area that was rubblized or in a transition or non-rubblized area of the project. In any event, the project had subgrade issues that are believed to have affected the performance of the pavement. Furthermore, it was noted that during the construction of the project, a large amount of wire mesh was removed. In fact, so much of the mesh was exposed on the surface of the rubblized pavement that a loader equipped with forks was used to pull up an unusually large amount of wire mesh (1.4 pounds of wire for each square meter of rubblized pavement). The removal of the wire mesh in such a manner and at such high quantities may have an adverse effect on performance of the pavement section due to the disruption of the underlying pavement layer.

In addition, wet weather conditions during construction exposed the rubblized and underlying pavement layers to moisture that may be contributing to the higher distress experienced on the M-18 project (as compared to the other rubblized sections in the study). Also the available pavement section characteristics show that the section was classified as having *partial drainage* with underdrains and an open-graded drainage course used along the outside edges of the pavement in localized areas, suggesting that poor drainage conditions might be contributing to some of the deterioration.

The other section that had distress other than transverse and longitudinal cracking was section I-69 in Genesee County (control section 25042). This section, constructed in 1998 with the MHB had some minor alligator cracking occurring in both directions of travel and block cracking occurring in the direction of decreasing mileposts. Together these distresses accounted for 12 percent of the DI. Construction documents for this pavement section indicate that very little if any steel was removed from the section during construction and that there was very little filler aggregate needed to even out the rubblized surface. Both of these characteristics are not suggestive of any construction-related problems that might contribute to the reduced performance of the section. However, a review of the pay items for the project shows that less than 10 percent of the project received an underdrain as part of the construction process.

Since the lack of full drainage seems to have an effect on the resulting performance of the rubblized section of M-18 and I-69, a review of sections that were constructed with drainage and with partial drainage was conducted for the sections constructed using the MHB. Plots of the DI for those sections classified as being *drained* pavements is shown in figure 11. The pavement sections considered to be *partially drained* or *not drained* are shown in figure 12.

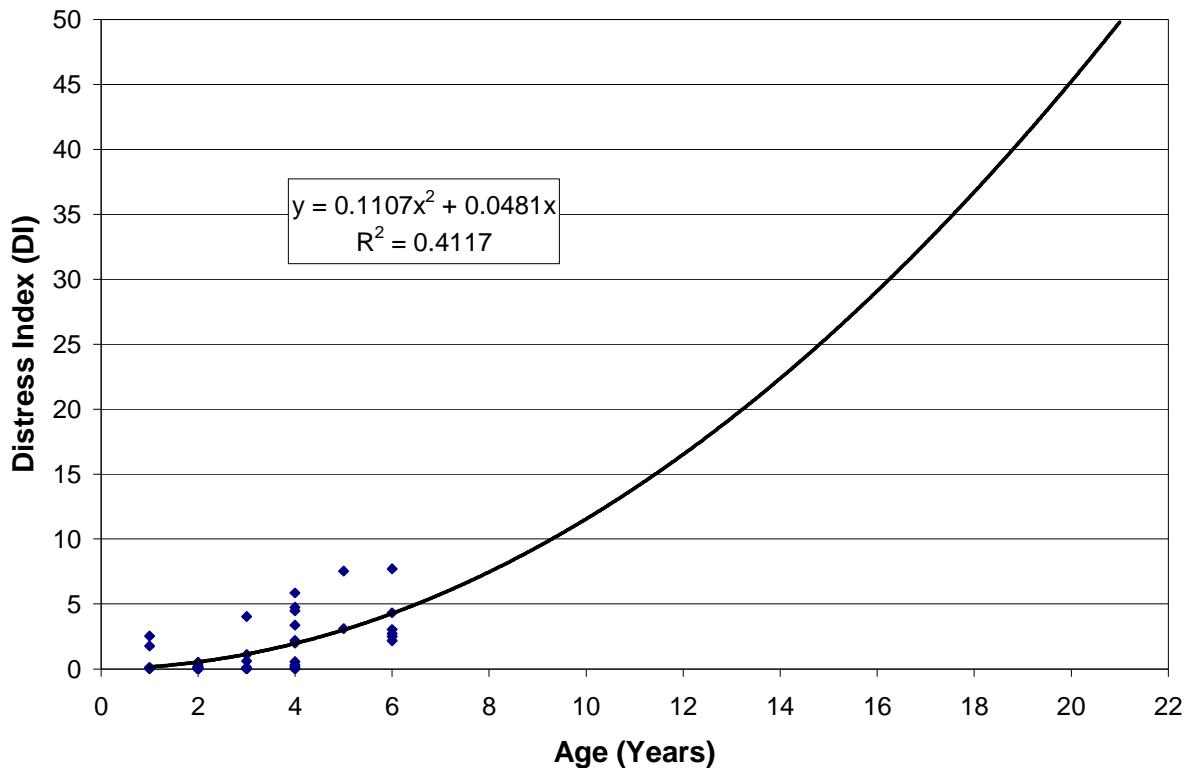


Figure 11. Predicted DI for all pavement sections constructed in Michigan between 1997 and 2002 using the MHB with *full drainage*.

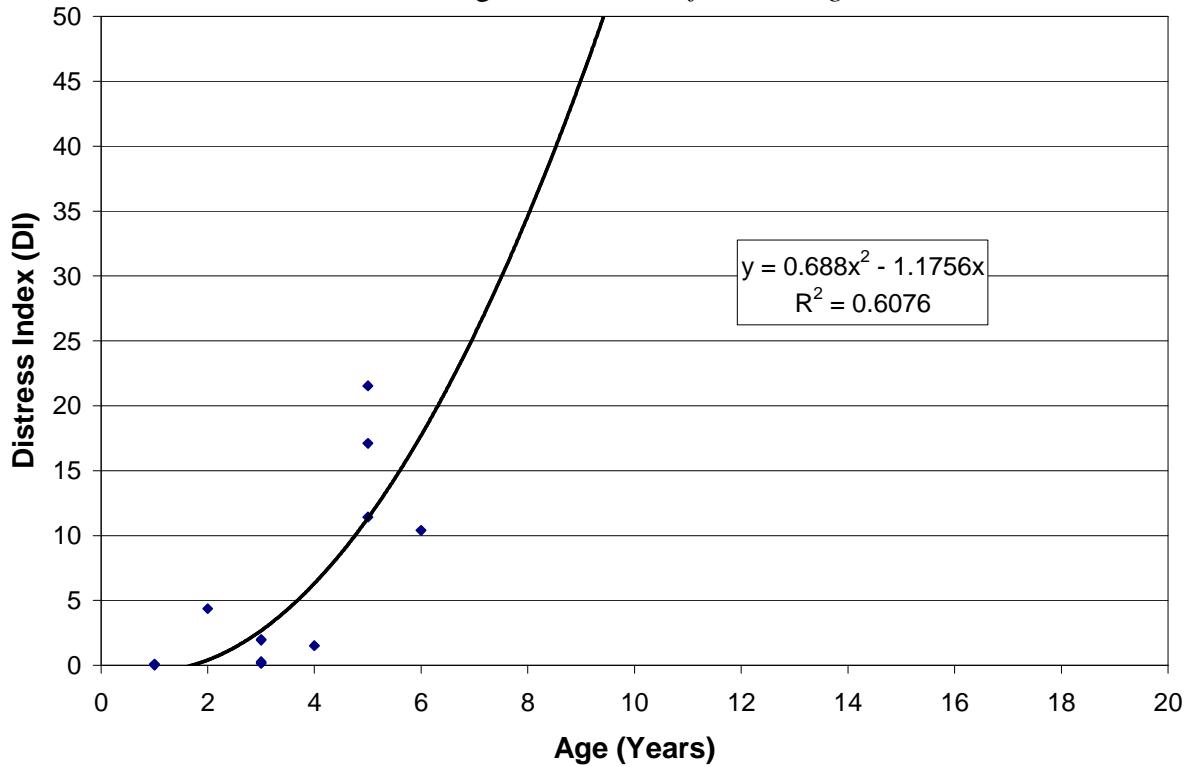


Figure 12. Predicted DI for all pavement sections constructed in Michigan between 1997 and 2002 using the MHB with *partial or no drainage*.

As shown in figures 12 and 13, the average expected service life of the MHB pavement sections constructed with full and partial/no drainage systems is 21.0 and 9.4 years, respectively. An expected average service life of 21 years for the rubblized pavement sections that had been constructed with drainage exceeds a 20-year design life that is often used by State Departments of Transportation in the design of new pavement structures.

It appears that the lack of a full drainage system and the possible poor compaction of the HMA pavement at the construction joints and pavement edge may have contributed in combination to the deterioration of the MHB pavement sections that are exhibiting higher DI values. Still, all but one pavement section rubblized using the MHB between 1997 and 2002 in Michigan are in good condition.

Distress Summary for RFB Pavement Sections

Following the review of the performance of the pavement sections rubblized with the MHB, a review of the sections rubblized using the RFB was also conducted which parallels the analysis conducted for the MHB sections. The assessment began with an evaluation of the amount of transverse cracking reported in the DI. A summary of the RFB pavement sections evaluated and the corresponding DI for the section and distress index due to transverse cracking are provided in table 14. Table 14 also includes a summary of the amount of DI due to all longitudinal cracking on the section and the portion of DI due to longitudinal cracking that is occurring at the paving lane joint (construction joint) or pavement edge of the pavement.

The values included in table 14 represent the most recent performance evaluation for each of the pavement sections included in the study. It should be noted that given the various control sections that made up certain projects lengths and the variety of ages at which data was collected, subsection data was not aggregated into projects in table 14.

For the 51 pavement subsections constructed prior to 1997, only 15 subsections had DI values greater than 20 indicating that all remaining sections have a *Low* distress level according to the DI used by MDOT and for those subsections constructed after 1996 no subsections had DI values greater than 20. Of the 15 subsections with DI values greater than 20, only 3 sections (I-75 NB/SB, Cheboygan; M28, Brimley, Chippewa County; and M-66 NB/SB, Ionia County) have over half of the recorded distress due to the occurrence of transverse cracking. Those 3 sections correspond to the 2 sections in which DIs due to transverse cracking are greater than 20. These sections were constructed in 1988 and 1989, suggesting that the rubblization process initially had some issues in providing the proper breaking patterns in order to eliminate the occurrence of reflective cracking. However, for the sections constructed in 1992 through 1995, the DI due to transverse cracking dropped significantly for the majority of sections. The overall performance of sections constructed since 1997 have performed significantly better than their counterparts that were constructed prior to that time.

It should be noted that the DI and the DI due to transverse cracking is less than 13.715 and 7.369, respectively, for all RFB pavement sections that have been rubblized since 1997 (36 of the total 87). In fact 27 of the 36 subsections have DIs less than 5 and 34 of the 36 subsections have DIs due to transverse cracking that are less than 5. These findings indicate that since 1997,

Table 14. RFB section DIs, showing amount attributed to transverse cracking, longitudinal cracking, and longitudinal cracking at the construction joint/pavement edge from latest survey.

Control Section	Location (Direction-Increasing/Decreasing)	Age at Testing/ Year Rubblized	DI	DI due to Transverse Cracking ¹	DI due to Longitudinal Cracking (Total) ¹	DI due to Longitudinal Cracking at the Construction Joint/Pavement Edge ¹
13081	I-94 EB/WB, Calhoun County (I)	11 / 1988	44.701	8.681	27.254	7.854
13081	I-94 EB/WB, Calhoun County (D)	11 / 1988	4.847	3.799	0.985	0.844
16093	I-75 NB/SB, Cheboygan County (I)	15 / 1988	31.791	20.364	11.000	5.155
16093	I-75 NB/SB, Cheboygan County (D)	15 / 1988	65.278	18.677	9.913	5.377
17062	M28, Brimley, Chippewa County (I)	10 / 1989	28.063	19.920	8.143	7.226
34031	M-66 NB/SB, Ionia County (I)	13 / 1989	57.411	29.875	7.904	1.726
34032	M-66 NB/SB, Ionia County (I)	15 / 1989	400.000	0.000	0.000	0.000
34031	M-66 NB/SB, Ionia County (D)	9 / 1989	34.324	27.210	7.114	3.405
34032	M-66 NB/SB, Ionia County (D)	9 / 1989	71.862	35.494	15.824	10.825
09101	US-10 EB / M-25 EB, Bay County (I)	10 / 1989	34.598	12.708	14.101	10.714
09101	US-10 EB / M-25 EB, Bay County (I)	10 / 1989	21.262	7.528	12.139	9.055
09042	US-10 EB / M-25 EB, Bay County (I)	9 / 1989	19.209	8.849	10.269	9.775
41131	US-131 NB/SB, Kent County (I)	13 / 1990	6.024	3.328	2.696	2.690
41131	US-131 NB/SB, Kent County (D)	13 / 1990	5.493	3.803	1.690	1.031
16032	M-27, Cheboygan County (I) ¹	12 / 1990	16.544	11.569	4.975	0.194
16032	M-27, Cheboygan County (I) ¹	12 / 1990	3.968	3.965	0.003	0.003
16032	M-27, Cheboygan County (I) ¹	12 / 1990	9.886	8.645	1.241	1.156
20014	I-75 SB, Crawford County (D)	9 / 1990	11.658	8.537	3.121	2.149
16021	M-68, Cheboygan County (I) ²	12 / 1990	21.908	9.983	2.702	2.115
41033	M-37 NB/SB, Kent County (I)	12 / 1992	19.466	5.023	11.047	10.817
41033	M-37 NB/SB, Kent County (D)	4 / 1992	1.863	1.284	0.579	0.467
41033	M-37 NB/SB, Kent County (D)	4 / 1992	1.366	0.913	0.453	0.433
47013	US-23 NB/SB, Livingston County (I)	11 / 1992	18.133	6.908	11.025	9.055
47013	US-23 NB/SB, Livingston County (D)	11 / 1992	8.740	2.003	6.673	6.673
47014	US-23 NB/SB, Livingston County (I)	7 / 1992	4.959	0.852	4.107	3.203
47014	US-23 NB/SB, Livingston County (D)	7 / 1992	2.225	0.418	1.806	1.131
37013	US-27 NB/SB, Isabella County (I)	4 / 1993	8.663	0.870	7.794	7.230
37013	US-27 NB/SB, Isabella County (D)	4 / 1993	10.502	2.820	7.682	6.416
37013	US-27 NB/SB, Isabella County (D)	4 / 1993	13.415	6.415	7.000	6.120
03112	US-131 NB/SB, Allegan County (I)	6 / 1993	2.983	0.087	2.896	2.877
03112	US-131 NB/SB, Allegan County (D)	6 / 1993	4.027	0.000	4.027	4.027
03112	US-131 NB/SB, Allegan County (D)	6 / 1993	3.381	0.124	3.257	3.228
33084	I-96 EB/WB, Ingham County (I)	6 / 1993	227.419	8.714	4.900	2.360
33084	I-96 EB/WB, Ingham County (D)	10 / 1993	2.483	0.633	1.841	1.810
13033	I-194/M-66 NB/SB, Calhoun County (I)	6 / 1993	14.863	4.171	10.692	8.032
13033	I-194/M-66 NB/SB, Calhoun County (D)	6 / 1993	15.762	6.129	9.633	7.495
41013	M-44 EB/WB, Kent County (I)	7 / 1993	6.913	1.292	5.621	5.497
41013	M-44 EB/WB, Kent County (D)	5 / 1993	0.877	0.377	0.500	0.500

¹ Calculated values based upon calculation using the distress code data provided by MDOT.

Table 14. RFB section DIs, showing amount attributed to transverse cracking, longitudinal cracking, and longitudinal cracking at the construction joint/pavement edge from latest survey (continued).

Control Section	Location (Direction-Increasing/Decreasing)	Age at Testing/ Year Rubblized	DI	DI due to Transverse Cracking ¹	DI due to Longitudinal Cracking (Total) ¹	DI due to Longitudinal Cracking at the Construction Joint/Pavement Edge ¹
33083	I-96 EB/WB, Ingham (I)	9 / 1994	11.607	1.567	10.040	9.515
33084	I-96 EB/WB, Ingham (I)	9 / 1994	8.872	0.977	7.895	7.860
33083	I-96 EB/WB, Ingham (D)	8 / 1994	13.820	2.473	11.346	10.932
33084	I-96 EB/WB, Ingham (D)	8 / 1994	2.323	0.775	1.549	1.375
25092	M-15, Genesee County (I) ³	7 / 1994	16.180	0.000	16.180	16.016
56021	M-20 WB, Midland County (D)	2 / 1994	0.031	0.027	0.004	0.000
74012	M-53, Sanilac County (I) ⁴	7 / 1995	21.421	2.738	1.302	0.361
41033	M-37 NB/SB, Kent County (I)	5 / 1995	339.776	5.191	5.662	4.462
41033	M-37 NB/SB, Kent County (I)	5 / 1995	231.668	14.740	22.315	12.944
41033	M-37 NB/SB, Kent County (D)	1 / 1995	0.306	0.152	0.154	0.138
41033	M-37 NB/SB, Kent County (D)	1 / 1995	0.182	0.136	0.046	0.037
01052	US-23, Alcona County (I)	3 / 1996	2.606	0.386	2.220	2.064
70024	I-196 EB, Ottawa County (I)	7 / 1996	1.141	0.114	1.027	0.936
03111	US-131 NB/SB, Allegan County (I)	6 / 1997	4.309	4.103	0.206	0.046
03111	US-131 NB/SB, Allegan County (D)	6 / 1997	0.835	0.009	0.825	0.825
03112	US-131 NB/SB, Allegan County (I)	6 / 1997	3.801	1.820	1.946	1.939
03112	US-131 NB/SB, Allegan County (I)	6 / 1997	1.664	1.567	0.098	0.098
03112	US-131 NB/SB, Allegan County (D)	6 / 1997	1.792	1.676	0.116	0.116
03112	US-131 NB/SB, Allegan County (D)	6 / 1997	1.700	1.700	0.000	0.000
03112	US-131 NB/SB, Allegan County (D)	6 / 1997	2.656	0.167	2.489	2.489
70024	I-196 EB, Ottawa County (I)	6 / 1997	5.132	0.996	4.025	2.327
13033	I-194/M-66 NB/SB, Calhoun County (I)	6 / 1997	10.333	0.267	10.067	10.067
13033	I-194/M-66 NB/SB, Calhoun County (D)	6 / 1997	12.000	0.067	11.933	11.933
70013	US-31 NB, Ottawa County (I)	6 / 1997	4.211	0.235	3.976	3.739
70013	US-31 NB, Ottawa County (I)	6 / 1997	3.311	0.021	3.290	2.894
37014	US-27 NB/SB, Isabella County (I)	6 / 1997	10.006	7.369	2.637	2.352
37014	US-27 NB/SB, Isabella County (D)	4 / 1997	2.884	0.665	2.219	2.212
37014	US-27 NB/SB, Isabella County (I)	5 / 1998	6.480	4.603	1.878	1.215
37014	US-27 NB/SB, Isabella County (D)	3 / 1998	0.265	0.245	0.011	0.000
74073	M-25, Sanilac County (I)	6 / 1998	13.715	3.412	4.382	0.772
41026	I-96 & I-296 EB/WB, Kent County (I)	5 / 1998	1.566	0.063	1.504	1.504
41026	I-96 & I-296 EB/WB, Kent County (I)	5 / 1998	2.720	0.000	2.720	2.720
41026	I-96 & I-296 EB/WB, Kent County (D)	5 / 1998	0.000	0.000	0.000	0.000
41026	I-96 & I-296 EB/WB, Kent County (D)	5 / 1998	0.270	0.270	0.000	0.000
41131	I-96 & I-296 EB/WB, Kent County (D)	5 / 1998	11.414	6.178	5.236	5.236
41131	I-96 & I-296 EB/WB, Kent County (D)	5 / 1998	2.640	0.000	2.640	2.640
41029	I-196 EB/WB, Kent County (I)	5 / 1998	2.131	0.013	2.118	2.085
41029	I-196 EB/WB, Kent County (D)	5 / 1998	1.708	0.017	1.669	1.664

¹ Calculated values based upon calculation using the distress code data provided by MDOT.

Table 14. RFB section DIs, showing amount attributed to transverse cracking, longitudinal cracking, and longitudinal cracking at the construction joint/pavement edge from latest survey (continued).

Control Section	Location (Direction-Increasing/Decreasing)	Age at Testing/ Year Rubblized	DI	DI due to Transverse Cracking ¹	DI due to Longitudinal Cracking (Total) ¹	DI due to Longitudinal Cracking at the Construction Joint/Pavement Edge ¹
01052	US-23, Alpena County (I)	4 / 1999	0.364	0.000	0.364	0.000
04031	US-23, Alpena County (I)	4 / 1999	0.000	0.000	0.000	0.000
04031	US-23, Alpena County (I)	4 / 1999	2.170	0.350	1.820	1.520
04031	US-23, Alpena County (I)	4 / 1999	1.909	0.000	1.909	1.766
04031	US-23, Alpena County (I)	4 / 1999	5.219	2.672	2.547	1.050
41133	US-131 NB/SB, Kent & Montcalm Counties (I)	4 / 1999	4.777	0.238	4.536	4.348
41133	US-131 NB/SB, Kent & Montcalm Counties (D)	4 / 1999	1.069	0.303	0.766	0.713
59012	US-131 NB/SB, Kent & Montcalm Counties (I)	4 / 1999	6.545	0.327	6.179	5.901
59012	US-131 NB/SB, Kent & Montcalm Counties (D)	4 / 1999	2.717	0.118	2.599	2.272
41033	M-37/M-46, Kent & Muskegon Counties (I)	4 / 2000	0.020	0.000	0.020	0.020
61171	M-37/M-46, Kent & Muskegon Counties (I)	4 / 2000	0.000	0.000	0.000	0.000

¹Calculated values based upon calculation using the distress code data provided by MDOT.

rubbilization has done a sufficient job of providing the breakage of the underlying concrete pavement to reduce the occurrence of transverse reflective cracking.

An examination of longitudinal cracking reveals that 60 percent of all subsections (48 of 75 subsections) with a DI greater than 1 have more distress due to longitudinal cracking than to transverse cracking. This is especially true on the sections that have been rubblized since 1997, which show 70 percent of those subsections (20 of 28 subsections) with a greater percentage of distress due to longitudinal cracking as compared to transverse cracking. For the majority of these pavement sections, the longitudinal cracking is concentrated at the construction joint or pavement edge. This trend matches that found on the MHB pavement sections—that the occurrence of longitudinal cracking at the construction joint and pavement edge is the most significant distress present on the majority of the pavement sections that have been rubblized since 1997.

Table 14 provides an indication of the amount of distress due to transverse and longitudinal cracking, but it does not provide an indication of the effect of other surface distress on the final DI. Seventy of the eighty-seven subsections have more than 95 percent of their distress attributed to the combination of longitudinal and transverse cracking. The other pavement sections have reflective shattered cracking, alligator cracking, and block cracking occurring along the pavement length. All subsections with DIs greater than 72 are due to the occurrence of reflective shattered area cracking. The distress points associated with this distress resulted in triple digit DI values that occurred on I-96 EB/WB, Ingram County (I); M-37, NB/SB, Kent County (I); and M-66 NB/SB, Ionia County (I). The pavement section M-66 NB/SB, Ionia

County (I and D) had significant alligator cracking, which resulted in higher associated DI values.

While the exact causes of these poor performing sections is not directly known, it is interesting to note that the three sections with reflective shattered area cracking and resulting very high (triple digit) DI values were constructed prior to 1993. These are also the pavement sections that were shown earlier to be statistical outliers from the data set. This finding raises the question of the relative value of the distress points for reflective shattered area cracking compared to the other typical distresses that are found on a pavement section and further confirms the decision to analyze the data set without these values present.

Distress Summary for MHB and RFB Pavement Sections Combined

With the removal of the data outliers further substantiated, a model with MHB and RFB sections combined without outliers was examined to determine if the data sets provide the same trends of DI. Figure 13 displays the DI data for both the MHB and RFB section data. A visual evaluation of the data set seems to indicate that both sets of data show no difference in reported DI based upon the overlap of the available data. An analysis of variance through linear regression verified that the method of rubblization (the use of MHB versus RFB) is not a significant factor for predicting DI. Therefore, indicating that the two data subsets (MHB and RFB) can be treated as one data set.

Given the previously described differences between the pavement sections constructed prior to 1997 and after 1996, the condition (DI) data for sections constructed after 1996 was evaluated for the MHB and RFB side-by-side as shown in figure 14. This figure shows the direct overlap in the DI information for both rubblization methods and also in the predicted remaining service lives of 15.4 and 16.0 years for the MHB and RFB, respectively.

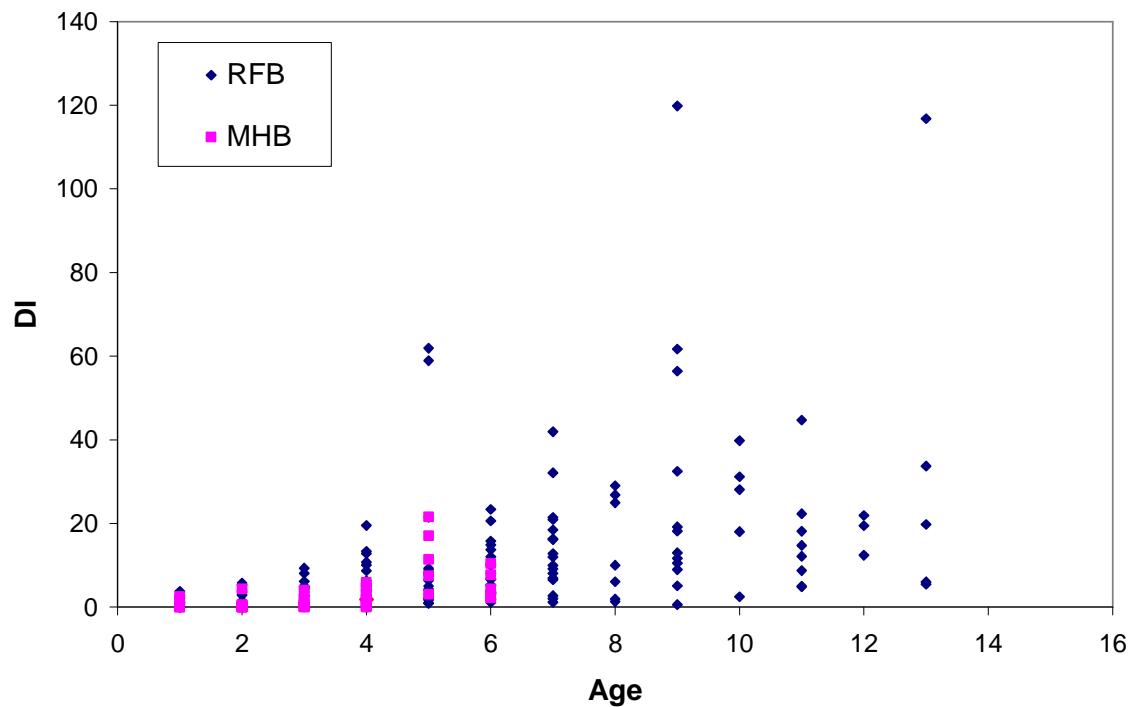


Figure 13. DI data for MHB and RFB sections with outliers removed.

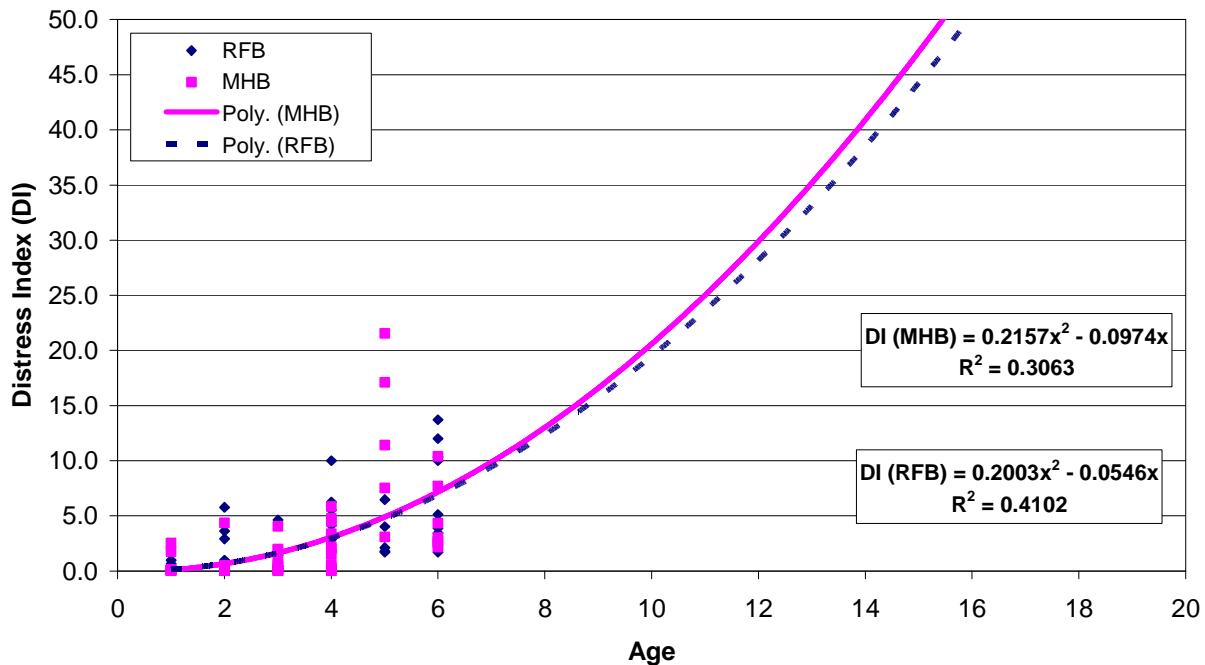


Figure 14. DI data for MHB and RFB sections rubblized between 1997 and 2002 with outliers removed.

The predictions of remaining service life as shown in figure 14 are only based upon 6 years of data. Therefore, it is advantageous to use DI values from the entire RFB data set to expand the timeframe of available data. Using the MHB and RFB data combined, a final regression model was developed that shows an expected average service life of 16.5 years for all rubblized pavement sections in Michigan, as shown in figure 15.

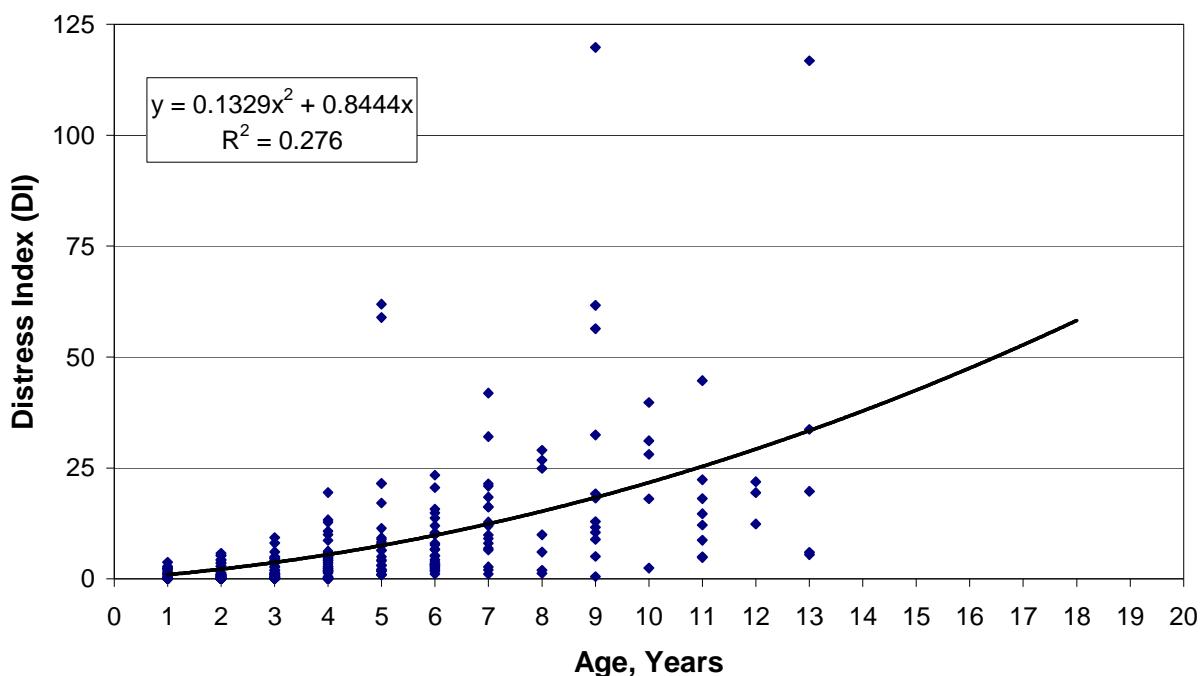


Figure 15. DI data for MHB and RFB sections rubblized between 1988 and 2002 with outliers removed.

Categorized Rubblization Uniformity

As part of the Baladi, Svasdisant, and Chatti study (2002), the researchers excavated trenches in the rubblized pavements and concluded that one cause of the underperformance of the rubblized pavements was “poor and non-uniform quality of the rubblization operation, which leads to joint and reflective cracks and TDC (top-down cracks) in the rubblized pavement.” As a point of investigation, the DI and RQI information obtained from MDOT had to first be combined into a project-by-project summary to allow a comparison of the MDOT data to that summarized in the Baladi, Svasdisant, and Chatti (2002) report.

The summary of trench excavation information from the Baladi, Svasdisant, and Chatti (2002) study is shown in table 15 for the MHB and RFB sections, respectively. Besides providing the detailed notes that were included in their study, table 15 includes APTech’s interpretation of the general quality of the rubblized material in terms of excellent, good, fair, and poor based upon descriptions in the Baladi, Svasdisant, and Chatti (2002) report. A summary of the DI and RQI from the latest survey by MDOT is also provided in table 15.

Table 15. Results from trench excavations for MHB and RFB sections (adapted from Baladi, Svasdisant, and Chatti 2002).

Control Section Number	Project	From Baladi, Svasdisant, and Chatti 2002		APTech Additions	
		Rubblization Process	Results of Drainability Tests	General Quality of Rubblized Material	DI/RQI from latest survey
67022	US 10 EB	• MHB - The quality of rubblization of the original concrete lane and widening strip varies from one location to another	• Good drainage	Poor	3.379 / 32.609
10032	US 31 NB	• MHB - Most aggregates were broken, which indicates that the strength of the aggregate is less than that of the cement paste	• Good drainage	Poor	2.191 / 36.321
5011	US 31 SB	• MHB - Shallow rubblization • No steel was debonded in two trenches	• Water drained laterally due to super-elevation	Poor	1.976 / 40.363
26011	M-18 NB	• MHB - High amount of dust • Poor quality of rubblization especially along the shoulder • Few fractures were observed in the fractured concrete • Dowel bars were exposed	• Poor drainage in 2 trenches	Poor	21.539 / 32.871
25081	M-21 WB	• MHB - Poor rubblization of the inner lane • Fair rubblization of the outer lane • A transverse crack had no apparent effect on the rubblization	• Poor drainage in 2 trenches • Excellent drainage along the 4-ft concrete widening strip	Fair	0.000 / 38.682
58042	M-50 EB	• MHB - The quality of rubblization was excellent • Dowel bars were exposed	• No tests were conducted	Excellent	0.062 / 31.186
44031	M-53 NB	• MHB - Poor rubblization at speed of 275-m/hr • Good rubblization at speed of 245-m/hr • The steel was poorly debonded	• Poor drainage	Poor	0.121 / 34.179
37011	US 27	• MHB - Hammer bounces • Frequent large pieces (more than 6 in.) • No temperature steel debonding	• No tests were conducted	Poor	4.480 / 32.392
01052 / 04031	US 23 SB	• RFB - Quality of rubblization along widening strip was poor • Well rubblized in original concrete lane	• No tests were conducted	Fair	4.157 / 31.456
41133 / 59012	US 131 SB	• RFB - Good rubblization • Dowel bars exposed	• No tests were conducted	Good	1.787 / 31.395

A comparison of the DI values to the generalized quality of the rubblized material for each pavement section reveals that there is little correlation between the two. Generally speaking, three of the ten sections (Control sections 26011, 58042, and 41133/59012) included in the study show a correlation between rubblized material quality from the trench analysis and final resulting performance of the pavement sections. For M-18, the quality of the rubblized material was rated as being poor, for M-50 the rating was excellent, and for US 131 the rating was good. All of these ratings are in line with the latest DI survey by MDOT, which reports values of 21.539, 0.062, and 1.787 for M-18, M-50, and US 131, respectively. However, for all other sections, the DI survey results do not match the rated quality of the rubblized material. For all the pavement sections, the RQI values indicate good performance, with values falling between 31 and 54.

The study by Baladi, Svasdisant, and Chatti (2002) also examined the observed distresses on each of the pavement sections included in the study. During their field observation, they described the distress types as transverse top-down cracking, longitudinal top-down cracking, segregation, and raveling. This distress information is very helpful to the investigation of the behavior of these rubblized sections because it considers segregation in the HMA mixture, which is not reported in the MDOT distress summary. Table 16 summarizes the distresses observed on each pavement section as determined by Baladi, Svasdisant, and Chatti (2002), along with the DI and RQI from the latest condition survey by MDOT. As expected, the observed distresses correlate well to the reported DI. The pavement sections with segregation in the pavement HMA mixture are showing the highest DI values, indicating the poorest performance. The RQI values are not showing specific correlation to the observed distresses since the values that fall within the good condition range are showing a tight band of performance. Only one project, US-10 EB (Control Section 67022), shows any discrepancy between the condition found early in the life of the pavement section by Baladi, Svasdisant, and Chatti (2002) and the condition from the latest distress survey conducted by MDOT.

Baladi, Svasdisant, and Chatti (2002) examined distress information for all rubblized pavement sections in Michigan in their study and determined that 58 percent of all projects had various degrees of segregation. In reviewing the 2002 distress data, 42 of the 48 reviewed rubblization projects had medium- or high-severity segregation and all transverse top-down cracking that occurred on the projects were located in the segregated areas. The cause of the segregation in these mixes is unknown, but it is apparent that segregation is a contributing factor to the reduced performance of some of the rubblized pavement sections (e.g., M-18). The occurrence of the segregation is an HMA mixture problem that is likely due to poor mix design or possible construction placement problems, both of which have no link to the rubblization process.

Table 16. Observed distress on rubblized pavement sections (adapted from Baladi, Svasdisant, and Chatti 2002).

Control Section Number	Project	Observed Distresses	DI/RQI from latest survey by MDOT
67022	US 10 EB	No Distress	3.379 / 32.609
10032	US 31 NB	Longitudinal top-down cracks, segregation	2.191 / 36.321
5011	US 31 SB	Segregation	1.976 / 40.363
26011	M-18 NB	Transverse top-down cracks, longitudinal top-down cracks, segregation	21.539 / 32.871
25081	M-21 WB	No distress	0.000 / 38.682
58042	M-50 EB	No distress	0.062 / 31.186
44031	M-53 NB	Longitudinal top-down cracks, segregation	0.121 / 34.179
37011	US 27	Segregation	4.480 / 32.392
01052/ 04031	US 23 SB	Longitudinal top-down cracks, segregation	4.157 / 31.456
41133/ 59012	US 131 SB	Longitudinal top-down cracks, segregation	1.787 / 31.395

Summary and Conclusions

The analysis of pavement sections constructed in Michigan using the MHB between 1997 and 2002 revealed that twenty of the twenty-one MHB pavement sections evaluated have DI condition ratings of good, and all of the sections have RQI values falling in the excellent or good category. The IRI values also indicate that all MHB pavements are in good condition with values less than 95 in/mile. For those RFB sections rubblized during the same timeframe as the MHB projects (1997 to 2002), all 36 sections had DI condition ratings of good (less than 20) and ride quality according to RQI of excellent or good. Also, sixty-five of the sixty-nine IRI measurements for sections rubblized since 1997 have IRI values less than the 95 in/mile threshold, further signifying that the pavement sections are providing good ride quality. For the RFB pavement sections constructed prior to 1997, 15 of 51 subsections had latest DI condition ratings that exceeded 20 indicating that they were in fair or poor condition.

Although the evaluation of the performance data shows the majority of pavement sections performing satisfactory (especially for those sections rubblized since 1997), the variability in performance data for the variety of pavement sections resulted in some prediction models with low R-squared values. This variability is expected given the differences in the pavement sections due to differences and variability in the selected construction materials, the underlying soil characteristics, the construction specifications, and the construction workmanship for each pavement section.

For the majority of MHB and RFB pavement sections, the primary distress occurring is longitudinal cracking. Of those MHB sections with longitudinal cracking occurring as the primary distress, all but three sections have over 90 percent of the longitudinal cracking

occurring at the pavement joint or pavement edge, suggesting that other factors outside of the rubblization process are contributing to the observed deterioration. Those MHB sections that have higher DI values and distresses other than transverse and longitudinal cracking all shared the common characteristic of being *partially drained*.

The pavement sections rubblized using the RFB prior to 1997 had significantly higher DI values than those sections rubblized since 1997. Also the majority of sections showing significant DI values due to transverse cracking were constructed prior to 1992, which suggests that the rubblization process at that time was not effectively eliminating the primary mechanism contributing to transverse cracking. However, the performance of sections rubblized with the RFB since 1997 indicates that all pavement sections are in good condition based upon the DI, and all sections have low DI values associated with transverse cracking (less than 7.369). For the RFB sections rubblized since 1997, longitudinal cracking is the primary distress for the majority of sections and the majority of this distress was concentrated at the pavement joint or pavement edge, which matches the trend found on the MHB pavement sections.

Using the DI as the method for estimating service life for the pavement sections, several estimated service lives were determined for various MHB and RFB data subsets. Based upon a statistical analysis of the data set, it was determined that the rubblization method, MHB and RFB, is not a significant factor for predicting DI because both methods resulted in similar trends in DI. Therefore, the data sets were combined with the exclusion of statistically proven outliers to determine an estimated service life of 16.5 years for the performance of rubblized pavement sections in the State of Michigan.

It should be noted, however, that the development of expected service life estimates was based on limited performance data, and in fact many of the pavement sections are less than 6 years old. Improved estimates of performance lives can be made as more data become available. Therefore, future performance data for the pavements will provide the needed information to better define the performance trends and expected service life of the rubblized pavement sections.

A qualitative comparison of the results of the uniformity of rubblization from the excavated trenches on the rubblization projects shows little correlation to the most recent MDOT DI information. Instead, the more indicative cause of the few poorly performing pavement sections since 1997 seems to be due to HMA mixture problems associated with segregation and perhaps poor compaction at the edges of the pavement lane. Overall, the pavement sections rubblized since 1997 with either the MHB or RFB are providing the desired level of performance except where other construction or HMA mixture issues that are not related to the rubblization process have occurred.

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**APPENDIX A – MHB PROJECT SECTION BEGINNING AND END
MILEPOSTS**

Control Section	Year Rubblized	Location (Direction-Increasing/Decreasing)	POB Milepost	POE Milepost
81076	1997	USH 23 NB/SB, Washtenaw County (I)	0.544	6.620
81076	1997	USH 23 NB/SB, Washtenaw County (D)	0.544	6.431
46082	1997	M-50, Lenawee County (I)	0.113	1.824
46082	1997	M-50, Lenawee County (I)	3.942	4.366
46082	1997	M-50, Lenawee County (I)	4.593	7.134
46082	1998	M-50, Lenawee County (I)	9.576	12.375
58041	1998	M-50, Lenawee County (I)	0.000	5.021
58171	1997	I-275 NB/SB, Monroe County (I)	0.466	1.963
58171	1997	I-275 NB/SB, Monroe County (D)	0.000	1.975
21031	1998	M-35, Delta County (I)	1.415	3.093
21031	1998	M-35, Delta County (I)	8.700	10.431
25042	1998	I-69 EB/WB, Genesee County (I)	0.040	5.932
25042	1998	I-69 EB/WB, Genesee County (D)	0.040	5.932
38061	1998	M-60 EB/WB, Jackson County (I)	12.650	16.045
25092	1998	M-15, Genesee County (I)	9.501	10.409
67021	1998	USH 10, Osceola County (I) ¹	1.935	2.625
67022	1998	USH 10, Osceola County (I) ¹	0.000	1.523
26011	1999	M-18, Gladwin County (I)	4.860	12.000
67022	1999	USH 10, Osceola County (I)	9.657	12.087
05011	1999	USH 31, Antrim County (I)	0.929	1.375
05011	1999	USH 31, Antrim County (I)	1.531	2.732
10032	1999	USH 31, Benzie County (I) ²	11.430	14.340
25081	1999	M-21, Genesee County (I)	4.981	7.285
58042	1999	M-50, Monroe County (I)	0.139	4.525
44031	1999	M-53, Lapeer County (I)	0.000	1.588
44031	1999	M-53, Lapeer County (I)	2.820	6.130
44031	1999	M-53, Lapeer County (I)	6.466	6.940
35032	2000	USH 23, Iosco County (I)	19.120	22.007
37011	2000	USH 27 NB/SB, Isabella County (I)	0.200	0.460
37013	2000	USH 27 NB/SB, Isabella County (I)	8.407	8.958
37013	2000	USH 27 NB/SB, Isabella County (D)	8.503	8.958
37014	2000	USH 27 NB/SB, Isabella County (I)	0.070	0.640
37014	2000	USH 27 NB/SB, Isabella County (I)	0.790	1.340
37014	2000	USH 27 NB/SB, Isabella County (D)	0.070	0.610
37014	2000	USH 27 NB/SB, Isabella County (D)	0.760	1.200
65041	2001	I-75 NB/SB, Ogemaw County (I)	6.540	11.366
65041	2001	I-75 NB/SB, Ogemaw County (D)	6.619	11.274
58042	2001	M-50 EB/WB, Monroe County (I)	4.521	6.898
51012	2002	USH 31, Manistee County (I)	17.213	18.312
51012	2002	USH 31, Manistee County (I)	18.511	19.212
51012	2002	USH 31, Manistee County (I)	19.392	19.941
51012	2002	USH 31, Manistee County (I)	21.475	21.917

¹ 1999 decreasing direction data used for DI, RQI, and IRI.² 2001 decreasing direction data used for RQI and IRI.

**APPENDIX B – RFB PROJECT SECTION BEGINNING AND END
MILEPOSTS**

Control Section	Year Rubblized	Location	POB Milepost	POE Milepost
13081	1988	I-94 EB/WB, Calhoun County (I)	2.474	5.650
13081	1988	I-94 EB/WB, Calhoun County (D)	2.474	5.650
16093	1988	I-75 NB/SB, Cheboygan County (I)	13.186	15.218
16093	1988	I-75 NB/SB, Cheboygan County (D)	13.186	15.218
17062	1989	M28, Brimley, Chippewa County (I)	18.686	22.289
34031	1989	M-66 NB/SB, Ionia County (I)	7.200	7.512
34032	1989	M-66 NB/SB, Ionia County (I)	0.000	0.446
34031	1989	M-66 NB/SB, Ionia County (D)	7.200	7.512
34032	1989	M-66 NB/SB, Ionia County (D)	0.000	0.446
09101	1989	US-10 EB / M-25 EB, Bay County (I)	0.924	7.356
09101	1989	US-10 EB / M-25 EB, Bay County (I)	9.122	11.357
09042	1989	US-10 EB / M-25 EB, Bay County (I)	0.056	1.271
41131	1990	US-131 NB/SB, Kent County (I)	6.467	10.137
41131	1990	US-131 NB/SB, Kent County (D)	6.467	10.321
16032	1990	M-27, Cheboygan County (I) ¹	0.998	2.570
16032	1990	M-27, Cheboygan County (I) ¹	9.309	9.579
16032	1990	M-27, Cheboygan County (I) ¹	9.664	11.375
20014	1990	I-75 SB, Crawford County (D)	0.000	3.730
16021	1990	M-68, Cheboygan County (I) ²	0.230	7.711
41033	1992	M-37 NB/SB, Kent County (I)	2.477	7.917
41033	1992	M-37 NB/SB, Kent County (D)	2.477	7.349
41033	1992	M-37 NB/SB, Kent County (D)	7.444	7.917
47013	1992	US-23 NB/SB, Livingston County (I)	5.494	6.951
47013	1992	US-23 NB/SB, Livingston County (D)	5.494	6.951
47014	1992	US-23 NB/SB, Livingston County (I)	0.000	7.165
47014	1992	US-23 NB/SB, Livingston County (D)	0.000	7.165
37013	1993	US-27 NB/SB, Isabella County (I)	8.958	11.664
37013	1993	US-27 NB/SB, Isabella County (D)	9.007	11.382
37013	1993	US-27 NB/SB, Isabella County (D)	11.476	11.712
03112	1993	US-131 NB/SB, Allegan County (I)	3.065	8.557
03112	1993	US-131 NB/SB, Allegan County (D)	3.065	3.521
03112	1993	US-131 NB/SB, Allegan County (D)	3.762	8.557
33084	1993	I-96 EB/WB, Ingham County (I)	8.979	17.491
33084	1993	I-96 EB/WB, Ingham County (D)	8.854	17.495
13033	1993	I-194/M-66 NB/SB, Calhoun County (I)	0.492	1.679
13033	1993	I-194/M-66 NB/SB, Calhoun County (D)	0.492	1.679
41013	1993	M-44 EB/WB, Kent County (I)	0.699	2.669
41013	1993	M-44 EB/WB, Kent County (D)	0.699	2.669
33083	1994	I-96 EB/WB, Ingham (I)	2.105	3.689
33084	1994	I-96 EB/WB, Ingham (I)	0.000	1.070
33083	1995	I-96 EB/WB, Ingham (D)	2.375	3.689
33084	1995	I-96 EB/WB, Ingham (D)	0.000	0.662
25092	1994	M-15, Genesee County (I) ³	8.610	8.904
56021	1994	M-20 WB, Midland County (D)	6.053	10.589

Control Section	Year Rubblized	Location	POB Milepost	POE Milepost
74012	1995	M-53, Sanilac County (I) ⁴	9.000	13.000
41033	1995	M-37 NB/SB, Kent County (I)	7.925	10.610
41033	1995	M-37 NB/SB, Kent County (I)	10.762	15.815
41033	1995	M-37 NB/SB, Kent County (D)	7.965	10.606
41033	1995	M-37 NB/SB, Kent County (D)	10.758	15.815
01052	1996	US-23, Alcona County (I)	0.491	2.470
70024	1996	I-196 EB, Ottawa County (I)	12.589	15.591
03111	1997	US-131 NB/SB, Allegan County (I)	6.728	7.959
03111	1997	US-131 NB/SB, Allegan County (D)	6.728	7.959
03112	1997	US-131 NB/SB, Allegan County (I)	0.015	1.941
03112	1997	US-131 NB/SB, Allegan County (I)	2.076	3.102
03112	1997	US-131 NB/SB, Allegan County (D)	0.015	0.893
03112	1997	US-131 NB/SB, Allegan County (D)	1.184	1.941
03112	1997	US-131 NB/SB, Allegan County (D)	2.076	3.102
70024	1997	I-196 EB, Ottawa County (I)	6.581	10.575
13033	1997	I-194/M-66 NB/SB, Calhoun County (I)	0.057	0.492
13033	1997	I-194/M-66 NB/SB, Calhoun County (D)	0.022	0.492
70013	1997	US-31 NB, Ottawa County (I)	1.233	8.278
70013	1997	US-31 NB, Ottawa County (I)	8.933	13.013
37014	1997	US-27 NB/SB, Isabella County (I)	7.150	14.426
37014	1997	US-27 NB/SB, Isabella County (D)	7.206	14.509
37014	1998	US-27 NB/SB, Isabella County (I)	1.540	7.011
37014	1998	US-27 NB/SB, Isabella County (D)	1.569	7.135
74073	1998	M-25, Sanilac County (I)	0.483	4.937
41026	1998	I-96 & I-296 EB/WB, Kent County (I)	4.725	5.639
41026	1998	I-96 & I-296 EB/WB, Kent County (I)	5.865	6.096
41026	1998	I-96 & I-296 EB/WB, Kent County (D)	4.760	5.199
41026	1998	I-96 & I-296 EB/WB, Kent County (D)	5.511	6.068
41131	1998	I-96 & I-296 EB/WB, Kent County (D)	17.357	17.881
41131	1998	I-96 & I-296 EB/WB, Kent County (D)	17.357	17.881
41029	1998	I-196 EB/WB, Kent County (I)	1.135	6.653
41029	1998	I-196 EB/WB, Kent County (D)	1.115	6.659
01052	1999	US-23, Alpena County (I)	16.369	16.393
04031	1999	US-23, Alpena County (I)	0.000	0.241
04031	1999	US-23, Alpena County (I)	0.449	0.908
04031	1999	US-23, Alpena County (I)	1.404	2.248
04031	1999	US-23, Alpena County (I)	4.218	7.893
41133	1999	US-131 NB/SB, Kent & Montcalm Counties (I)	3.200	8.691

Control Section	Year Rubblized	Location	POB Milepost	POE Milepost
41133	1999	US-131 NB/SB, Kent & Montcalm Counties (D)	3.205	8.691
59012	1999	US-131 NB/SB, Kent & Montcalm Counties (I)	0.000	4.214
59012	1999	US-131 NB/SB, Kent & Montcalm Counties (D)	0.000	4.233
41033	2000	M-37/M-46, Kent & Muskegon Counties (I)	15.738	17.120
61171	2000	M-37/M-46, Kent & Muskegon Counties (I)	0.000	0.571

¹ 1992 DI data and 1994, 1996, and 2000 RQI and IRI data reported for decreasing direction.

² 1996 and 1998 DI data, 1994 and 1998 RQI data, and 1994 IRI data reported for decreasing direction.

³ 1996 and 1998 DI and RQI data and 1996 IRI reported for decreasing direction.

⁴ 1996 DI, RQI, and IRI data reported for decreasing direction.

APPENDIX C – MHB DISTRESS INDEX (DI) DATA

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1997	USH 23 NB/SB, Washtenaw County	81076	I	0.544	6.620	1998	0.058	0.000	0.640	0.119
1997	USH 23 NB/SB, Washtenaw County	81076	I	0.544	6.620	1999	0.000	0.000	0.000	0.000
1997	USH 23 NB/SB, Washtenaw County	81076	I	0.544	6.620	2001	0.045	0.000	2.270	0.297
1997	USH 23 NB/SB, Washtenaw County	81076	I	0.544	6.620	2003	7.701	4.000	16.820	3.127
1997	USH 23 NB/SB, Washtenaw County	81076	D	0.544	6.431	1998	0.074	0.000	0.480	0.114
1997	USH 23 NB/SB, Washtenaw County	81076	D	0.544	6.431	1999	0.021	0.000	0.560	0.083
1997	USH 23 NB/SB, Washtenaw County	81076	D	0.544	6.431	2001	0.308	0.000	4.240	0.817
1997	USH 23 NB/SB, Washtenaw County	81076	D	0.544	6.431	2003	2.712	0.000	7.760	1.776
1997	M-50, Lenawee County	46082	I	0.113	1.824	1998	0.069	0.000	0.480	0.151
1997	M-50, Lenawee County	46082	I	0.113	1.824	2001	7.869	2.620	19.720	4.255
1997	M-50, Lenawee County	46082	I	0.113	1.824	2002	10.556	2.242	22.687	5.808
1997	M-50, Lenawee County	46082	I	3.942	4.366	1998	0.080	0.000	0.240	0.139
1997	M-50, Lenawee County	46082	I	3.942	4.366	2001	8.733	6.980	11.500	2.424
1997	M-50, Lenawee County	46082	I	3.942	4.366	2002	7.857	1.500	11.702	5.545
1997	M-50, Lenawee County	46082	I	4.593	7.134	1998	0.127	0.000	1.120	0.303

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1997	M-50, Lenawee County	46082	I	4.593	7.134	2001	4.011	0.520	15.020	3.870
1997	M-50, Lenawee County	46082	I	4.593	7.134	2002	5.426	0.894	17.356	4.159
1998	M-50, Lenawee County	46082	I	9.576	12.375	2001	0.756	0.000	5.800	1.349
1998	M-50, Lenawee County	46082	I	9.576	12.375	2002	0.305	0.002	1.741	0.429
1998	M-50, Lenawee County	58041	I	0.000	5.021	2001	1.283	0.000	6.590	1.625
1998	M-50, Lenawee County	58041	I	0.000	5.021	2002	0.132	0.000	2.120	0.432
1998	M-50, Lenawee County	58041	I	0.000	5.021	2004	2.170	0.000	7.161	2.349
1997	I-275 NB/SB, Monroe County	58171	I	0.466	1.963	1999	0.067	0.000	0.940	0.251
1997	I-275 NB/SB, Monroe County	58171	I	0.466	1.963	2001	0.000	0.000	0.000	0.000
1997	I-275 NB/SB, Monroe County	58171	I	0.466	1.963	2003	3.034	0.720	4.440	1.007
1997	I-275 NB/SB, Monroe County	58171	D	0.000	1.975	1999	0.000	0.000	0.000	0.000
1997	I-275 NB/SB, Monroe County	58171	D	0.000	1.975	2003	2.488	0.000	4.620	1.673
1998	M-35, Delta County	21031	I	1.415	3.093	2000	0.691	0.000	3.040	0.856
1998	M-35, Delta County	21031	I	1.415	3.093	2002	0.927	0.046	3.191	0.975
1998	M-35, Delta County	21031	I	1.415	3.093	2004	4.424	0.295	8.841	2.834
1998	M-35, Delta County	21031	I	8.700	10.431	2000	0.340	0.000	1.200	0.423
1998	M-35, Delta County	21031	I	8.700	10.431	2002	0.196	0.018	1.195	0.329
1998	M-35, Delta County	21031	I	8.700	10.431	2004	4.234	0.942	6.866	1.846
1998	I-69 EB/WB, Genesee County	25042	I	0.040	5.932	1999	0.093	0.000	2.040	0.371

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1998	I-69 EB/WB, Genesee County	25042	I	0.040	5.932	2001	0.265	0.000	7.178	0.986
1998	I-69 EB/WB, Genesee County	25042	I	0.040	5.932	2003	11.418	4.000	39.110	6.513
1998	I-69 EB/WB, Genesee County	25042	D	0.040	5.932	1999	0.017	0.000	0.560	0.090
1998	I-69 EB/WB, Genesee County	25042	D	0.040	5.932	2001	0.145	0.000	2.040	0.362
1998	I-69 EB/WB, Genesee County	25042	D	0.040	5.932	2003	17.104	8.000	157.837	19.281
1998	M-60 EB/WB, Jackson County	38061	I	12.650	16.045	2002	4.757	0.000	9.680	3.241
1998	M-15, Genesee County	25092	I	9.501	10.409	2001	1.984	0.000	7.210	2.829
1998	M-15, Genesee County	25092	I	9.501	10.409	2002	1.513	0.000	5.100	2.193
1998	M-15, Genesee County	25092	I	9.501	10.409	2004	10.395	3.440	27.630	8.406
1998	USH 10, Osceola County	67021	D	1.935	2.625	1999	0.000	0.000	0.000	0.000
1998	USH 10, Osceola County	67021	I	1.935	2.625	2001	0.037	0.000	0.164	0.072
1998	USH 10, Osceola County	67021	I	1.935	2.625	2003	3.914	1.400	9.690	3.382
1998	USH 10, Osceola County	67022	D	0.000	1.523	1999	0.154	0.000	2.160	0.577
1998	USH 10, Osceola County	67022	I	0.000	1.523	2001	0.032	0.000	0.062	0.021
1998	USH 10, Osceola County	67022	I	0.000	1.523	2003	2.732	1.600	4.120	0.769
1999	M-18, Gladwin County	26011	I	4.860	12.000	2001	4.357	0.000	124.260	19.812

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1999	M-18, Gladwin County	26011	I	4.860	12.000	2002	0.195	0.000	5.080	0.653
1999	M-18, Gladwin County	26011	I	4.860	12.000	2004	21.539	1.060	337.360	39.842
1999	USH 10, Osceola County	67022	I	9.657	12.087	2001	0.008	0.000	0.172	0.036
1999	USH 10, Osceola County	67022	I	9.657	12.087	2003	3.379	0.780	6.840	1.789
1999	USH 31, Antrim County	5011	I	0.929	1.375	2001	0.013	0.000	0.040	0.023
1999	USH 31, Antrim County	5011	I	0.929	1.375	2003	0.450	0.280	0.600	0.154
1999	USH 31, Antrim County	5011	I	1.531	2.732	2001	0.095	0.000	0.800	0.245
1999	USH 31, Antrim County	5011	I	1.531	2.732	2003	2.543	0.280	7.280	2.294
1999	USH 31, Benzie County	10032	I	11.430	14.340	2003	2.191	0.000	5.480	1.658
1999	M-21, Genesee County	25081	I	4.981	7.285	2001	0.125	0.000	0.920	0.243
1999	M-21, Genesee County	25081	I	4.981	7.285	2002	0.000	0.000	0.000	0.000
1999	M-50, Monroe County	58042	I	0.139	4.525	2001	0.054	0.000	0.640	0.173
1999	M-50, Monroe County	58042	I	0.139	4.525	2002	0.062	0.000	1.760	0.273
1999	M-53, Lapeer County	44031	I	0.000	1.588	2001	0.265	0.000	1.720	0.551
1999	M-53, Lapeer County	44031	I	0.000	1.588	2002	0.048	0.000	0.560	0.148
1999	M-53, Lapeer County	44031	I	2.820	6.130	2001	0.481	0.000	3.290	0.915

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1999	M-53, Lapeer County	44031	I	2.820	6.130	2002	0.174	0.000	2.280	0.530
1999	M-53, Lapeer County	44031	I	6.466	6.940	2001	0.000	0.000	0.000	0.000
1999	M-53, Lapeer County	44031	I	6.466	6.940	2002	0.000	0.000	0.000	0.000
2000	USH 23, Iosco County	35032	I	19.120	22.007	2003	1.932	0.077	8.918	1.591
2000	USH 27 NB/SB, Isabella County	37011	I	0.200	0.460	2002	0.500	0.500	0.500	0.000
2000	USH 27 NB/SB, Isabella County	37011	I	0.200	0.460	2004	4.480	4.480	4.480	0.000
2000	USH 27 NB/SB, Isabella County	37013	I	8.407	8.958	2001	5.366	0.000	15.480	7.089
2000	USH 27 NB/SB, Isabella County	37013	D	8.503	8.958	2001	0.000	0.000	0.000	0.000
2000	USH 27 NB/SB, Isabella County	37013	D	8.503	8.958	2003	4.045	4.000	4.100	0.051
2000	USH 27 NB/SB, Isabella County	37014	I	0.070	0.640	2001	0.000	0.000	0.000	0.000
2000	USH 27 NB/SB, Isabella County	37014	I	0.070	0.640	2003	0.000	0.000	0.000	0.000
2000	USH 27 NB/SB, Isabella County	37014	I	0.790	1.340	2001	0.000	0.000	0.000	0.000
2000	USH 27 NB/SB, Isabella County	37014	I	0.790	1.340	2003	1.232	0.000	2.680	1.287
2000	USH 27 NB/SB, Isabella County	37014	D	0.070	0.610	2001	6.736	0.251	13.220	9.170
2000	USH 27 NB/SB, Isabella County	37014	D	0.760	1.200	2001	0.000	0.000	0.000	0.000
2001	I-75 NB/SB, Ogemaw County	65041	I	6.540	11.366	2003	0.153	0.000	4.000	0.682

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
2001	I-75 NB/SB, Ogemaw County	65041	D	6.619	11.274	2003	0.221	0.000	5.526	0.858
2001	M-50 EB/WB, Monroe County	58042	I	4.521	6.898	2002	0.009	0.000	0.100	0.029
2002	USH 31, Manistee County	51012	I	17.213	18.312	2003	0.020	0.000	0.100	0.042
2002	USH 31, Manistee County	51012	I	18.511	19.212	2003	0.000	0.000	0.000	0.000
2002	USH 31, Manistee County	51012	I	19.392	19.941	2003	0.170	0.000	0.680	0.340
2002	USH 31, Manistee County	51012	I	21.475	21.917	2003	0.000	0.000	0.000	0.000

APPENDIX D – RFB DISTRESS INDEX (DI) DATA

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1988	I-94 EB/WB, Calhoun County	13081	I	2.474	5.650	1993	61.915	12.620	117.370	32.185
1988	I-94 EB/WB, Calhoun County	13081	I	2.474	5.650	1995	18.475	9.560	43.183	7.946
1988	I-94 EB/WB, Calhoun County	13081	I	2.474	5.650	1997	61.665	26.060	133.480	23.575
1988	I-94 EB/WB, Calhoun County	13081	I	2.474	5.650	1999	44.701	14.690	107.590	22.543
1988	I-94 EB/WB, Calhoun County	13081	D	2.474	5.650	1993	7.968	4.000	16.180	3.225
1988	I-94 EB/WB, Calhoun County	13081	D	2.474	5.650	1995	9.919	6.100	14.648	1.840
1988	I-94 EB/WB, Calhoun County	13081	D	2.474	5.650	1997	12.952	9.500	20.980	3.105
1988	I-94 EB/WB, Calhoun County	13081	D	2.474	5.650	1999	4.847	2.440	9.410	1.680
1988	I-75 NB/SB, Cheboygan County	16092	I	13.186	15.218	1993	2.115	0.160	7.210	1.951
1988	I-75 NB/SB, Cheboygan County	16092	I	13.186	15.218	1995	20.925	8.280	38.990	8.068
1988	I-75 NB/SB, Cheboygan County	16092	I	13.186	15.218	1997	18.212	10.430	27.530	5.378
1988	I-75 NB/SB, Cheboygan County	16092	I	13.186	15.218	1999	12.136	5.640	22.830	4.412
1988	I-75 NB/SB, Cheboygan County	16092	I	13.186	15.218	2001	33.704	15.610	60.360	12.189
1988	I-75 NB/SB, Cheboygan County	16092	I	13.186	15.218	2003	31.791	15.800	51.640	9.926
1988	I-75 NB/SB, Cheboygan County	16092	D	13.186	15.218	1993	6.403	1.800	11.060	2.611

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1988	I-75 NB/SB, Cheboygan County	16092	D	13.186	15.218	1995	16.290	8.490	23.230	4.668
1988	I-75 NB/SB, Cheboygan County	16092	D	13.186	15.218	1997	32.452	14.530	50.082	11.108
1988	I-75 NB/SB, Cheboygan County	16092	D	13.186	15.218	1999	22.339	10.350	36.050	7.356
1988	I-75 NB/SB, Cheboygan County	16092	D	13.186	15.218	2001	19.742	8.988	29.856	6.185
1988	I-75 NB/SB, Cheboygan County	16092	D	13.186	15.218	2003	65.278	10.391	700.210	150.186
1989	M28, Brimley, Chippewa County	17062	I	18.686	22.289	1992	1.251	0.000	12.056	2.360
1989	M28, Brimley, Chippewa County	17062	I	18.686	22.289	1993	3.681	0.260	16.200	3.726
1989	M28, Brimley, Chippewa County	17062	I	18.686	22.289	1995	20.595	3.200	51.080	9.514
1989	M28, Brimley, Chippewa County	17062	I	18.686	22.289	1997	26.816	2.880	48.320	11.893
1989	M28, Brimley, Chippewa County	17062	I	18.686	22.289	1999	28.063	7.780	45.380	9.258
1989	M-66 NB/SB, Ionia County	34031	I	7.200	7.512	1992	0.311	0.311	0.311	0.000
1989	M-66 NB/SB, Ionia County	34031	I	7.200	7.512	1994	117.000	117.000	117.000	0.000
1989	M-66 NB/SB, Ionia County	34031	I	7.200	7.512	1996	21.444	21.444	21.444	0.000
1989	M-66 NB/SB, Ionia County	34031	I	7.200	7.512	1998	36.122	34.574	37.670	2.189
1989	M-66 NB/SB, Ionia County	34031	I	7.200	7.512	2002	57.410	34.891	79.929	31.847
1989	M-66 NB/SB, Ionia County	34032	I	0.000	0.446	1992	5.938	4.000	9.310	2.500

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1989	M-66 NB/SB, Ionia County	34032	I	0.000	0.446	1994	18.313	12.880	26.970	7.578
1989	M-66 NB/SB, Ionia County	34032	I	0.000	0.446	1996	56.223	28.980	105.420	42.688
1989	M-66 NB/SB, Ionia County	34032	I	0.000	0.446	1998	178.378	66.780	337.210	117.777
1989	M-66 NB/SB, Ionia County	34032	I	0.000	0.446	2000	195.738	77.438	342.741	120.281
1989	M-66 NB/SB, Ionia County	34032	I	0.000	0.446	2002	158.354	52.063	302.575	113.321
1989	M-66 NB/SB, Ionia County	34032	I	0.000	0.446	2004	400.000	400.000	400.000	0.000
1989	M-66 NB/SB, Ionia County	34031	D	7.200	7.512	1992	1.140	0.620	1.660	0.735
1989	M-66 NB/SB, Ionia County	34031	D	7.200	7.512	1994	30.377	19.660	49.400	16.519
1989	M-66 NB/SB, Ionia County	34031	D	7.200	7.512	1996	41.383	31.320	61.000	16.990
1989	M-66 NB/SB, Ionia County	34031	D	7.200	7.512	1998	34.324	25.284	43.363	12.784
1989	M-66 NB/SB, Ionia County	34032	D	0.000	0.446	1992	4.090	3.320	4.640	0.687
1989	M-66 NB/SB, Ionia County	34032	D	0.000	0.446	1994	15.283	13.520	16.550	1.575
1989	M-66 NB/SB, Ionia County	34032	D	0.000	0.446	1996	25.590	22.990	28.290	2.651
1989	M-66 NB/SB, Ionia County	34032	D	0.000	0.446	1998	71.860	49.260	90.130	20.776
1989	US-10 EB / M-25 EB, Bay County	09101	I	0.924	7.356	1993	2.840	0.000	10.360	1.900
1989	US-10 EB / M-25 EB, Bay County	09101	I	0.924	7.356	1995	27.626	5.000	54.360	13.832

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1989	US-10 EB / M-25 EB, Bay County	09101	I	0.924	7.356	1997	31.575	14.650	74.360	11.671
1989	US-10 EB / M-25 EB, Bay County	09101	I	0.924	7.356	1999	34.598	12.020	183.300	26.838
1989	US-10 EB / M-25 EB, Bay County	09101	I	9.122	11.357	1993	1.483	0.000	3.920	1.043
1989	US-10 EB / M-25 EB, Bay County	09101	I	9.122	11.357	1995	11.151	6.520	18.920	3.422
1989	US-10 EB / M-25 EB, Bay County	09101	I	9.122	11.357	1997	21.711	10.500	38.200	5.755
1989	US-10 EB / M-25 EB, Bay County	09101	I	9.122	11.357	1999	21.262	12.300	39.280	6.657
1989	US-10 EB / M-25 EB, Bay County	09042	I	0.056	1.271	1994	7.644	5.000	11.600	2.174
1989	US-10 EB / M-25 EB, Bay County	09042	I	0.056	1.271	1996	12.834	9.850	15.900	2.169
1989	US-10 EB / M-25 EB, Bay County	09042	I	0.056	1.271	1998	19.209	13.690	25.200	3.858
1990	US-131 NB/SB, Kent County	41131	I	6.467	10.137	1993	4.244	0.320	8.880	1.978
1990	US-131 NB/SB, Kent County	41131	I	6.467	10.137	1995	5.026	0.840	9.480	2.236
1990	US-131 NB/SB, Kent County	41131	I	6.467	10.137	1997	11.970	5.800	19.610	3.614
1990	US-131 NB/SB, Kent County	41131	I	6.467	10.137	1999	8.940	1.480	18.090	3.818
1990	US-131 NB/SB, Kent County	41131	I	6.467	10.137	2001	14.728	6.699	23.481	4.213
1990	US-131 NB/SB, Kent County	41131	I	6.467	10.137	2003	6.023	2.000	15.183	3.371

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1990	US-131 NB/SB, Kent County	41131	D	6.467	10.321	1993	0.918	0.000	6.240	1.647
1990	US-131 NB/SB, Kent County	41131	D	6.467	10.321	1995	2.959	0.000	12.380	2.934
1990	US-131 NB/SB, Kent County	41131	D	6.467	10.321	1997	8.055	2.000	15.890	3.628
1990	US-131 NB/SB, Kent County	41131	D	6.467	10.321	1999	5.093	1.000	13.120	2.809
1990	US-131 NB/SB, Kent County	41131	D	6.467	10.321	2001	4.991	0.558	20.759	4.843
1990	US-131 NB/SB, Kent County	41131	D	6.467	10.321	2003	5.493	0.607	18.990	4.053
1990	M-27, Cheboygan County	16032	D	0.998	2.570	1992	0.000	0.000	0.000	0.000
1990	M-27, Cheboygan County	16032	I	0.998	2.570	1994	0.261	0.000	1.600	0.447
1990	M-27, Cheboygan County	16032	I	0.998	2.570	1996	5.859	2.000	11.550	2.610
1990	M-27, Cheboygan County	16032	I	0.998	2.570	1998	7.220	2.360	13.400	3.045
1990	M-27, Cheboygan County	16032	I	0.998	2.570	2002	16.544	4.082	50.425	15.642
1990	M-27, Cheboygan County	16032	D	9.309	9.579	1992	0.000	0.000	0.000	0.000
1990	M-27, Cheboygan County	16032	I	9.309	9.579	1994	0.450	0.400	0.500	0.071
1990	M-27, Cheboygan County	16032	I	9.309	9.579	1996	3.870	3.260	4.480	0.863
1990	M-27, Cheboygan County	16032	I	9.309	9.579	1998	2.725	1.480	3.970	1.761
1990	M-27, Cheboygan County	16032	I	9.309	9.579	2002	3.967	3.831	4.104	0.193

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1990	M-27, Cheboygan County	16032	D	9.664	11.375	1992	1.544	0.000	4.000	1.857
1990	M-27, Cheboygan County	16032	I	9.664	11.375	1994	2.448	1.060	3.940	0.801
1990	M-27, Cheboygan County	16032	I	9.664	11.375	1996	4.921	1.040	8.760	1.882
1990	M-27, Cheboygan County	16032	I	9.664	11.375	1998	5.494	1.520	9.100	1.879
1990	M-27, Cheboygan County	16032	I	9.664	11.375	2002	9.886	2.550	20.580	5.539
1990	I-75 SB, Crawford County	20014	D	0.000	3.730	1993	4.760	4.000	8.980	1.597
1990	I-75 SB, Crawford County	20014	D	0.000	3.730	1995	9.262	0.000	16.420	3.394
1990	I-75 SB, Crawford County	20014	D	0.000	3.730	1997	9.153	2.764	20.135	3.576
1990	I-75 SB, Crawford County	20014	D	0.000	3.730	1999	11.658	1.667	35.844	8.527
1990	M-68, Cheboygan County	16021	I	0.230	7.711	1992	5.371	0.000	91.270	15.518
1990	M-68, Cheboygan County	16021	I	0.230	7.711	1994	0.368	0.000	3.350	0.751
1990	M-68, Cheboygan County	16021	D	0.230	7.711	1996	1.914	0.000	7.850	2.097
1990	M-68, Cheboygan County	16021	D	0.230	7.711	1998	1.958	0.000	10.600	2.488
1990	M-68, Cheboygan County	16021	I	0.230	7.711	2000	39.774	0.834	375.170	58.662
1990	M-68, Cheboygan County	16021	I	0.230	7.711	2002	21.908	0.110	269.550	44.374
1992	M-37 NB/SB, Kent County	41033	I	2.477	7.917	1994	0.780	0.144	2.099	0.488

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1992	M-37 NB/SB, Kent County	41033	I	2.477	7.917	1996	2.769	0.130	9.017	1.617
1992	M-37 NB/SB, Kent County	41033	I	2.477	7.917	1998	3.318	1.280	11.990	1.695
1992	M-37 NB/SB, Kent County	41033	I	2.477	7.917	2000	24.915	12.218	69.120	9.761
1992	M-37 NB/SB, Kent County	41033	I	2.477	7.917	2002	18.040	1.294	94.452	16.341
1992	M-37 NB/SB, Kent County	41033	I	2.477	7.917	2004	19.466	6.155	77.545	15.631
1992	M-37 NB/SB, Kent County	41033	D	2.477	7.349	1994	1.094	0.050	7.132	1.255
1992	M-37 NB/SB, Kent County	41033	D	2.477	7.349	1996	1.863	0.048	6.842	1.490
1992	M-37 NB/SB, Kent County	41033	D	7.444	7.917	1994	0.377	0.123	0.550	0.190
1992	M-37 NB/SB, Kent County	41033	D	7.444	7.917	1996	1.365	0.147	2.329	0.924
1992	US-23 NB/SB, Livingston County	47013	I	5.494	6.951	1993	4.250	2.320	7.840	1.563
1992	US-23 NB/SB, Livingston County	47013	I	5.494	6.951	1995	3.464	0.320	7.740	2.501
1992	US-23 NB/SB, Livingston County	47013	I	5.494	6.951	1997	11.548	3.360	22.310	6.925
1992	US-23 NB/SB, Livingston County	47013	I	5.494	6.951	1999	14.295	8.120	31.050	7.049
1992	US-23 NB/SB, Livingston County	47013	I	5.494	6.951	2003	18.133	11.780	44.600	10.798
1992	US-23 NB/SB, Livingston County	47013	D	5.494	6.951	1993	0.319	0.000	2.475	0.819
1992	US-23 NB/SB, Livingston County	47013	D	5.494	6.951	1995	11.014	7.440	16.500	3.153
1992	US-23 NB/SB, Livingston County	47013	D	5.494	6.951	1997	16.732	7.640	25.620	6.234

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1992	US-23 NB/SB, Livingston County	47013	D	5.494	6.951	1999	5.264	1.560	19.039	5.390
1992	US-23 NB/SB, Livingston County	47013	D	5.494	6.951	2001	0.555	0.000	2.883	1.092
1992	US-23 NB/SB, Livingston County	47013	D	5.494	6.951	2003	8.740	5.930	13.066	2.495
1992	US-23 NB/SB, Livingston County	47014	I	0.000	7.165	1993	3.669	0.000	4.704	1.100
1992	US-23 NB/SB, Livingston County	47014	I	0.000	7.165	1995	9.007	0.400	50.170	7.246
1992	US-23 NB/SB, Livingston County	47014	I	0.000	7.165	1997	8.388	0.000	20.960	3.353
1992	US-23 NB/SB, Livingston County	47014	I	0.000	7.165	1999	4.959	0.000	29.630	4.673
1992	US-23 NB/SB, Livingston County	47014	D	0.000	7.165	1993	2.525	0.000	4.080	1.882
1992	US-23 NB/SB, Livingston County	47014	D	0.000	7.165	1995	5.119	0.000	20.560	4.429
1992	US-23 NB/SB, Livingston County	47014	D	0.000	7.165	1997	6.658	2.340	24.240	4.624
1992	US-23 NB/SB, Livingston County	47014	D	0.000	7.165	1999	2.225	0.000	15.920	2.902
1993	US-27 NB/SB, Isabella County	37013	I	8.958	11.664	1995	0.118	0.000	1.220	0.309
1993	US-27 NB/SB, Isabella County	37013	I	8.958	11.664	1997	8.663	4.280	12.340	1.627
1993	US-27 NB/SB, Isabella County	37013	D	9.007	11.382	1995	3.980	3.120	4.520	0.368
1993	US-27 NB/SB, Isabella County	37013	D	9.007	11.382	1997	10.502	4.900	16.480	3.012
1993	US-27 NB/SB, Isabella County	37013	D	11.476	11.712	1995	6.170	6.040	6.300	0.184
1993	US-27 NB/SB, Isabella County	37013	D	11.476	11.712	1997	13.415	12.330	14.500	1.534

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1993	US-131 NB/SB, Allegan County	03112	I	3.065	8.557	1995	2.799	0.160	4.170	1.199
1993	US-131 NB/SB, Allegan County	03112	I	3.065	8.557	1997	4.227	0.000	9.120	2.607
1993	US-131 NB/SB, Allegan County	03112	I	3.065	8.557	1999	2.983	0.080	8.620	1.784
1993	US-131 NB/SB, Allegan County	03112	D	3.065	3.521	1995	0.000	0.000	0.000	0.000
1993	US-131 NB/SB, Allegan County	03112	D	3.065	3.521	1997	0.080	0.000	0.240	0.139
1993	US-131 NB/SB, Allegan County	03112	D	3.065	3.521	1999	4.027	2.880	4.880	1.032
1993	US-131 NB/SB, Allegan County	03112	D	3.762	8.557	1995	1.166	0.000	8.000	2.077
1993	US-131 NB/SB, Allegan County	03112	D	3.762	8.557	1997	2.511	0.000	10.660	2.540
1993	US-131 NB/SB, Allegan County	03112	D	3.762	8.557	1999	3.381	0.000	10.560	2.753
1993	I-96 EB/WB, Ingham County	33084	I	8.979	17.491	1995	5.220	0.840	15.280	2.870
1993	I-96 EB/WB, Ingham County	33084	I	8.979	17.491	1997	13.310	2.400	37.000	7.268
1993	I-96 EB/WB, Ingham County	33084	I	8.979	17.491	1999	6.719	0.000	28.070	5.682
1993	I-96 EB/WB, Ingham County	33084	I	8.979	17.491	2003	227.419	12.050	400.000	170.704
1993	I-96 EB/WB, Ingham County	33084	D	8.854	17.495	1995	0.564	0.000	4.500	0.910
1993	I-96 EB/WB, Ingham County	33084	D	8.854	17.495	1997	5.083	0.000	18.820	3.288
1993	I-96 EB/WB, Ingham County	33084	D	8.854	17.495	1999	6.613	0.000	16.339	4.621
1993	I-96 EB/WB, Ingham County	33084	D	8.854	17.495	2001	1.287	0.000	9.613	2.535

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1993	I-96 EB/WB, Ingham County	33084	D	8.854	17.495	2003	2.483	0.000	10.760	2.496
1993	I-194/M-66 NB/SB, Calhoun County	13033	I	0.492	1.679	1995	1.438	0.400	2.400	0.729
1993	I-194/M-66 NB/SB, Calhoun County	13033	I	0.492	1.679	1997	19.516	9.500	29.070	5.546
1993	I-194/M-66 NB/SB, Calhoun County	13033	I	0.492	1.679	1999	14.863	7.600	22.070	4.314
1993	I-194/M-66 NB/SB, Calhoun County	13033	D	0.492	1.679	1995	0.491	0.000	1.760	0.558
1993	I-194/M-66 NB/SB, Calhoun County	13033	D	0.492	1.679	1997	12.805	9.320	20.240	3.994
1993	I-194/M-66 NB/SB, Calhoun County	13033	D	0.492	1.679	1999	15.762	9.700	28.140	6.064
1993	M-44 EB/WB, Kent County	41013	I	0.699	2.669	1994	2.789	0.000	4.581	1.850
1993	M-44 EB/WB, Kent County	41013	I	0.699	2.669	1996	9.309	0.800	30.545	10.561
1993	M-44 EB/WB, Kent County	41013	I	0.699	2.669	1998	1.022	0.000	3.520	1.153
1993	M-44 EB/WB, Kent County	41013	I	0.699	2.669	2000	6.913	0.920	14.670	4.032
1993	M-44 EB/WB, Kent County	41013	D	0.699	2.669	1994	1.074	0.000	4.000	1.495
1993	M-44 EB/WB, Kent County	41013	D	0.699	2.669	1996	0.467	0.000	4.200	1.027
1993	M-44 EB/WB, Kent County	41013	D	0.699	2.669	1998	0.877	0.000	3.200	0.948
1994	I-96 EB/WB, Ingham	33083	I	2.105	3.689	1995	0.023	0.000	0.321	0.086
1994	I-96 EB/WB, Ingham	33083	I	2.105	3.689	1997	0.370	0.000	2.760	0.771
1994	I-96 EB/WB, Ingham	33083	I	2.105	3.689	1999	4.222	0.000	8.500	3.699

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1994	I-96 EB/WB, Ingham	33083	I	2.105	3.689	2001	2.023	0.000	5.071	1.926
1994	I-96 EB/WB, Ingham	33083	I	2.105	3.689	2003	11.606	0.634	28.662	8.550
1994	I-96 EB/WB, Ingham	33084	I	0.000	1.070	1995	0.044	0.000	0.400	0.133
1994	I-96 EB/WB, Ingham	33084	I	0.000	1.070	1997	0.218	0.000	1.140	0.359
1994	I-96 EB/WB, Ingham	33084	I	0.000	1.070	1999	4.396	0.000	8.000	2.985
1994	I-96 EB/WB, Ingham	33084	I	0.000	1.070	2003	8.872	1.676	21.115	6.506
1995	I-96 EB/WB, Ingham	33083	D	2.375	3.689	1997	4.463	0.000	50.000	13.698
1995	I-96 EB/WB, Ingham	33083	D	2.375	3.689	1999	0.218	0.000	1.930	0.574
1995	I-96 EB/WB, Ingham	33083	D	2.375	3.689	2001	0.749	0.000	3.640	1.231
1995	I-96 EB/WB, Ingham	33083	D	2.375	3.689	2003	13.819	0.030	36.991	9.621
1995	I-96 EB/WB, Ingham	33084	D	0.000	0.662	1997	1.684	0.540	3.000	0.941
1995	I-96 EB/WB, Ingham	33084	D	0.000	0.662	1999	0.000	0.000	0.000	0.000
1995	I-96 EB/WB, Ingham	33084	D	0.000	0.662	2001	1.859	0.100	4.064	1.890
1995	I-96 EB/WB, Ingham	33084	D	0.000	0.662	2003	2.323	0.429	7.629	2.761
1994	M-15, Genesee County	25092	D	8.610	8.904	1996	0.731	0.731	0.731	0.000
1994	M-15, Genesee County	25092	D	8.610	8.904	1998	5.034	5.034	5.034	0.000
1994	M-15, Genesee County	25092	I	8.610	8.904	2001	16.179	16.179	16.179	0.000

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1994	M-20 WB, Midland County	56021	D	6.053	10.589	1996	0.031	0.000	0.615	0.119
1995	M-53, Sanilac County	74012	I	9.000	13.000	1996	0.160	0.000	3.840	0.640
1995	M-53, Sanilac County	74012	I	9.000	13.000	1998	1.020	0.000	4.728	1.327
1995	M-53, Sanilac County	74012	I	9.000	13.000	2001	8.059	0.260	40.973	8.464
1995	M-53, Sanilac County	74012	I	9.000	13.000	2002	21.420	0.057	273.888	51.920
1995	M-37 NB/SB, Kent County	41033	I	7.925	10.610	1996	2.381	2.381	2.381	0.000
1995	M-37 NB/SB, Kent County	41033	I	7.925	10.610	1998	5.009	5.009	5.009	0.000
1995	M-37 NB/SB, Kent County	41033	I	7.925	10.610	2000	339.776	107.411	400.000	88.631
1995	M-37 NB/SB, Kent County	41033	I	10.762	15.815	2000	231.667	30.385	400.000	145.911
1995	M-37 NB/SB, Kent County	41033	D	7.965	10.606	1996	0.306	0.000	1.760	0.411
1995	M-37 NB/SB, Kent County	41033	D	10.758	15.815	1996	0.182	0.000	3.500	0.515
1996	US-23, Alcona County	01052	I	0.491	2.470	1997	1.316	0.000	4.240	1.252
1996	US-23, Alcona County	01052	I	0.491	2.470	1999	2.606	0.100	9.230	2.440
1996	I-196 EB, Ottawa County	70024	I	12.589	15.591	1999	0.036	0.000	0.500	0.131
1996	I-196 EB, Ottawa County	70024	I	12.589	15.591	2001	0.929	0.000	7.360	2.071
1996	I-196 EB, Ottawa County	70024	I	12.589	15.591	2003	1.141	0.000	6.480	1.825
1997	US-131 NB/SB, Allegan County	03111	I	6.728	7.959	1999	3.240	0.240	5.520	1.511

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1997	US-131 NB/SB, Allegan County	03111	I	6.728	7.959	2001	0.003	0.000	0.021	0.007
1997	US-131 NB/SB, Allegan County	03111	I	6.728	7.959	2003	4.309	0.016	6.660	2.070
1997	US-131 NB/SB, Allegan County	03111	D	6.728	7.959	1999	0.007	0.000	0.080	0.024
1997	US-131 NB/SB, Allegan County	03111	D	6.728	7.959	2001	0.000	0.000	0.000	0.000
1997	US-131 NB/SB, Allegan County	03111	D	6.728	7.959	2003	0.835	0.000	3.620	1.147
1997	US-131 NB/SB, Allegan County	03112	I	0.015	1.941	1999	0.009	0.000	0.160	0.039
1997	US-131 NB/SB, Allegan County	03112	I	0.015	1.941	2001	0.056	0.000	0.516	0.151
1997	US-131 NB/SB, Allegan County	03112	I	0.015	1.941	2003	3.801	1.140	8.960	2.052
1997	US-131 NB/SB, Allegan County	03112	I	2.076	3.102	1999	0.000	0.000	0.000	0.000
1997	US-131 NB/SB, Allegan County	03112	I	2.076	3.102	2001	0.000	0.000	0.000	0.000
1997	US-131 NB/SB, Allegan County	03112	I	2.076	3.102	2003	1.664	0.500	3.000	0.821
1997	US-131 NB/SB, Allegan County	03112	D	0.015	0.893	1999	0.000	0.000	0.000	0.000
1997	US-131 NB/SB, Allegan County	03112	D	0.015	0.893	2001	0.014	0.000	0.050	0.023
1997	US-131 NB/SB, Allegan County	03112	D	0.015	0.893	2003	1.792	0.050	6.080	2.067
1997	US-131 NB/SB, Allegan County	03112	D	1.184	1.941	1999	0.267	0.000	0.960	0.349
1997	US-131 NB/SB, Allegan County	03112	D	1.184	1.941	2001	0.000	0.000	0.000	0.000
1997	US-131 NB/SB, Allegan County	03112	D	1.184	1.941	2003	1.700	0.000	4.000	1.462

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1997	US-131 NB/SB, Allegan County	03112	D	2.076	3.102	1999	0.304	0.000	1.760	0.567
1997	US-131 NB/SB, Allegan County	03112	D	2.076	3.102	2001	0.000	0.000	0.000	0.000
1997	US-131 NB/SB, Allegan County	03112	D	2.076	3.102	2003	2.656	0.160	5.300	1.569
1997	I-196 EB, Ottawa County	70024	I	6.581	10.575	1999	2.910	0.000	8.000	3.750
1997	I-196 EB, Ottawa County	70024	I	6.581	10.575	2001	10.014	0.000	19.240	4.153
1997	I-196 EB, Ottawa County	70024	I	6.581	10.575	2003	5.131	0.320	14.320	3.288
1997	I-194/M-66 NB/SB, Calhoun County	13033	I	0.057	0.492	1999	3.635	2.880	5.320	1.142
1997	I-194/M-66 NB/SB, Calhoun County	13033	I	0.057	0.492	2003	10.333	8.780	13.420	2.673
1997	I-194/M-66 NB/SB, Calhoun County	13033	D	0.022	0.492	1999	5.767	3.380	9.460	3.244
1997	I-194/M-66 NB/SB, Calhoun County	13033	D	0.022	0.492	2001	1.800	1.800	1.800	0.000
1997	I-194/M-66 NB/SB, Calhoun County	13033	D	0.022	0.492	2003	12.000	7.920	15.720	3.912
1997	US-31 NB, Ottawa County	70013	I	1.233	8.278	1999	0.043	0.000	0.880	0.159
1997	US-31 NB, Ottawa County	70013	I	1.233	8.278	2003	4.211	0.360	15.530	2.800
1997	US-31 NB, Ottawa County	70013	I	8.933	13.013	1999	0.000	0.000	0.000	0.000
1997	US-31 NB, Ottawa County	70013	I	8.933	13.013	2003	3.311	0.600	9.240	1.734
1997	US-27 NB/SB, Isabella County	37014	I	7.150	14.426	1999	0.023	0.000	0.580	0.090
1997	US-27 NB/SB, Isabella County	37014	I	7.150	14.426	2001	6.262	1.520	11.160	2.218

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1997	US-27 NB/SB, Isabella County	37014	I	7.150	14.426	2003	10.005	0.570	28.750	5.521
1997	US-27 NB/SB, Isabella County	37014	D	7.206	14.509	1999	0.000	0.000	0.000	0.000
1997	US-27 NB/SB, Isabella County	37014	D	7.206	14.509	2001	2.884	0.000	8.760	2.784
1998	US-27 NB/SB, Isabella County	37014	I	1.540	7.011	1999	0.015	0.000	0.660	0.093
1998	US-27 NB/SB, Isabella County	37014	I	1.540	7.011	2001	0.760	0.000	6.540	1.270
1998	US-27 NB/SB, Isabella County	37014	I	1.540	7.011	2003	6.480	0.609	30.084	6.555
1998	US-27 NB/SB, Isabella County	37014	D	1.569	7.135	1999	0.054	0.000	2.880	0.396
1998	US-27 NB/SB, Isabella County	37014	D	1.569	7.135	2001	0.265	0.000	2.980	0.491
1998	M-25, Sanilac County	74073	I	0.483	4.937	2001	0.035	0.000	0.400	0.083
1998	M-25, Sanilac County	74073	I	0.483	4.937	2002	0.035	0.000	0.500	0.110
1998	M-25, Sanilac County	74073	I	0.483	4.937	2004	13.715	0.100	62.220	13.037
1998	I-96 & I-296 EB/WB, Kent County	41026	I	4.725	5.639	1999	0.063	0.000	0.500	0.177
1998	I-96 & I-296 EB/WB, Kent County	41026	I	4.725	5.639	2001	0.013	0.000	0.100	0.035
1998	I-96 & I-296 EB/WB, Kent County	41026	I	4.725	5.639	2003	1.566	0.000	4.000	1.148
1998	I-96 & I-296 EB/WB, Kent County	41026	I	5.865	6.096	1999	0.000	0.000	0.000	0.000

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1998	I-96 & I-296 EB/WB, Kent County	41026	I	5.865	6.096	2003	2.720	2.720	2.720	0.000
1998	I-96 & I-296 EB/WB, Kent County	41026	D	4.760	5.199	1999	0.000	0.000	0.000	0.000
1998	I-96 & I-296 EB/WB, Kent County	41026	D	4.760	5.199	2001	1.113	0.000	3.340	1.928
1998	I-96 & I-296 EB/WB, Kent County	41026	D	4.760	5.199	2003	0.000	0.000	0.000	0.000
1998	I-96 & I-296 EB/WB, Kent County	41026	D	5.511	6.068	1999	0.000	0.000	0.000	0.000
1998	I-96 & I-296 EB/WB, Kent County	41026	D	5.511	6.068	2001	0.188	0.000	0.940	0.420
1998	I-96 & I-296 EB/WB, Kent County	41026	D	5.511	6.068	2003	0.270	0.000	0.500	0.228
1998	I-96 & I-296 EB/WB, Kent County	41131	D	17.357	17.881	1999	0.000	0.000	0.000	0.000
1998	I-96 & I-296 EB/WB, Kent County	41131	D	17.357	17.881	2001	12.271	0.000	36.813	21.254
1998	I-96 & I-296 EB/WB, Kent County	41131	D	17.357	17.881	2003	11.413	0.000	34.000	19.561
1998	I-96 & I-296 EB/WB, Kent County	41131	I	17.586	17.761	2001	2.640	2.640	2.640	0.000
1998	I-196 EB/WB, Kent County	41029	I	1.135	6.653	1999	1.000	0.000	6.240	1.138

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1998	I-196 EB/WB, Kent County	41029	I	1.135	6.653	2003	2.131	0.000	4.840	1.226
1998	I-196 EB/WB, Kent County	41029	D	1.115	6.659	1999	0.661	0.000	2.880	0.643
1998	I-196 EB/WB, Kent County	41029	D	1.115	6.659	2001	1.402	0.000	10.040	2.466
1998	I-196 EB/WB, Kent County	41029	D	1.115	6.659	2003	1.708	0.000	7.060	1.920
1999	US-23, Alpena County	01052	I	16.369	16.393	2003	0.364	0.364	0.364	0.000
1999	US-23, Alpena County	04031	I	0.000	0.241	2001	0.000	0.000	0.000	0.000
1999	US-23, Alpena County	04031	I	0.000	0.241	2003	0.000	0.000	0.000	0.000
1999	US-23, Alpena County	04031	I	0.449	0.908	2001	0.070	0.000	0.160	0.082
1999	US-23, Alpena County	04031	I	0.449	0.908	2003	2.170	0.000	4.480	1.831
1999	US-23, Alpena County	04031	I	1.404	2.248	2001	0.000	0.000	0.000	0.000
1999	US-23, Alpena County	04031	I	1.404	2.248	2003	1.909	0.600	3.840	1.120
1999	US-23, Alpena County	04031	I	4.218	7.893	2001	0.244	0.000	8.550	1.445
1999	US-23, Alpena County	04031	I	4.218	7.893	2003	5.219	0.360	11.380	3.101
1999	US-131 NB/SB, Kent & Montcalm Counties	41133	I	3.200	8.691	2003	4.777	1.160	9.920	2.034
1999	US-131 NB/SB, Kent & Montcalm Counties	41133	D	3.205	8.691	2001	1.523	0.000	4.960	1.418

Year Rubblized	Location	Control Section	Direction (Increasing/Decreasing)	POB Milepost	POE Milepost	Test Year	Avg DI	Min DI	Max DI	StDev of DI
1999	US-131 NB/SB, Kent & Montcalm Counties	41133	D	3.205	8.691	2003	1.069	0.000	4.704	1.304
1999	US-131 NB/SB, Kent & Montcalm Counties	59012	I	0.000	4.214	2003	6.545	3.760	16.000	2.587
1999	US-131 NB/SB, Kent & Montcalm Counties	59012	D	0.000	4.233	2001	0.245	0.000	3.120	0.567
1999	US-131 NB/SB, Kent & Montcalm Counties	59012	D	0.000	4.233	2003	2.717	0.160	7.691	1.545
2000	M-37/M-46, Kent & Muskegon Counties	41033	I	15.738	17.120	2002	0.008	0.000	0.100	0.029
2000	M-37/M-46, Kent & Muskegon Counties	41033	I	15.738	17.120	2004	0.020	0.000	0.120	0.047
2000	M-37/M-46, Kent & Muskegon Counties	61171	I	0.000	0.571	2002	0.208	0.000	1.040	0.465
2000	M-37/M-46, Kent & Muskegon Counties	61171	I	0.000	0.571	2004	0.000	0.000	0.000	0.000

APPENDIX E – MHB RIDE QUALITY INDEX (RQI) DATA

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average RQI	Min RQI	Max RQI	StDev
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	1998	23.831	14.000	51.000	7.486
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	1999	22.283	13.000	53.000	8.076
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	2001	34.733	23.000	58.000	6.749
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	2003	29.000	19.000	51.000	5.957
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	2005	34.050	30.000	49.000	3.422
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	1998	20.328	14.000	31.000	3.958
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	1999	18.017	11.000	30.000	4.766
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	2001	34.448	27.000	52.000	4.960
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	2003	27.448	19.000	36.000	3.584
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	2005	32.224	27.000	35.000	1.947
46082	1997	M-50, Lenawee County	I	0.113	1.824	1998	30.313	25.000	47.000	5.689
46082	1997	M-50, Lenawee County	I	0.113	1.824	2000	43.875	37.000	53.000	5.097
46082	1997	M-50, Lenawee County	I	0.113	1.824	2002	30.625	24.000	38.000	3.344
46082	1997	M-50, Lenawee County	I	0.113	1.824	2004	36.250	32.000	67.000	8.274
46082	1997	M-50, Lenawee County	I	3.942	4.366	1998	40.667	31.000	58.000	15.044
46082	1997	M-50, Lenawee County	I	3.942	4.366	2000	56.667	55.000	59.000	2.082
46082	1997	M-50, Lenawee County	I	3.942	4.366	2002	41.667	37.000	49.000	6.429
46082	1997	M-50, Lenawee County	I	3.942	4.366	2004	46.333	38.000	57.000	9.713

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average RQI	Min RQI	Max RQI	StDev
46082	1997	M-50, Lenawee County	I	4.593	7.134	1998	22.960	13.000	36.000	5.842
46082	1997	M-50, Lenawee County	I	4.593	7.134	2000	44.080	31.000	76.000	8.650
46082	1997	M-50, Lenawee County	I	4.593	7.134	2002	31.760	21.000	64.000	8.363
46082	1997	M-50, Lenawee County	I	4.593	7.134	2004	35.652	30.000	58.000	5.271
46082	1998	M-50, Lenawee County	I	9.576	12.375	2000	41.704	30.000	68.000	8.516
46082	1998	M-50, Lenawee County	I	9.576	12.375	2002	29.000	20.000	68.000	9.089
46082	1998	M-50, Lenawee County	I	9.576	12.375	2004	32.808	25.000	47.000	4.345
58041	1998	M-50, Lenawee County	I	0.000	5.021	2000	45.880	38.000	63.000	5.550
58041	1998	M-50, Lenawee County	I	0.000	5.021	2002	34.360	25.000	53.000	6.712
58041	1998	M-50, Lenawee County	I	0.000	5.021	2004	36.224	32.000	61.000	4.579
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	1999	28.286	17.000	79.000	18.382
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	2001	44.000	31.000	101.00	16.834
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	2003	31.429	21.000	82.000	15.401
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	2005	34.833	31.000	55.000	6.603
58171	1997	I-275 NB/SB, Monroe County	D	0.000	1.975	1999	30.316	14.000	71.000	13.404
58171	1997	I-275 NB/SB, Monroe County	D	0.000	1.975	2003	33.526	22.000	73.000	14.721
58171	1997	I-275 NB/SB, Monroe County	D	0.000	1.975	2005	37.000	30.000	68.000	10.344
21031	1998	M-35, Delta County	I	1.415	3.093	2000	46.133	31.000	68.000	9.826
21031	1998	M-35, Delta County	I	1.415	3.093	2002	34.000	26.000	63.000	8.594
21031	1998	M-35, Delta County	I	1.415	3.093	2004	35.357	33.000	49.000	4.012
21031	1998	M-35, Delta County	I	8.700	10.431	2000	51.529	33.000	59.000	6.453
21031	1998	M-35, Delta County	I	8.700	10.431	2002	39.588	30.000	44.000	3.483
21031	1998	M-35, Delta County	I	8.700	10.431	2004	39.941	34.000	47.000	3.344

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average RQI	Min RQI	Max RQI	StDev
25042	1998	I-69 EB/WB, Genesee County	I	0.040	5.932	1999	27.000	21.000	35.000	3.770
25042	1998	I-69 EB/WB, Genesee County	I	0.040	5.932	2001	35.655	29.000	45.000	3.572
25042	1998	I-69 EB/WB, Genesee County	I	0.040	5.932	2005	34.793	32.000	72.000	5.122
25042	1998	I-69 EB/WB, Genesee County	D	0.040	5.932	1999	25.828	19.000	32.000	3.101
25042	1998	I-69 EB/WB, Genesee County	D	0.040	5.932	2001	35.379	27.000	89.000	7.929
25042	1998	I-69 EB/WB, Genesee County	D	0.040	5.932	2005	34.517	32.000	39.000	1.525
38061	1998	M-60 EB/WB, Jackson County	I	12.65	16.045	2002	30.029	5.000	85.000	13.971
38061	1998	M-60 EB/WB, Jackson County	I	12.65	16.045	2004	35.935	29.000	82.000	10.178
25092	1998	M-15, Genesee County	I	9.501	10.409	2000	44.750	38.000	54.000	5.922
25092	1998	M-15, Genesee County	I	9.501	10.409	2002	39.000	31.000	48.000	5.264
25092	1998	M-15, Genesee County	I	9.501	10.409	2004	38.500	34.000	46.000	4.000
67021	1998	USH 10, Osceola County	D	1.935	2.625	1999	40.200	30.000	53.000	9.602
67021	1998	USH 10, Osceola County	I	1.935	2.625	2001	38.000	5.000	63.000	25.985
67021	1998	USH 10, Osceola County	I	1.935	2.625	2003	38.500	29.000	60.000	11.675
67021	1998	USH 10, Osceola County	I	1.935	2.625	2005	41.200	35.000	64.000	12.755
67022	1998	USH 10, Osceola County	D	0.000	1.523	1999	36.500	22.000	52.000	10.639
67022	1998	USH 10, Osceola County	I	0.000	1.523	2001	33.733	23.000	43.000	5.509
67022	1998	USH 10, Osceola County	I	0.000	1.523	2003	29.133	22.000	40.000	5.041
67022	1998	USH 10, Osceola County	I	0.000	1.523	2005	34.133	31.000	38.000	1.767
26011	1999	M-18, Gladwin County	I	4.860	12.000	2000	39.648	27.000	128.00	19.258
26011	1999	M-18, Gladwin County	I	4.860	12.000	2002	26.729	14.000	59.000	8.339
26011	1999	M-18, Gladwin County	I	4.860	12.000	2004	32.871	24.000	76.000	7.219

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average RQI	Min RQI	Max RQI	StDev
67022	1999	USH 10, Osceola County	I	9.657	12.087	2001	33.435	22.000	48.000	6.808
67022	1999	USH 10, Osceola County	I	9.657	12.087	2003	25.478	18.000	35.000	4.491
67022	1999	USH 10, Osceola County	I	9.657	12.087	2005	32.609	29.000	36.000	1.971
5011	1999	USH 31, Antrim County	I	0.929	1.375	2001	38.333	36.000	42.000	3.215
5011	1999	USH 31, Antrim County	I	0.929	1.375	2003	33.000	30.000	38.000	4.359
5011	1999	USH 31, Antrim County	I	0.929	1.375	2005	37.667	33.000	43.000	5.033
5011	1999	USH 31, Antrim County	I	1.531	2.732	2001	49.364	40.000	62.000	7.103
5011	1999	USH 31, Antrim County	I	1.531	2.732	2003	37.818	31.000	53.000	6.030
5011	1999	USH 31, Antrim County	I	1.531	2.732	2005	41.364	33.000	50.000	5.221
10032	1999	USH 31, Benzie County	D	11.430	14.340	2001	48.750	33.000	71.000	10.039
10032	1999	USH 31, Benzie County	I	11.430	14.340	2003	31.857	23.000	55.000	7.957
10032	1999	USH 31, Benzie County	I	11.430	14.340	2005	36.321	31.000	47.000	4.587
25081	1999	M-21, Genesee County	I	4.981	7.285	2000	47.364	37.000	65.000	6.980
25081	1999	M-21, Genesee County	I	4.981	7.285	2002	38.500	31.000	63.000	7.209
25081	1999	M-21, Genesee County	I	4.981	7.285	2004	38.682	32.000	51.000	5.149
58042	1999	M-50, Monroe County	I	0.139	4.525	2000	34.860	30.000	41.000	3.052
58042	1999	M-50, Monroe County	I	0.139	4.525	2002	24.395	17.000	32.000	3.749
58042	1999	M-50, Monroe County	I	0.139	4.525	2004	31.186	26.000	40.000	2.471
44031	1999	M-53, Lapeer County	I	0.000	1.588	2000	41.733	32.000	55.000	7.648
44031	1999	M-53, Lapeer County	I	0.000	1.588	2002	36.000	23.000	49.000	7.973
44031	1999	M-53, Lapeer County	I	0.000	1.588	2004	38.733	32.000	51.000	5.496

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average RQI	Min RQI	Max RQI	StDev
44031	1999	M-53, Lapeer County	I	2.820	6.130	2000	38.719	26.000	69.000	10.973
44031	1999	M-53, Lapeer County	I	2.820	6.130	2002	26.750	12.000	63.000	13.038
44031	1999	M-53, Lapeer County	I	2.820	6.130	2004	32.844	24.000	60.000	8.919
44031	1999	M-53, Lapeer County	I	6.466	6.940	2000	32.750	28.000	39.000	4.856
44031	1999	M-53, Lapeer County	I	6.466	6.940	2002	19.750	15.000	27.000	5.500
44031	1999	M-53, Lapeer County	I	6.466	6.940	2004	28.250	26.000	31.000	2.217
35032	2000	USH 23, Iosco County	I	19.120	22.007	2001	24.069	13.000	66.000	9.138
35032	2000	USH 23, Iosco County	I	19.120	22.007	2003	22.000	12.000	55.000	8.452
35032	2000	USH 23, Iosco County	I	19.120	22.007	2005	29.414	24.000	53.000	5.389
37011	2000	USH 27 NB/SB, Isabella County	I	0.200	0.460	2002	31.000	30.000	32.000	1.414
37011	2000	USH 27 NB/SB, Isabella County	I	0.200	0.460	2004	35.000	33.000	37.000	2.828
37013	2000	USH 27 NB/SB, Isabella County	I	8.407	8.958	2001	38.250	36.000	40.000	2.062
37013	2000	USH 27 NB/SB, Isabella County	I	8.407	8.958	2003	30.000	28.000	33.000	2.160
37013	2000	USH 27 NB/SB, Isabella County	I	8.407	8.958	2005	35.000	33.000	37.000	1.633
37013	2000	USH 27 NB/SB, Isabella County	D	8.503	8.958	2001	34.500	32.000	37.000	2.082
37013	2000	USH 27 NB/SB, Isabella County	D	8.503	8.958	2003	26.500	25.000	30.000	2.380
37013	2000	USH 27 NB/SB, Isabella County	D	8.503	8.958	2005	32.250	30.000	34.000	1.708
37014	2000	USH 27 NB/SB, Isabella County	I	0.070	0.640	2001	39.600	32.000	46.000	5.595
37014	2000	USH 27 NB/SB, Isabella County	I	0.070	0.640	2003	25.800	18.000	32.000	5.805
37014	2000	USH 27 NB/SB, Isabella County	I	0.070	0.640	2005	31.600	28.000	34.000	2.302

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average RQI	Min RQI	Max RQI	StDev
37014	2000	USH 27 NB/SB, Isabella County	I	0.790	1.340	2001	34.200	29.000	40.000	5.357
37014	2000	USH 27 NB/SB, Isabella County	I	0.790	1.340	2003	24.400	21.000	27.000	2.408
37014	2000	USH 27 NB/SB, Isabella County	I	0.790	1.340	2005	30.600	28.000	32.000	1.673
37014	2000	USH 27 NB/SB, Isabella County	D	0.070	0.610	2001	54.500	33.000	82.000	20.793
37014	2000	USH 27 NB/SB, Isabella County	D	0.070	0.610	2003	25.250	19.000	32.000	6.702
37014	2000	USH 27 NB/SB, Isabella County	D	0.070	0.610	2005	34.400	28.000	40.000	4.775
37014	2000	USH 27 NB/SB, Isabella County	D	0.760	1.200	2001	31.667	28.000	37.000	4.726
37014	2000	USH 27 NB/SB, Isabella County	D	0.760	1.200	2003	22.667	18.000	27.000	4.509
37014	2000	USH 27 NB/SB, Isabella County	D	0.760	1.200	2005	29.250	27.000	31.000	1.708
65041	2001	I-75 NB/SB, Ogemaw County	I	6.540	11.366	2003	26.213	12.000	90.000	16.116
65041	2001	I-75 NB/SB, Ogemaw County	D	6.619	11.274	2003	27.326	13.000	87.000	16.443
65041	2001	I-75 NB/SB, Ogemaw County	D	6.619	11.274	2005	29.675	24.000	47.000	4.166
58042	2001	M-50 EB/WB, Monroe County	I	4.521	6.898	2002	23.909	18.000	44.000	5.863
58042	2001	M-50 EB/WB, Monroe County	I	4.521	6.898	2004	31.727	29.000	40.000	3.027
51012	2002	USH 31, Manistee County	I	17.213	18.312	2003	31.600	22.000	36.000	4.248
51012	2002	USH 31, Manistee County	I	17.213	18.312	2005	34.700	33.000	37.000	1.494
51012	2002	USH 31, Manistee County	I	18.511	19.212	2003	34.833	22.000	46.000	7.935
51012	2002	USH 31, Manistee County	I	18.511	19.212	2005	36.500	34.000	39.000	1.643
51012	2002	USH 31, Manistee County	I	19.392	19.941	2003	39.400	37.000	41.000	1.673
51012	2002	USH 31, Manistee County	I	19.392	19.941	2005	37.600	34.000	42.000	3.050
51012	2002	USH 31, Manistee County	I	21.475	21.917	2003	31.250	24.000	43.000	8.221
51012	2002	USH 31, Manistee County	I	21.475	21.917	2005	33.000	31.000	35.000	1.826

APPENDIX F – MHB INTERNATIONAL ROUGHNESS INDEX (IRI) DATA

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average IRI	Min IRI	Max IRI	StDev
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	1999	53.433	41.000	87.000	8.916
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	2001	67.100	46.000	122.000	15.461
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	2003	56.700	42.000	100.000	11.287
81076	1997	USH 23 NB/SB, Washtenaw County	I	0.544	6.620	2005	57.917	44.000	99.000	10.918
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	1999	49.086	34.000	90.000	13.542
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	2001	70.707	49.000	103.000	11.391
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	2003	53.414	42.000	75.000	7.537
81076	1997	USH 23 NB/SB, Washtenaw County	D	0.544	6.431	2005	53.017	37.000	75.000	8.407
46082	1997	M-50, Lenawee County	I	0.113	1.824	2000	67.563	50.000	94.000	12.972
46082	1997	M-50, Lenawee County	I	0.113	1.824	2002	58.500	43.000	79.000	10.424
46082	1997	M-50, Lenawee County	I	0.113	1.824	2004	61.125	48.000	83.000	9.722
46082	1997	M-50, Lenawee County	I	3.942	4.366	2000	78.333	67.000	88.000	10.599
46082	1997	M-50, Lenawee County	I	3.942	4.366	2002	72.667	61.000	88.000	13.868
46082	1997	M-50, Lenawee County	I	3.942	4.366	2004	80.333	68.000	94.000	13.051
46082	1997	M-50, Lenawee County	I	4.593	7.134	2000	71.520	52.000	159.000	21.770
46082	1997	M-50, Lenawee County	I	4.593	7.134	2002	61.240	43.000	144.000	20.875
46082	1997	M-50, Lenawee County	I	4.593	7.134	2004	62.087	43.000	86.000	13.273
46082	1998	M-50, Lenawee County	I	9.576	12.375	2000	72.370	55.000	134.000	18.919
46082	1998	M-50, Lenawee County	I	9.576	12.375	2002	60.222	47.000	162.000	21.716
46082	1998	M-50, Lenawee County	I	9.576	12.375	2004	55.923	46.000	67.000	5.999
58041	1998	M-50, Lenawee County	I	0.000	5.021	2000	78.100	63.000	140.000	12.791
58041	1998	M-50, Lenawee County	I	0.000	5.021	2002	66.100	50.000	125.000	14.127
58041	1998	M-50, Lenawee County	I	0.000	5.021	2004	72.694	55.000	107.000	10.556

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average IRI	Min IRI	Max IRI	StDev
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	1999	52.929	38.000	156.000	30.060
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	2001	90.643	68.000	226.000	39.777
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	2003	62.143	43.000	195.000	38.789
58171	1997	I-275 NB/SB, Monroe County	I	0.466	1.963	2005	51.250	45.000	63.000	5.833
58171	1997	I-275 NB/SB, Monroe County	D	0.000	1.975	1999	65.158	49.000	118.000	16.487
58171	1997	I-275 NB/SB, Monroe County	D	0.000	1.975	2003	66.158	45.000	154.000	26.313
58171	1997	I-275 NB/SB, Monroe County	D	0.000	1.975	2005	64.000	47.000	130.000	20.618
21031	1998	M-35, Delta County	I	1.415	3.093	2000	56.267	26.000	122.000	26.534
21031	1998	M-35, Delta County	I	1.415	3.093	2002	64.933	50.000	135.000	21.402
21031	1998	M-35, Delta County	I	1.415	3.093	2004	63.571	55.000	86.000	9.205
21031	1998	M-35, Delta County	I	8.700	10.431	2000	58.353	27.000	97.000	16.259
21031	1998	M-35, Delta County	I	8.700	10.431	2002	71.294	52.000	84.000	8.417
21031	1998	M-35, Delta County	I	8.700	10.431	2004	76.824	59.000	94.000	8.420
25042	1998	I-69 EB/WB, Genesee County	I	0.040	5.932	1999	53.810	40.000	76.000	7.328
25042	1998	I-69 EB/WB, Genesee County	I	0.040	5.932	2001	71.517	55.000	89.000	7.632
25042	1998	I-69 EB/WB, Genesee County	I	0.040	5.932	2005	60.793	47.000	80.000	5.961
25042	1998	I-69 EB/WB, Genesee County	D	0.040	5.932	1999	50.897	42.000	66.000	5.733
25042	1998	I-69 EB/WB, Genesee County	D	0.040	5.932	2001	74.259	57.000	216.000	20.723
25042	1998	I-69 EB/WB, Genesee County	D	0.040	5.932	2005	59.017	50.000	78.000	5.210

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average IRI	Min IRI	Max IRI	StDev
38061	1998	M-60 EB/WB, Jackson County	I	12.650	16.045	2002	64.882	0.000	259.000	39.324
38061	1998	M-60 EB/WB, Jackson County	I	12.650	16.045	2004	69.452	46.000	283.000	40.591
25092	1998	M-15, Genesee County	I	9.501	10.409	2000	71.125	57.000	82.000	9.731
25092	1998	M-15, Genesee County	I	9.501	10.409	2002	69.250	56.000	81.000	10.110
25092	1998	M-15, Genesee County	I	9.501	10.409	2004	75.500	61.000	95.000	12.570
67021	1998	USH 10, Osceola County	D	1.935	2.625	1999	56.667	42.000	76.000	15.306
67021	1998	USH 10, Osceola County	I	1.935	2.625	2001	70.667	55.000	107.000	19.408
67021	1998	USH 10, Osceola County	I	1.935	2.625	2003	74.500	60.000	109.000	18.512
67021	1998	USH 10, Osceola County	I	1.935	2.625	2005	74.000	58.000	82.000	9.670
67022	1998	USH 10, Osceola County	D	0.000	1.523	1999	49.429	35.000	72.000	10.331
67022	1998	USH 10, Osceola County	I	0.000	1.523	2001	65.400	52.000	77.000	8.253
67022	1998	USH 10, Osceola County	I	0.000	1.523	2003	59.400	47.000	88.000	11.051
67022	1998	USH 10, Osceola County	I	0.000	1.523	2005	65.733	50.000	103.000	12.464
26011	1999	M-18, Gladwin County	I	4.860	12.000	2000	73.479	37.000	727.000	99.613
26011	1999	M-18, Gladwin County	I	4.860	12.000	2002	52.257	36.000	131.000	14.753
26011	1999	M-18, Gladwin County	I	4.860	12.000	2004	53.071	34.000	132.000	14.694

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average IRI	Min IRI	Max IRI	StDev
67022	1999	USH 10, Osceola County		9.657	12.087	2001	57.043	44.000	72.000	7.252
67022	1999	USH 10, Osceola County		9.657	12.087	2003	49.174	39.000	60.000	5.890
67022	1999	USH 10, Osceola County		9.657	12.087	2005	52.522	43.000	65.000	6.215
5011	1999	USH 31, Antrim County		0.929	1.375	2001	66.667	60.000	78.000	9.866
5011	1999	USH 31, Antrim County		0.929	1.375	2003	63.333	57.000	74.000	9.292
5011	1999	USH 31, Antrim County		0.929	1.375	2005	69.667	63.000	81.000	9.866
5011	1999	USH 31, Antrim County		1.531	2.732	2001	76.000	55.000	109.000	14.574
5011	1999	USH 31, Antrim County		1.531	2.732	2003	70.273	56.000	87.000	9.210
5011	1999	USH 31, Antrim County		1.531	2.732	2005	76.636	53.000	89.000	10.063
10032	1999	USH 31, Benzie County	D	11.430	14.340	2001	77.321	59.000	120.000	16.571
10032	1999	USH 31, Benzie County		11.430	14.340	2003	54.464	44.000	84.000	9.457
10032	1999	USH 31, Benzie County		11.430	14.340	2005	57.429	44.000	80.000	9.315
25081	1999	M-21, Genesee County		4.981	7.285	2000	83.318	62.000	110.000	12.124
25081	1999	M-21, Genesee County		4.981	7.285	2002	74.136	60.000	101.000	10.278
25081	1999	M-21, Genesee County		4.981	7.285	2004	77.000	60.000	98.000	10.673
58042	1999	M-50, Monroe County		0.139	4.525	2000	53.256	44.000	67.000	5.242
58042	1999	M-50, Monroe County		0.139	4.525	2002	44.233	37.000	52.000	4.297
58042	1999	M-50, Monroe County		0.139	4.525	2004	47.791	39.000	61.000	4.789
44031	1999	M-53, Lapeer County		0.000	1.588	2000	80.600	54.000	123.000	21.118
44031	1999	M-53, Lapeer County		0.000	1.588	2002	73.867	46.000	115.000	20.753
44031	1999	M-53, Lapeer County		0.000	1.588	2004	80.600	52.000	125.000	19.134
44031	1999	M-53, Lapeer County		2.820	6.130	2000	67.063	41.000	133.000	23.895
44031	1999	M-53, Lapeer County		2.820	6.130	2002	61.688	38.000	153.000	24.430
44031	1999	M-53, Lapeer County		2.820	6.130	2004	63.375	39.000	167.000	26.096
44031	1999	M-53, Lapeer County		6.466	6.940	2000	46.250	41.000	53.000	5.377
44031	1999	M-53, Lapeer County		6.466	6.940	2002	44.500	39.000	48.000	3.873
44031	1999	M-53, Lapeer County		6.466	6.940	2004	44.500	42.000	46.000	1.915

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average IRI	Min IRI	Max IRI	StDev
35032	2000	USH 23, Isco County	I	19.120	22.007	2001	47.103	36.000	128.000	16.680
35032	2000	USH 23, Isco County	I	19.120	22.007	2003	45.655	32.000	120.000	15.871
35032	2000	USH 23, Isco County	I	19.120	22.007	2005	48.310	38.000	95.000	11.317
37011	2000	USH 27 NB/SB, Isabella County	I	0.200	0.460	2002	65.000	62.000	68.000	4.243
37011	2000	USH 27 NB/SB, Isabella County	I	0.200	0.460	2004	65.500	64.000	67.000	2.121
37013	2000	USH 27 NB/SB, Isabella County	I	8.407	8.958	2001	75.500	72.000	80.000	3.416
37013	2000	USH 27 NB/SB, Isabella County	I	8.407	8.958	2003	58.000	54.000	63.000	4.243
37013	2000	USH 27 NB/SB, Isabella County	I	8.407	8.958	2005	59.750	50.000	66.000	6.946
37013	2000	USH 27 NB/SB, Isabella County	D	8.503	8.958	2001	70.000	58.000	83.000	10.296
37013	2000	USH 27 NB/SB, Isabella County	D	8.503	8.958	2003	55.750	52.000	60.000	3.500
37013	2000	USH 27 NB/SB, Isabella County	D	8.503	8.958	2005	53.750	45.000	65.000	9.069
37014	2000	USH 27 NB/SB, Isabella County	I	0.070	0.640	2001	62.800	53.000	76.000	8.983
37014	2000	USH 27 NB/SB, Isabella County	I	0.070	0.640	2003	46.600	39.000	54.000	5.941
37014	2000	USH 27 NB/SB, Isabella County	I	0.070	0.640	2005	46.000	36.000	55.000	7.348
37014	2000	USH 27 NB/SB, Isabella County	I	0.790	1.340	2001	60.000	52.000	70.000	8.456
37014	2000	USH 27 NB/SB, Isabella County	I	0.790	1.340	2003	41.600	38.000	47.000	3.912
37014	2000	USH 27 NB/SB, Isabella County	I	0.790	1.340	2005	41.600	37.000	45.000	3.209

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average IRI	Min IRI	Max IRI	StDev
37014	2000	USH 27 NB/SB, Isabella County	D	0.070	0.610	2001	109.750	71.000	193.000	56.694
37014	2000	USH 27 NB/SB, Isabella County	D	0.070	0.610	2003	57.000	47.000	67.000	10.456
37014	2000	USH 27 NB/SB, Isabella County	D	0.070	0.610	2005	53.400	41.000	64.000	9.555
37014	2000	USH 27 NB/SB, Isabella County	D	0.760	1.200	2001	57.000	52.000	64.000	6.245
37014	2000	USH 27 NB/SB, Isabella County	D	0.760	1.200	2003	51.667	47.000	57.000	5.033
37014	2000	USH 27 NB/SB, Isabella County	D	0.760	1.200	2005	45.000	36.000	51.000	6.683
65041	2001	I-75 NB/SB, Ogemaw County	I	6.540	11.366	2003	54.064	34.000	206.000	33.528
65041	2001	I-75 NB/SB, Ogemaw County	D	6.619	11.274	2003	55.522	35.000	183.000	32.622
65041	2001	I-75 NB/SB, Ogemaw County	D	6.619	11.274	2005	45.200	33.000	67.000	8.055
58042	2001	M-50 EB/WB, Monroe County	I	4.521	6.898	2002	48.091	36.000	90.000	13.989
58042	2001	M-50 EB/WB, Monroe County	I	4.521	6.898	2004	48.909	41.000	82.000	11.284
51012	2002	USH 31, Manistee County	I	17.213	18.312	2003	66.800	58.000	74.000	6.339
51012	2002	USH 31, Manistee County	I	17.213	18.312	2005	68.200	63.000	75.000	3.736
51012	2002	USH 31, Manistee County	I	18.511	19.212	2003	61.500	54.000	77.000	8.337

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Average IRI	Min IRI	Max IRI	StDev
51012	2002	USH 31, Manistee County	I	18.511	19.212	2005	63.833	57.000	77.000	7.387
51012	2002	USH 31, Manistee County	I	19.392	19.941	2003	68.800	62.000	75.000	5.630
51012	2002	USH 31, Manistee County	I	19.392	19.941	2005	71.800	59.000	81.000	9.203
51012	2002	USH 31, Manistee County	I	21.475	21.917	2003	61.000	50.000	81.000	13.976
51012	2002	USH 31, Manistee County	I	21.475	21.917	2005	61.250	55.000	75.000	9.465

APPENDIX G – RFB RIDE QUALITY INDEX (RQI) DATA

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1992	52.516	33.000	82.000	12.959
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1993	62.643	41.000	93.000	14.920
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1994	33.935	20.000	54.000	9.654
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1995	42.323	26.000	68.000	10.061
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1996	47.968	31.000	65.000	9.962
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1999	73.500	33.000	102.000	17.579
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1992	39.581	27.000	53.000	6.903
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1993	38.345	27.000	58.000	7.696
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1994	24.484	11.000	46.000	8.508
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1995	30.893	18.000	52.000	8.517
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1996	36.161	23.000	44.000	5.460
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1999	44.548	26.000	92.000	13.899
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1992	18.667	10.000	29.000	5.633
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1993	18.000	10.000	31.000	5.215
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1994	18.905	11.000	29.000	5.098
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1995	27.952	21.000	38.000	5.054
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1996	35.429	26.000	44.000	5.390
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1999	34.700	24.000	72.000	10.668
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	2001	51.700	35.000	71.000	10.514
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	2003	50.400	31.000	77.000	10.713
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	2005	53.316	36.000	68.000	9.268
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1992	21.714	12.000	32.000	5.934
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1993	21.524	12.000	35.000	6.361
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1994	23.952	13.000	35.000	6.070
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1995	34.619	24.000	49.000	6.461
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1996	38.714	27.000	50.000	5.198
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1999	36.421	26.000	50.000	7.404
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	2001	54.850	39.000	70.000	9.252
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	2003	50.100	32.000	69.000	9.640
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	2005	51.450	38.000	70.000	9.128
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1992	35.057	27.000	43.000	3.873

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1993	35.857	30.000	45.000	4.008
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1994	38.657	29.000	61.000	5.755
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1995	44.143	36.000	70.000	7.059
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1996	44.914	37.000	76.000	7.081
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1999	63.629	39.000	102.000	16.156
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1993	40.000	34.000	48.000	7.211
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1994	41.000	34.000	45.000	6.083
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1995	44.500	41.000	48.000	4.950
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1996	48.000	47.000	49.000	1.414
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1998	61.200	44.000	76.000	14.237
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	2000	62.000	56.000	66.000	5.292
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	2002	57.333	50.000	63.000	6.658
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	2004	59.500	58.000	61.000	2.121
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	1993	27.667	23.000	32.000	4.509
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	1994	32.667	30.000	36.000	3.055
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	1996	44.333	40.000	47.000	3.786
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	1998	55.250	43.000	65.000	10.532
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	2000	63.000	57.000	67.000	4.320
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	2002	64.250	48.000	94.000	20.532
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	2004	62.000	52.000	78.000	11.165
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	1994	46.333	37.000	54.000	8.622
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	1995	52.000	45.000	59.000	9.899
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	1996	60.000	53.000	67.000	9.899
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	2000	81.333	78.000	85.000	3.512
34032	1989	M-66 NB/SB, Ionia County	D	0.000	0.446	1994	31.667	27.000	35.000	4.163
34032	1989	M-66 NB/SB, Ionia County	D	0.000	0.446	1995	38.000	36.000	39.000	1.732
34032	1989	M-66 NB/SB, Ionia County	D	0.000	0.446	1998	47.000	42.000	50.000	4.359
34032	1989	M-66 NB/SB, Ionia County	D	0.000	0.446	2000	68.000	63.000	78.000	6.880
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1992	30.921	13.000	48.000	7.210
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1993	29.841	13.000	46.000	7.247
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1994	31.063	19.000	47.000	5.806
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1995	36.587	22.000	51.000	5.223

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1999	44.381	29.000	60.000	6.467
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1992	24.667	13.000	37.000	6.931
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1993	24.619	12.000	42.000	7.775
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1994	27.667	17.000	43.000	7.819
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1995	35.000	23.000	50.000	8.185
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1999	43.857	31.000	71.000	10.051
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1992	39.091	34.000	50.000	5.029
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1993	21.545	14.000	29.000	5.556
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1994	23.636	15.000	38.000	7.406
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1995	33.727	28.000	44.000	5.312
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1998	41.364	21.000	78.000	14.975
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1993	22.971	15.000	32.000	4.956
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1994	26.029	17.000	64.000	7.846
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1995	29.200	21.000	39.000	4.296
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1996	33.706	24.000	43.000	4.530
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1999	38.806	22.000	60.000	9.939
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	2001	45.306	24.000	105.000	12.804
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	2003	41.000	28.000	54.000	9.265
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1993	22.243	11.000	43.000	6.495
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1994	25.054	14.000	56.000	7.188
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1995	30.054	22.000	41.000	4.371
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1996	33.270	24.000	48.000	5.640
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1999	33.395	20.000	75.000	10.031
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	2001	40.553	27.000	81.000	10.415
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	2003	46.158	22.000	72.000	13.789
16032	1990	M-27, Cheboygan County	I	0.998	2.570	1992	20.133	16.000	23.000	2.475
16032	1990	M-27, Cheboygan County	I	0.998	2.570	1993	21.600	18.000	26.000	2.354
16032	1990	M-27, Cheboygan County	D	0.998	2.570	1994	21.667	11.000	28.000	4.655
16032	1990	M-27, Cheboygan County	I	0.998	2.570	1995	32.000	28.000	35.000	1.813
16032	1990	M-27, Cheboygan County	D	0.998	2.570	1996	32.533	27.000	38.000	3.962
16032	1990	M-27, Cheboygan County	I	0.998	2.570	1998	25.400	19.000	34.000	3.334
16032	1990	M-27, Cheboygan County	D	0.998	2.570	2000	49.067	34.000	59.000	6.552

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
16032	1990	M-27, Cheboygan County	I	0.998	2.570	2002	33.933	28.000	51.000	5.509
16032	1990	M-27, Cheboygan County	I	0.998	2.570	2004	37.733	32.000	51.000	5.405
16032	1990	M-27, Cheboygan County	I	9.309	9.579	1992	31.000	31.000	31.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	1993	26.000	26.000	26.000	0.000
16032	1990	M-27, Cheboygan County	D	9.309	9.579	1994	30.000	30.000	30.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	1995	38.000	38.000	38.000	0.000
16032	1990	M-27, Cheboygan County	D	9.309	9.579	1996	39.000	39.000	39.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	1998	36.000	36.000	36.000	0.000
16032	1990	M-27, Cheboygan County	D	9.309	9.579	2000	61.000	61.000	61.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	2002	42.000	42.000	42.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	2004	43.000	43.000	43.000	0.000
16032	1990	M-27, Cheboygan County	I	9.664	11.375	1992	18.938	11.000	50.000	9.398
16032	1990	M-27, Cheboygan County	I	9.664	11.375	1993	20.063	13.000	39.000	6.678
16032	1990	M-27, Cheboygan County	D	9.664	11.375	1994	21.000	15.000	30.000	3.651
16032	1990	M-27, Cheboygan County	I	9.664	11.375	1995	29.688	25.000	44.000	4.686
16032	1990	M-27, Cheboygan County	D	9.664	11.375	1996	30.250	25.000	36.000	2.955
16032	1990	M-27, Cheboygan County	I	9.664	11.375	1998	24.563	18.000	32.000	3.464
16032	1990	M-27, Cheboygan County	D	9.664	11.375	2000	49.941	37.000	66.000	6.329
16032	1990	M-27, Cheboygan County	I	9.664	11.375	2002	31.813	23.000	41.000	4.636
16032	1990	M-27, Cheboygan County	I	9.664	11.375	2004	35.563	32.000	48.000	4.258
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1992	23.703	11.000	41.000	6.064
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1993	25.324	14.000	41.000	6.490
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1994	25.667	15.000	39.000	6.127
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1995	31.568	24.000	41.000	5.367
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1996	38.108	30.000	48.000	4.971
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1999	42.297	30.000	70.000	8.472
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1992	30.681	12.000	86.000	18.970
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1993	26.583	12.000	75.000	10.941
16021	1990	M-68, Cheboygan County	D	0.230	7.711	1994	27.722	15.000	65.000	9.880
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1995	34.571	21.000	63.000	6.764
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1996	37.205	25.000	67.000	8.508
16021	1990	M-68, Cheboygan County	D	0.230	7.711	1998	31.301	17.000	78.000	12.577

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
16021	1990	M-68, Cheboygan County	I	0.230	7.711	2000	53.041	31.000	83.000	8.185
16021	1990	M-68, Cheboygan County	I	0.230	7.711	2002	40.270	24.000	87.000	11.083
16021	1990	M-68, Cheboygan County	I	0.230	7.711	2004	45.431	32.000	89.000	12.888
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1993	22.833	8.000	70.000	8.963
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1994	23.944	11.000	68.000	8.167
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1995	31.852	23.000	48.000	5.399
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1996	35.389	27.000	54.000	5.451
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1998	28.396	12.000	55.000	8.111
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	2000	46.741	20.000	79.000	11.566
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	2002	35.500	19.000	76.000	9.053
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	2004	38.151	32.000	63.000	6.778
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1993	22.771	10.000	70.000	9.777
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1994	24.292	14.000	68.000	8.558
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1995	30.854	23.000	54.000	5.231
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1996	35.854	29.000	57.000	5.295
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1998	27.170	14.000	55.000	7.806
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	2000	48.188	28.000	75.000	8.631
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1993	30.750	16.000	46.000	13.048
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1994	31.250	20.000	39.000	8.655
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1995	38.500	29.000	47.000	8.062
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1996	44.250	36.000	50.000	6.946
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1998	39.667	37.000	43.000	3.055
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	2000	54.667	49.000	63.000	7.371
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1993	47.643	27.000	77.000	16.232
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1994	47.357	29.000	75.000	16.137
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1995	51.786	34.000	78.000	14.813
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1996	52.357	33.000	78.000	14.521
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1999	60.571	37.000	90.000	18.583
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	2003	48.000	26.000	93.000	21.548
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1993	47.786	30.000	75.000	17.586
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1994	46.786	30.000	77.000	17.321
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1995	48.000	35.000	79.000	15.510

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1996	51.857	33.000	78.000	16.608
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1999	56.615	40.000	93.000	17.533
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	2001	62.000	33.000	114.000	25.302
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	2003	41.077	26.000	63.000	11.934
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1993	32.232	23.000	46.000	5.396
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1994	33.261	26.000	54.000	5.257
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1995	37.565	30.000	49.000	4.310
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1996	39.029	32.000	50.000	4.298
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1999	42.225	30.000	90.000	11.809
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1993	30.314	21.000	46.000	5.298
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1994	31.343	18.000	48.000	6.157
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1995	35.829	27.000	49.000	5.311
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1996	37.457	27.000	54.000	6.657
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1999	36.761	20.000	74.000	9.865
37013	1993	US-27 NB/SB, Isabella County	I	8.958	11.664	1994	27.808	20.000	36.000	3.763
37013	1993	US-27 NB/SB, Isabella County	I	8.958	11.664	1995	34.769	28.000	42.000	3.615
37013	1993	US-27 NB/SB, Isabella County	I	8.958	11.664	1996	35.423	30.000	41.000	2.656
37013	1993	US-27 NB/SB, Isabella County	D	9.007	11.382	1994	25.105	16.000	32.000	5.141
37013	1993	US-27 NB/SB, Isabella County	D	9.007	11.382	1995	33.364	25.000	39.000	4.089
37013	1993	US-27 NB/SB, Isabella County	D	9.007	11.382	1996	36.727	30.000	41.000	3.326
37013	1993	US-27 NB/SB, Isabella County	D	11.476	11.712	1994	37.000	31.000	43.000	8.485
37013	1993	US-27 NB/SB, Isabella County	D	11.476	11.712	1995	38.000	38.000	38.000	0.000
37013	1993	US-27 NB/SB, Isabella County	D	11.476	11.712	1996	40.000	40.000	40.000	0.000
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1994	37.759	26.000	48.000	4.891
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1995	45.667	29.000	58.000	7.821
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1996	46.623	30.000	57.000	6.948
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1999	40.704	25.000	52.000	7.189
03112	1993	US-131 NB/SB, Allegan County	D	3.065	3.521	1994	33.000	31.000	35.000	1.826
03112	1993	US-131 NB/SB, Allegan County	D	3.065	3.521	1995	41.000	39.000	44.000	2.160
03112	1993	US-131 NB/SB, Allegan County	D	3.065	3.521	1999	34.333	29.000	38.000	4.726
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1994	36.128	25.000	51.000	5.652
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1995	45.000	29.000	57.000	6.544

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1996	45.340	33.000	56.000	5.798
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1999	39.362	24.000	73.000	9.263
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1994	21.378	10.000	46.000	7.169
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1995	29.753	21.000	46.000	5.176
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1996	30.675	20.000	46.000	5.317
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1999	33.810	20.000	67.000	7.063
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	2001	44.167	30.000	72.000	7.135
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	2003	42.576	31.000	70.000	7.018
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1994	21.398	14.000	43.000	5.144
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1995	34.939	25.000	47.000	5.009
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1996	34.553	24.000	47.000	5.201
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1999	28.698	17.000	67.000	8.762
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	2001	35.105	22.000	91.000	9.347
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	2003	31.023	18.000	71.000	7.205
13033	1993	I-194/M-66 NB/SB, Calhoun County	I	0.492	1.679	1995	35.636	31.000	43.000	3.695
13033	1993	I-194/M-66 NB/SB, Calhoun County	I	0.492	1.679	1996	35.636	31.000	42.000	3.472
13033	1993	I-194/M-66 NB/SB, Calhoun County	I	0.492	1.679	1999	33.909	28.000	40.000	3.807
13033	1993	I-194/M-66 NB/SB, Calhoun County	D	0.492	1.679	1995	32.909	27.000	38.000	3.300
13033	1993	I-194/M-66 NB/SB, Calhoun County	D	0.492	1.679	1996	34.182	27.000	50.000	6.210
13033	1993	I-194/M-66 NB/SB, Calhoun County	D	0.492	1.679	1999	39.909	26.000	82.000	19.081
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	1994	32.263	21.000	43.000	6.975
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	1995	36.000	25.000	50.000	7.024
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	1996	36.474	28.000	50.000	7.058
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	1998	37.632	22.000	77.000	12.628
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	2000	43.211	20.000	83.000	13.994
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	2004	44.000	32.000	59.000	7.753
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	1994	31.789	19.000	49.000	8.257
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	1995	35.316	27.000	51.000	7.273
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	1996	38.333	31.000	52.000	5.552
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	1998	34.474	27.000	61.000	8.834
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	2000	50.105	36.000	70.000	8.993
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	1995	40.154	32.000	57.000	7.010

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	1996	11.250	7.000	17.000	2.563
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	1999	4.667	2.000	8.000	2.422
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	2001	27.000	14.000	51.000	12.070
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	2003	24.733	9.000	65.000	17.031
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	2005	27.167	23.000	35.000	3.689
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	1995	40.000	33.000	60.000	8.880
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	1996	15.750	12.000	21.000	3.370
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	1999	24.300	10.000	57.000	17.321
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	2001	39.900	25.000	57.000	11.742
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	2003	30.000	17.000	64.000	15.846
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	2005	32.250	26.000	50.000	7.440
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	1996	19.300	14.000	24.000	3.653
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	1999	23.615	11.000	66.000	17.690
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	2001	37.231	21.000	59.000	13.461
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	2003	31.923	17.000	84.000	20.332
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	2005	29.444	26.000	32.000	1.878
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	1996	16.800	14.000	18.000	1.643
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	1999	15.400	9.000	29.000	7.829
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	2001	28.800	20.000	38.000	6.834
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	2003	21.000	19.000	25.000	2.449
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	2005	29.000	28.000	30.000	1.000
25092	1994	M-15, Genesee County	I	8.610	8.904	1995	45.500	45.000	46.000	0.707
25092	1994	M-15, Genesee County	D	8.610	8.904	1996	45.500	43.000	48.000	3.536
25092	1994	M-15, Genesee County	D	8.610	8.904	1998	37.500	33.000	42.000	6.364
25092	1994	M-15, Genesee County	I	8.610	8.904	2000	60.000	57.000	63.000	4.243
56021	1994	M-20 WB, Midland County	D	6.053	10.589	1995	13.386	7.000	25.000	3.506
56021	1994	M-20 WB, Midland County	D	6.053	10.589	2000	33.022	28.000	53.000	4.104
74012	1995	M-53, Sanilac County	D	9.000	13.000	1996	27.769	22.000	49.000	4.976
74012	1995	M-53, Sanilac County	I	9.000	13.000	1998	30.425	21.000	69.000	9.487
74012	1995	M-53, Sanilac County	I	9.000	13.000	2002	34.875	24.000	82.000	11.813
41033	1995	M-37 NB/SB, Kent County	I	7.925	10.610	1996	35.400	29.000	45.000	4.041
41033	1995	M-37 NB/SB, Kent County	I	7.925	10.610	1998	50.000	50.000	50.000	0.000

Evaluation of Rubblized Pavement Sections in Michigan – Appendix G

December 2006

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
41033	1995	M-37 NB/SB, Kent County	I	7.925	10.610	2000	48.385	30.000	61.000	6.975
41033	1995	M-37 NB/SB, Kent County	I	10.762	15.815	1996	33.440	25.000	44.000	4.339
41033	1995	M-37 NB/SB, Kent County	I	10.762	15.815	2000	44.020	30.000	56.000	6.622
41033	1995	M-37 NB/SB, Kent County	D	7.965	10.606	1996	32.417	27.000	44.000	3.955
41033	1995	M-37 NB/SB, Kent County	D	7.965	10.606	1998	24.280	15.000	69.000	11.062
41033	1995	M-37 NB/SB, Kent County	D	7.965	10.606	2000	52.040	41.000	65.000	5.834
41033	1995	M-37 NB/SB, Kent County	D	10.758	15.815	1996	30.960	25.000	44.000	3.928
41033	1995	M-37 NB/SB, Kent County	D	10.758	15.815	1998	18.347	10.000	35.000	5.337
41033	1995	M-37 NB/SB, Kent County	D	10.758	15.815	2000	45.224	35.000	56.000	5.889
01052	1996	US-23, Alcona County	I	0.491	2.470	1999	21.737	15.000	32.000	4.653
01052	1996	US-23, Alcona County	I	0.491	2.470	2001	36.000	29.000	45.000	5.647
70024	1996	I-196 EB, Ottawa County	I	12.589	15.591	1999	23.621	9.000	85.000	14.453
70024	1996	I-196 EB, Ottawa County	I	12.589	15.591	2001	34.414	26.000	55.000	6.732
70024	1996	I-196 EB, Ottawa County	I	12.589	15.591	2003	28.724	26.000	47.000	6.551
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	1999	28.636	23.000	38.000	4.478
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	2001	39.273	32.000	46.000	4.407
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	2003	34.455	31.000	37.000	2.423
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	2005	34.000	32.000	36.000	1.414
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	1999	26.091	23.000	30.000	2.071
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	2001	38.818	35.000	42.000	2.359
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	2003	33.818	31.000	39.000	2.786
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	2005	35.000	33.000	38.000	1.342
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	1999	31.111	22.000	39.000	3.924
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	2001	40.833	35.000	46.000	3.185
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	2003	35.944	31.000	41.000	2.689
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	2005	34.500	32.000	39.000	1.689
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	1999	25.600	18.000	33.000	4.695
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	2001	41.800	36.000	54.000	5.922
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	2003	32.300	28.000	41.000	3.743
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	2005	35.500	31.000	42.000	2.991
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	1999	30.000	26.000	35.000	3.546

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	2001	41.625	39.000	47.000	2.973
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	2003	36.625	34.000	40.000	2.615
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	2005	35.875	34.000	40.000	2.100
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	1999	26.000	23.000	30.000	2.608
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	2001	38.667	37.000	42.000	1.751
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	2003	33.000	28.000	36.000	2.757
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	2005	33.333	32.000	34.000	0.816
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	1999	29.222	24.000	39.000	4.816
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	2001	42.667	39.000	49.000	2.872
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	2003	32.889	28.000	37.000	3.180
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	2005	33.778	33.000	35.000	0.667
70024	1997	I-196 EB, Ottawa County	I	6.581	10.575	1999	34.359	25.000	68.000	9.109
70024	1997	I-196 EB, Ottawa County	I	6.581	10.575	2001	45.513	35.000	79.000	7.170
70024	1997	I-196 EB, Ottawa County	I	6.581	10.575	2003	42.564	33.000	76.000	8.328
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	1999	31.000	20.000	52.000	18.193
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	2001	31.333	28.000	35.000	3.512
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	2003	23.333	22.000	25.000	1.528
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	2005	32.000	30.000	34.000	2.000
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	1999	34.000	27.000	40.000	5.354
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	2001	37.750	33.000	40.000	3.202
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	2003	27.500	19.000	31.000	5.686
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	2005	33.667	30.000	39.000	4.726
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	1999	21.870	0.000	77.000	14.426
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	2001	30.435	13.000	70.000	12.893
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	2003	25.319	9.000	60.000	12.139
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	2005	31.731	21.000	49.000	8.091
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	1999	10.400	1.000	63.000	10.089
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	2001	20.975	13.000	46.000	7.241
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	2003	15.775	9.000	37.000	5.985
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	2005	25.625	22.000	36.000	3.036
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	1999	22.153	14.000	83.000	8.012

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	2001	34.542	23.000	75.000	7.791
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	2003	27.944	21.000	69.000	6.397
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	2005	32.380	28.000	38.000	2.213
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	1999	22.222	14.000	87.000	10.777
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	2001	35.528	29.000	66.000	6.016
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	2003	31.931	23.000	79.000	8.044
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	2005	36.181	31.000	51.000	3.880
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	1999	27.944	17.000	82.000	11.729
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	2001	35.759	24.000	73.000	8.571
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	2003	31.463	21.000	75.000	8.453
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	2005	33.500	30.000	40.000	1.975
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	1999	26.836	15.000	75.000	11.869
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	2001	36.491	26.000	83.000	11.919
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	2003	32.145	20.000	80.000	9.166
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	2005	35.811	33.000	66.000	4.860
74073	1998	M-25, Sanilac County	I	0.483	4.937	2000	36.227	30.000	52.000	4.142
74073	1998	M-25, Sanilac County	I	0.483	4.937	2002	27.682	19.000	36.000	3.790
74073	1998	M-25, Sanilac County	I	0.483	4.937	2004	33.477	30.000	37.000	1.823
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	1999	29.375	19.000	38.000	6.070
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	2001	40.625	28.000	52.000	7.945
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	2003	33.750	27.000	39.000	4.432
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	2005	35.500	33.000	39.000	2.138
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	1999	34.000	34.000	34.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	2001	42.000	42.000	42.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	2003	36.000	36.000	36.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	2005	35.000	35.000	35.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	1999	27.667	20.000	35.000	7.506
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	2001	33.667	31.000	38.000	3.786
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	2003	26.667	22.000	35.000	7.234
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	2005	33.000	31.000	35.000	2.000
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	1999	42.400	28.000	63.000	14.571

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	2001	38.400	34.000	46.000	5.030
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	2003	36.800	29.000	55.000	10.592
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	2005	35.000	32.000	36.000	2.000
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	1999	28.800	21.000	37.000	5.933
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	2001	58.500	40.000	102.000	29.240
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	2003	52.250	34.000	100.000	31.941
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	2005	35.333	33.000	37.000	2.082
41131	1998	I-96 & I-296 EB/WB, Kent County	I	17.586	17.761	1999	80.000	80.000	80.000	0.000
41131	1998	I-96 & I-296 EB/WB, Kent County	I	17.586	17.761	2001	87.000	87.000	87.000	0.000
41131	1998	I-96 & I-296 EB/WB, Kent County	I	17.586	17.761	2003	82.000	82.000	82.000	0.000
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	1999	44.241	23.000	92.000	19.579
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	2001	49.870	31.000	98.000	17.412
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	2003	42.333	27.000	99.000	18.118
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	2005	38.750	32.000	58.000	6.394
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	1999	39.630	22.000	92.000	18.795
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	2001	48.611	29.000	100.000	17.549
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	2003	42.130	23.000	91.000	17.027
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	2005	39.419	30.000	74.000	9.095
04031	1999	US-23, Alpena County	I	0.000	0.241	2001	55.500	31.000	80.000	34.648
04031	1999	US-23, Alpena County	I	0.000	0.241	2003	21.500	19.000	24.000	3.536
04031	1999	US-23, Alpena County	I	0.000	0.241	2005	30.500	29.000	32.000	2.121
04031	1999	US-23, Alpena County	I	0.449	0.908	2001	31.750	27.000	37.000	4.113
04031	1999	US-23, Alpena County	I	0.449	0.908	2003	26.250	24.000	32.000	3.862
04031	1999	US-23, Alpena County	I	0.449	0.908	2005	32.500	30.000	36.000	3.000
04031	1999	US-23, Alpena County	I	1.404	2.248	2001	37.286	29.000	53.000	9.358
04031	1999	US-23, Alpena County	I	1.404	2.248	2003	27.857	18.000	33.000	5.610
04031	1999	US-23, Alpena County	I	1.404	2.248	2005	33.286	29.000	38.000	2.870
04031	1999	US-23, Alpena County	I	4.218	7.893	2001	29.086	18.000	84.000	14.039
04031	1999	US-23, Alpena County	I	4.218	7.893	2003	25.714	11.000	84.000	14.391
04031	1999	US-23, Alpena County	I	4.218	7.893	2005	30.968	24.000	51.000	4.895

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg RQI	Min	Max	StDev
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	I	3.200	8.691	2001	30.382	16.000	97.000	14.362
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	I	3.200	8.691	2003	26.073	13.000	83.000	14.173
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	I	3.200	8.691	2005	30.529	24.000	47.000	4.211
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	D	3.205	8.691	2001	30.537	19.000	100.000	13.914
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	D	3.205	8.691	2003	24.944	14.000	90.000	14.708
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	D	3.205	8.691	2005	33.060	25.000	74.000	9.164
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	I	0.000	4.214	2001	27.667	5.000	63.000	7.364
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	I	0.000	4.214	2003	22.738	13.000	54.000	6.290
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	I	0.000	4.214	2005	31.976	25.000	51.000	3.935
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	D	0.000	4.233	2001	25.829	19.000	35.000	3.840
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	D	0.000	4.233	2003	22.488	15.000	53.000	6.450
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	D	0.000	4.233	2005	29.238	24.000	35.000	2.748
41033	2000	M-37/M-46, Kent & Muskegon Counties	I	15.738	17.120	2002	30.462	22.000	45.000	6.641
41033	2000	M-37/M-46, Kent & Muskegon Counties	I	15.738	17.120	2004	33.692	30.000	44.000	3.728
61171	2000	M-37/M-46, Kent & Muskegon Counties	I	0.000	0.571	2002	33.333	30.000	40.000	3.724
61171	2000	M-37/M-46, Kent & Muskegon Counties	I	0.000	0.571	2004	34.600	33.000	36.000	1.140

APPENDIX H – RFB INTERNATIONAL RIDE INDEX (IRI) DATA

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1992	100.935	64.000	175.000	29.445
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1993	124.968	73.000	276.000	51.203
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1994	59.032	40.000	113.000	17.419
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1995	67.871	41.000	118.000	19.080
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1996	76.774	49.000	127.000	17.907
13081	1988	I-94 EB/WB, Calhoun County	I	2.474	5.650	1999	117.645	59.000	186.000	29.616
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1992	83.226	60.000	140.000	17.308
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1993	87.097	64.000	138.000	19.695
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1994	47.387	33.000	75.000	9.838
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1995	52.964	37.000	73.000	9.826
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1996	55.806	43.000	74.000	8.064
13081	1988	I-94 EB/WB, Calhoun County	D	2.474	5.650	1999	64.871	49.000	91.000	10.871
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1992	36.762	30.000	49.000	5.449
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1993	36.429	28.000	50.000	6.209
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1994	37.952	31.000	50.000	5.783
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1995	43.381	35.000	57.000	6.257
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1996	52.429	39.000	71.000	8.286
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	1999	79.400	50.000	108.000	15.729
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	2001	100.600	53.000	144.000	23.992
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	2003	109.800	58.000	149.000	24.466
16092	1988	I-75 NB/SB, Cheboygan County	I	13.186	15.218	2005	116.211	59.000	163.000	31.117
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1992	40.667	31.000	63.000	8.422
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1993	42.000	31.000	65.000	9.077
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1994	43.810	32.000	66.000	9.282
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1995	52.714	38.000	75.000	10.115
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1996	57.714	42.000	73.000	9.073
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	1999	70.300	54.000	107.000	13.627
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	2001	98.150	76.000	155.000	21.813
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	2003	91.850	55.000	147.000	22.129
16092	1988	I-75 NB/SB, Cheboygan County	D	13.186	15.218	2005	97.200	63.000	167.000	30.015
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1992	63.057	44.000	83.000	8.003
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1993	64.943	47.000	87.000	9.210

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1994	70.400	50.000	128.000	13.705
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1995	76.543	61.000	149.000	18.339
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1996	76.429	56.000	201.000	23.953
17062	1989	M28, Brimley, Chippewa County	I	18.686	22.289	1999	90.400	67.000	129.000	17.473
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1993	79.667	76.000	83.000	3.512
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1994	84.000	77.000	88.000	6.083
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1995	83.000	76.000	90.000	9.899
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	1996	90.000	89.000	91.000	1.414
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	2000	105.000	91.000	116.000	12.767
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	2002	108.333	86.000	121.000	19.399
34031	1989	M-66 NB/SB, Ionia County	I	7.200	7.512	2004	117.000	99.000	135.000	25.456
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	1993	56.000	46.000	61.000	8.660
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	1994	60.000	53.000	66.000	6.557
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	1996	72.333	66.000	78.000	6.028
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	2000	83.000	59.000	114.000	22.818
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	2002	97.500	83.000	106.000	10.017
34032	1989	M-66 NB/SB, Ionia County	I	0.000	0.446	2004	116.000	93.000	161.000	30.540
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	1994	98.000	69.000	147.000	42.673
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	1995	111.500	78.000	145.000	47.376
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	1996	124.000	91.000	157.000	46.669
34031	1989	M-66 NB/SB, Ionia County	D	7.200	7.512	2000	193.000	187.000	203.000	8.718
34032	1989	M-66 NB/SB, Ionia County	D	0.000	0.446	1994	59.000	56.000	62.000	3.000
34032	1989	M-66 NB/SB, Ionia County	D	0.000	0.446	1995	60.333	60.000	61.000	0.577
34032	1989	M-66 NB/SB, Ionia County	D	0.000	0.446	2000	101.000	84.000	115.000	14.166
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1992	69.000	38.000	105.000	13.986
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1994	69.175	42.000	106.000	11.609
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1995	69.524	41.000	108.000	12.116
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1996	77.889	57.000	115.000	12.362
09101	1989	US-10 EB / M-25 EB, Bay County	I	0.924	7.356	1999	84.286	53.000	120.000	13.896
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1992	58.238	39.000	103.000	15.313
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1994	62.762	44.000	115.000	16.724
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1995	65.667	46.000	112.000	16.088

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1996	71.619	47.000	118.000	17.665
09101	1989	US-10 EB / M-25 EB, Bay County	I	9.122	11.357	1999	77.286	56.000	120.000	17.445
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1992	99.545	42.000	226.000	57.844
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1994	59.091	36.000	85.000	14.300
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1995	63.364	43.000	87.000	13.902
09042	1989	US-10 EB / M-25 EB, Bay County	I	0.056	1.271	1996	66.273	49.000	88.000	13.835
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1993	52.714	40.000	69.000	8.187
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1994	53.371	38.000	105.000	12.269
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1995	54.457	42.000	71.000	8.060
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1996	58.500	44.000	79.000	8.497
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	1999	65.500	45.000	177.000	21.713
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	2001	88.361	53.000	192.000	22.417
41131	1990	US-131 NB/SB, Kent County	I	6.467	10.137	2003	83.000	63.000	109.000	15.816
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1993	53.297	35.000	83.000	9.174
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1994	53.324	35.000	77.000	8.683
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1995	55.054	40.000	72.000	7.341
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1996	58.946	43.000	80.000	8.819
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	1999	64.474	44.000	145.000	17.045
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	2001	89.684	60.000	187.000	22.156
41131	1990	US-131 NB/SB, Kent County	D	6.467	10.321	2003	99.342	54.000	178.000	33.855
16032	1990	M-27, Cheboygan County	I	0.998	2.570	1992	52.533	41.000	61.000	6.174
16032	1990	M-27, Cheboygan County	I	0.998	2.570	1993	53.067	41.000	61.000	6.029
16032	1990	M-27, Cheboygan County	D	0.998	2.570	1994	52.800	36.000	71.000	10.213
16032	1990	M-27, Cheboygan County	I	0.998	2.570	1995	59.133	46.000	66.000	6.357
16032	1990	M-27, Cheboygan County	D	0.998	2.570	1996	60.067	46.000	73.000	9.852
16032	1990	M-27, Cheboygan County	D	0.998	2.570	2000	95.600	55.000	136.000	20.371
16032	1990	M-27, Cheboygan County	I	0.998	2.570	2002	76.333	59.000	117.000	14.812
16032	1990	M-27, Cheboygan County	I	0.998	2.570	2004	84.200	66.000	138.000	21.808
16032	1990	M-27, Cheboygan County	I	9.309	9.579	1992	75.000	75.000	75.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	1993	75.000	75.000	75.000	0.000
16032	1990	M-27, Cheboygan County	D	9.309	9.579	1994	63.000	63.000	63.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	1995	80.000	80.000	80.000	0.000

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
16032	1990	M-27, Cheboygan County	D	9.309	9.579	1996	71.000	71.000	71.000	0.000
16032	1990	M-27, Cheboygan County	D	9.309	9.579	2000	130.000	121.000	139.000	12.728
16032	1990	M-27, Cheboygan County	I	9.309	9.579	2002	96.000	96.000	96.000	0.000
16032	1990	M-27, Cheboygan County	I	9.309	9.579	2004	100.000	100.000	100.000	0.000
16032	1990	M-27, Cheboygan County	I	9.664	11.375	1992	49.688	37.000	88.000	12.289
16032	1990	M-27, Cheboygan County	I	9.664	11.375	1993	50.875	39.000	84.000	11.342
16032	1990	M-27, Cheboygan County	D	9.664	11.375	1994	49.688	35.000	76.000	9.741
16032	1990	M-27, Cheboygan County	I	9.664	11.375	1995	54.000	42.000	83.000	10.690
16032	1990	M-27, Cheboygan County	D	9.664	11.375	1996	54.563	44.000	77.000	8.302
16032	1990	M-27, Cheboygan County	D	9.664	11.375	2000	90.882	62.000	186.000	27.200
16032	1990	M-27, Cheboygan County	I	9.664	11.375	2002	64.500	49.000	101.000	12.006
16032	1990	M-27, Cheboygan County	I	9.664	11.375	2004	67.188	54.000	98.000	10.672
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1992	48.162	35.000	67.000	8.298
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1993	50.757	36.000	79.000	8.600
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1994	50.222	35.000	81.000	8.877
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1995	53.351	42.000	75.000	8.377
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1996	60.378	47.000	78.000	8.613
20014	1990	I-75 SB, Crawford County	D	0.000	3.730	1999	72.789	52.000	100.000	12.840
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1992	77.595	39.000	240.000	45.735
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1993	63.808	35.000	133.000	20.422
16021	1990	M-68, Cheboygan County	D	0.230	7.711	1994	64.292	34.000	128.000	20.191
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1995	66.957	40.000	126.000	16.697
16021	1990	M-68, Cheboygan County	I	0.230	7.711	1996	70.644	43.000	149.000	21.711
16021	1990	M-68, Cheboygan County	I	0.230	7.711	2000	81.905	30.000	161.000	26.175
16021	1990	M-68, Cheboygan County	I	0.230	7.711	2002	86.135	49.000	209.000	28.926
16021	1990	M-68, Cheboygan County	I	0.230	7.711	2004	94.111	56.000	191.000	29.045
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1993	50.500	32.000	144.000	16.502
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1994	51.593	36.000	146.000	16.238
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1995	57.296	41.000	97.000	11.245
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	1996	58.537	45.000	101.000	11.665
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	2002	70.778	48.000	129.000	15.544
41033	1992	M-37 NB/SB, Kent County	I	2.477	7.917	2004	69.717	50.000	133.000	17.164

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1993	50.604	32.000	157.000	18.080
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1994	52.667	36.000	153.000	16.980
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1995	55.229	40.000	124.000	12.638
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	1996	59.396	45.000	130.000	12.936
41033	1992	M-37 NB/SB, Kent County	D	2.477	7.349	2000	71.458	18.000	121.000	24.580
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1993	73.000	41.000	113.000	31.326
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1994	75.500	47.000	106.000	25.593
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1995	79.250	52.000	110.000	24.998
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	1996	84.250	57.000	111.000	23.114
41033	1992	M-37 NB/SB, Kent County	D	7.444	7.917	2000	99.000	74.000	120.000	23.259
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1993	101.000	58.000	183.000	36.980
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1994	99.071	55.000	181.000	38.968
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1995	104.214	59.000	189.000	41.830
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1996	103.286	55.000	194.000	41.564
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	1999	116.929	58.000	241.000	51.545
47013	1992	US-23 NB/SB, Livingston County	I	5.494	6.951	2003	87.143	49.000	145.000	31.647
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1993	102.714	57.000	164.000	42.081
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1994	99.571	63.000	177.000	41.785
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1995	96.500	62.000	172.000	42.611
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1996	104.786	55.000	170.000	45.037
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	1999	120.692	74.000	192.000	44.806
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	2001	148.077	70.000	349.000	86.724
47013	1992	US-23 NB/SB, Livingston County	D	5.494	6.951	2003	81.000	54.000	123.000	20.025
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1993	63.783	46.000	109.000	13.501
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1994	66.130	48.000	118.000	12.540
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1995	68.014	51.000	105.000	11.735
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1996	69.696	53.000	114.000	12.302
47014	1992	US-23 NB/SB, Livingston County	I	0.000	7.165	1999	83.620	55.000	171.000	23.618
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1993	60.771	45.000	101.000	10.984
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1994	63.286	43.000	112.000	13.164
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1995	64.986	47.000	103.000	12.249
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1996	67.671	43.000	104.000	14.770

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
47014	1992	US-23 NB/SB, Livingston County	D	0.000	7.165	1999	87.014	61.000	222.000	24.805
37013	1993	US-27 NB/SB, Isabella County	I	8.958	11.664	1994	53.308	40.000	72.000	6.710
37013	1993	US-27 NB/SB, Isabella County	I	8.958	11.664	1995	56.000	44.000	73.000	7.082
37013	1993	US-27 NB/SB, Isabella County	I	8.958	11.664	1996	55.846	45.000	72.000	6.143
37013	1993	US-27 NB/SB, Isabella County	D	9.007	11.382	1994	49.611	39.000	65.000	7.678
37013	1993	US-27 NB/SB, Isabella County	D	9.007	11.382	1995	53.682	42.000	65.000	7.141
37013	1993	US-27 NB/SB, Isabella County	D	9.007	11.382	1996	57.136	48.000	66.000	5.285
37013	1993	US-27 NB/SB, Isabella County	D	11.476	11.712	1995	56.000	56.000	56.000	0.000
37013	1993	US-27 NB/SB, Isabella County	D	11.476	11.712	1996	59.000	59.000	59.000	0.000
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1994	67.667	49.000	89.000	10.021
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1995	74.185	49.000	100.000	13.197
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1996	76.396	51.000	99.000	12.326
03112	1993	US-131 NB/SB, Allegan County	I	3.065	8.557	1999	71.074	53.000	91.000	9.914
03112	1993	US-131 NB/SB, Allegan County	D	3.065	3.521	1994	56.500	54.000	58.000	1.915
03112	1993	US-131 NB/SB, Allegan County	D	3.065	3.521	1995	62.500	60.000	65.000	2.082
03112	1993	US-131 NB/SB, Allegan County	D	3.065	3.521	1999	51.667	46.000	55.000	4.933
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1994	63.255	47.000	99.000	11.569
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1995	72.596	48.000	101.000	11.549
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1996	73.000	54.000	99.000	10.974
03112	1993	US-131 NB/SB, Allegan County	D	3.762	8.557	1999	63.915	43.000	101.000	12.321
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1994	46.524	31.000	88.000	11.417
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1995	51.444	38.000	88.000	9.689
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1996	53.221	35.000	93.000	10.261
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	1999	75.388	45.000	133.000	18.522
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	2001	94.500	54.000	157.000	20.029
33084	1993	I-96 EB/WB, Ingham County	I	8.979	17.491	2003	89.953	61.000	168.000	17.885
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1994	41.108	30.000	59.000	6.565
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1995	52.280	40.000	72.000	7.918
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1996	51.763	40.000	69.000	6.914
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	1999	58.209	41.000	112.000	13.719
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	2001	60.733	39.000	142.000	15.020
33084	1993	I-96 EB/WB, Ingham County	D	8.854	17.495	2003	56.116	39.000	115.000	12.808

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
13033	1993	I-194/M-66 NB/SB, Calhoun County	I	0.492	1.679	1995	68.909	55.000	85.000	10.691
13033	1993	I-194/M-66 NB/SB, Calhoun County	I	0.492	1.679	1996	66.636	54.000	81.000	9.760
13033	1993	I-194/M-66 NB/SB, Calhoun County	I	0.492	1.679	1999	75.000	63.000	86.000	7.141
13033	1993	I-194/M-66 NB/SB, Calhoun County	D	0.492	1.679	1995	64.909	52.000	76.000	6.891
13033	1993	I-194/M-66 NB/SB, Calhoun County	D	0.492	1.679	1996	64.182	51.000	84.000	9.745
13033	1993	I-194/M-66 NB/SB, Calhoun County	D	0.492	1.679	1999	64.909	51.000	117.000	18.052
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	1994	62.526	42.000	91.000	15.543
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	1995	67.158	45.000	110.000	18.933
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	1996	65.579	46.000	99.000	18.295
41013	1993	M-44 EB/WB, Kent County	I	0.699	2.669	2004	83.579	54.000	129.000	21.498
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	1994	60.368	39.000	101.000	15.756
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	1995	63.632	46.000	103.000	15.614
41013	1993	M-44 EB/WB, Kent County	D	0.699	2.669	1996	66.722	53.000	99.000	13.257
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	1995	65.462	50.000	101.000	14.791
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	1996	27.917	24.000	34.000	2.746
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	1999	45.933	29.000	102.000	20.541
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	2001	46.286	32.000	97.000	18.586
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	2003	43.933	30.000	88.000	20.044
33083	1994	I-96 EB/WB, Ingham	I	2.105	3.689	2005	37.333	28.000	44.000	4.097
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	1995	63.750	54.000	94.000	13.264
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	1996	33.000	27.000	37.000	4.375
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	1999	49.900	31.000	95.000	23.572
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	2001	79.900	46.000	132.000	29.034
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	2003	55.900	40.000	115.000	25.071
33084	1994	I-96 EB/WB, Ingham	I	0.000	1.070	2005	43.875	37.000	58.000	6.446
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	1996	35.400	30.000	43.000	3.534
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	1999	41.615	30.000	112.000	21.539
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	2001	69.538	44.000	157.000	32.446
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	2003	56.769	38.000	133.000	26.712
33083	1995	I-96 EB/WB, Ingham	D	2.375	3.689	2005	42.889	37.000	49.000	3.689
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	1996	33.400	32.000	35.000	1.517
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	1999	31.400	24.000	37.000	4.722

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	2001	44.800	39.000	53.000	5.404
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	2003	38.000	30.000	46.000	5.477
33084	1995	I-96 EB/WB, Ingham	D	0.000	0.662	2005	40.000	34.000	43.000	3.742
25092	1994	M-15, Genesee County	I	8.610	8.904	1995	86.500	82.000	91.000	6.364
25092	1994	M-15, Genesee County	D	8.610	8.904	1996	83.000	73.000	93.000	14.142
25092	1994	M-15, Genesee County	I	8.610	8.904	2000	109.000	108.000	110.000	1.414
56021	1994	M-20 WB, Midland County	D	6.053	10.589	1995	31.432	24.000	45.000	3.914
56021	1994	M-20 WB, Midland County	D	6.053	10.589	1996	41.341	35.000	53.000	3.716
56021	1994	M-20 WB, Midland County	D	6.053	10.589	2000	49.511	35.000	98.000	9.368
74012	1995	M-53, Sanilac County	D	9.000	13.000	1996	47.692	38.000	79.000	7.831
74012	1995	M-53, Sanilac County	I	9.000	13.000	2000	66.250	49.000	138.000	17.633
74012	1995	M-53, Sanilac County	I	9.000	13.000	2002	63.400	46.000	168.000	19.804
41033	1995	M-37 NB/SB, Kent County	I	7.925	10.610	1996	63.440	47.000	125.000	17.248
41033	1995	M-37 NB/SB, Kent County	I	10.762	15.815	1996	55.100	40.000	90.000	11.332
41033	1995	M-37 NB/SB, Kent County	D	7.965	10.606	1996	54.833	40.000	77.000	8.746
41033	1995	M-37 NB/SB, Kent County	D	7.965	10.606	2000	86.760	52.000	112.000	16.799
41033	1995	M-37 NB/SB, Kent County	D	10.758	15.815	1996	51.220	40.000	70.000	7.993
41033	1995	M-37 NB/SB, Kent County	D	10.758	15.815	2000	63.837	27.000	105.000	20.832
01052	1996	US-23, Alcona County	I	0.491	2.470	1999	45.316	35.000	57.000	5.427
01052	1996	US-23, Alcona County	I	0.491	2.470	2001	62.421	50.000	78.000	8.228
70024	1996	I-196 EB, Ottawa County	I	12.589	15.591	1999	46.034	35.000	80.000	9.515
70024	1996	I-196 EB, Ottawa County	I	12.589	15.591	2001	70.138	50.000	106.000	12.727
70024	1996	I-196 EB, Ottawa County	I	12.589	15.591	2003	58.207	47.000	102.000	11.733
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	1999	55.182	51.000	59.000	2.857
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	2001	72.364	62.000	82.000	5.500
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	2003	61.909	50.000	68.000	5.356
03111	1997	US-131 NB/SB, Allegan County	I	6.728	7.959	2005	61.182	51.000	68.000	5.456
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	1999	55.727	50.000	72.000	6.246
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	2001	82.091	64.000	103.000	11.768
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	2003	62.545	56.000	79.000	6.154
03111	1997	US-131 NB/SB, Allegan County	D	6.728	7.959	2005	60.364	54.000	83.000	8.016

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	1999	56.333	47.000	65.000	4.971
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	2001	87.278	66.000	104.000	11.646
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	2003	62.833	56.000	74.000	5.032
03112	1997	US-131 NB/SB, Allegan County	I	0.015	1.941	2005	63.722	56.000	74.000	5.799
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	1999	52.900	41.000	70.000	9.689
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	2001	79.500	64.000	99.000	13.058
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	2003	62.500	50.000	80.000	11.501
03112	1997	US-131 NB/SB, Allegan County	I	2.076	3.102	2005	61.200	46.000	83.000	12.839
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	1999	59.625	52.000	71.000	5.553
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	2001	83.875	69.000	99.000	10.602
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	2003	65.625	61.000	76.000	5.502
03112	1997	US-131 NB/SB, Allegan County	D	0.015	0.893	2005	65.250	60.000	76.000	5.258
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	1999	52.667	47.000	60.000	5.279
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	2001	83.167	70.000	97.000	10.420
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	2003	59.500	53.000	66.000	4.722
03112	1997	US-131 NB/SB, Allegan County	D	1.184	1.941	2005	58.167	52.000	65.000	4.708
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	1999	59.222	51.000	69.000	5.869
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	2001	86.889	79.000	103.000	7.623
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	2003	65.889	54.000	86.000	10.374
03112	1997	US-131 NB/SB, Allegan County	D	2.076	3.102	2005	67.556	55.000	91.000	10.795
70024	1997	I-196 EB, Ottawa County	I	6.581	10.575	1999	70.128	53.000	157.000	17.068
70024	1997	I-196 EB, Ottawa County	I	6.581	10.575	2001	103.590	79.000	212.000	22.540
70024	1997	I-196 EB, Ottawa County	I	6.581	10.575	2003	87.051	61.000	188.000	21.001
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	1999	56.000	51.000	63.000	6.245
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	2001	70.667	69.000	74.000	2.887
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	2003	55.000	51.000	60.000	4.583
13033	1997	I-194/M-66 NB/SB, Calhoun County	I	0.057	0.492	2005	71.000	59.000	95.000	20.785
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	1999	60.000	52.000	74.000	9.764
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	2001	71.250	62.000	84.000	9.215
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	2003	60.250	44.000	71.000	12.176
13033	1997	I-194/M-66 NB/SB, Calhoun County	D	0.022	0.492	2005	60.000	43.000	76.000	16.523

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	1999	46.159	27.000	104.000	12.755
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	2001	59.203	40.000	121.000	15.476
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	2003	50.870	30.000	113.000	15.624
70013	1997	US-31 NB, Ottawa County	I	1.233	8.278	2005	52.179	32.000	105.000	16.442
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	1999	35.225	26.000	53.000	4.875
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	2001	46.525	35.000	70.000	7.042
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	2003	37.975	29.000	72.000	7.347
70013	1997	US-31 NB, Ottawa County	I	8.933	13.013	2005	38.675	31.000	61.000	5.502
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	1999	50.500	40.000	83.000	6.951
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	2001	78.653	53.000	161.000	17.616
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	2003	55.361	42.000	123.000	11.044
37014	1997	US-27 NB/SB, Isabella County	I	7.150	14.426	2005	56.282	43.000	92.000	9.073
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	1999	57.306	44.000	120.000	10.107
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	2001	75.778	53.000	161.000	14.375
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	2003	64.653	50.000	101.000	8.459
37014	1997	US-27 NB/SB, Isabella County	D	7.206	14.509	2005	65.347	52.000	88.000	7.279
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	1999	49.611	36.000	171.000	18.789
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	2001	76.907	51.000	147.000	16.472
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	2003	59.407	44.000	129.000	14.378
37014	1998	US-27 NB/SB, Isabella County	I	1.540	7.011	2005	59.038	46.000	88.000	9.963
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	1999	55.455	35.000	174.000	24.374
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	2001	74.291	45.000	212.000	30.981
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	2003	65.673	42.000	210.000	26.435
37014	1998	US-27 NB/SB, Isabella County	D	1.569	7.135	2005	62.415	42.000	110.000	13.058
74073	1998	M-25, Sanilac County	I	0.483	4.937	2000	60.500	47.000	76.000	6.957
74073	1998	M-25, Sanilac County	I	0.483	4.937	2002	55.455	45.000	72.000	6.522
74073	1998	M-25, Sanilac County	I	0.483	4.937	2004	58.159	44.000	72.000	6.577
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	1999	54.125	43.000	76.000	11.495
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	2001	73.000	45.000	96.000	17.230
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	2003	63.375	51.000	80.000	10.225
41026	1998	I-96 & I-296 EB/WB, Kent County	I	4.725	5.639	2005	65.750	51.000	81.000	10.727

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	1999	65.000	65.000	65.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	2001	87.000	87.000	87.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	2003	79.000	79.000	79.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	I	5.865	6.096	2005	83.000	83.000	83.000	0.000
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	1999	44.667	35.000	55.000	10.017
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	2001	67.667	61.000	80.000	10.693
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	2003	53.000	41.000	66.000	12.530
41026	1998	I-96 & I-296 EB/WB, Kent County	D	4.760	5.199	2005	51.333	45.000	61.000	8.505
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	1999	54.400	46.000	65.000	8.264
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	2001	77.600	65.000	95.000	11.459
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	2003	68.000	54.000	93.000	15.764
41026	1998	I-96 & I-296 EB/WB, Kent County	D	5.511	6.068	2005	65.250	54.000	76.000	9.430
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	1999	58.000	42.000	64.000	9.192
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	2001	154.250	78.000	358.000	135.962
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	2003	146.500	73.000	363.000	144.339
41131	1998	I-96 & I-296 EB/WB, Kent County	D	17.357	17.881	2005	70.000	59.000	78.000	9.849
41131	1998	I-96 & I-296 EB/WB, Kent County	I	17.586	17.761	1999	52.000	52.000	52.000	0.000
41131	1998	I-96 & I-296 EB/WB, Kent County	I	17.586	17.761	2001	248.000	248.000	248.000	0.000
41131	1998	I-96 & I-296 EB/WB, Kent County	I	17.586	17.761	2003	202.000	202.000	202.000	0.000
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	1999	82.241	40.000	249.000	57.195
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	2001	101.204	59.000	344.000	62.195
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	2003	86.093	49.000	281.000	53.056
41029	1998	I-196 EB/WB, Kent County	I	1.135	6.653	2005	65.932	50.000	134.000	17.035
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	1999	70.056	36.000	206.000	37.689
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	2001	90.833	44.000	282.000	50.771
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	2003	82.037	46.000	212.000	41.317
41029	1998	I-196 EB/WB, Kent County	D	1.115	6.659	2005	66.209	42.000	144.000	22.167
04031	1999	US-23, Alpena County	I	0.000	0.241	2001	62.000	54.000	70.000	11.314
04031	1999	US-23, Alpena County	I	0.000	0.241	2003	56.500	50.000	63.000	9.192
04031	1999	US-23, Alpena County	I	0.000	0.241	2005	53.000	48.000	58.000	7.071
04031	1999	US-23, Alpena County	I	0.449	0.908	2001	62.750	58.000	68.000	4.272
04031	1999	US-23, Alpena County	I	0.449	0.908	2003	61.250	59.000	66.000	3.202

Control Section	Year Rubblized	Location	Direction	POB Milepost	POE Milepost	Test Year	Avg IRI	Min	Max	StDev
04031	1999	US-23, Alpena County	I	0.449	0.908	2005	60.250	56.000	68.000	5.315
04031	1999	US-23, Alpena County	I	1.404	2.248	2001	54.714	45.000	60.000	5.155
04031	1999	US-23, Alpena County	I	1.404	2.248	2003	52.714	39.000	69.000	9.340
04031	1999	US-23, Alpena County	I	1.404	2.248	2005	58.286	49.000	70.000	8.480
04031	1999	US-23, Alpena County	I	4.218	7.893	2001	56.857	38.000	121.000	19.829
04031	1999	US-23, Alpena County	I	4.218	7.893	2003	52.657	35.000	116.000	19.873
04031	1999	US-23, Alpena County	I	4.218	7.893	2005	52.710	37.000	68.000	7.807
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	I	3.200	8.691	2001	61.400	39.000	227.000	30.018
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	I	3.200	8.691	2003	54.691	32.000	163.000	25.977
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	I	3.200	8.691	2005	43.412	29.000	101.000	10.259
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	D	3.205	8.691	2001	59.963	38.000	246.000	31.560
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	D	3.205	8.691	2003	53.000	37.000	222.000	33.077
41133	1999	US-131 NB/SB, Kent & Montcalm Counties	D	3.205	8.691	2005	43.720	32.000	98.000	10.375
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	I	0.000	4.214	2001	59.381	41.000	121.000	13.263
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	I	0.000	4.214	2003	47.190	38.000	86.000	9.208
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	I	0.000	4.214	2005	43.310	33.000	65.000	6.916
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	D	0.000	4.233	2001	50.171	37.000	68.000	7.436
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	D	0.000	4.233	2003	47.951	38.000	91.000	8.815
59012	1999	US-131 NB/SB, Kent & Montcalm Counties	D	0.000	4.233	2005	42.405	33.000	88.000	8.715
41033	2000	M-37/M-46, Kent & Muskegon Counties	I	15.738	17.120	2002	58.615	44.000	88.000	12.686
41033	2000	M-37/M-46, Kent & Muskegon Counties	I	15.738	17.120	2004	58.923	42.000	92.000	13.432
61171	2000	M-37/M-46, Kent & Muskegon Counties	I	0.000	0.571	2002	67.500	54.000	79.000	10.114
61171	2000	M-37/M-46, Kent & Muskegon Counties	I	0.000	0.571	2004	63.800	54.000	74.000	7.430

APPENDIX I – STATISTICAL ANALYSIS RESULTS FOR REVIEW OF RFB DATA FOR OUTLIERS

Control Section	DI	Age	Model Prediction	Residual	T-Statistics from Outlier Test	Leverage	Cook's Distance
34031/34032	400.000	15	140.896	259.104	11.705	0.279	5.753
16092	31.791	15	140.896	-108.896	-4.094	0.279	1.016
16092	65.278	15	140.896	-75.896	-2.806	0.279	0.494
41033	269.180	5	14.8332	254.167	9.147	0.018	0.198
33084	227.419	10	24.4949	202.505	6.926	0.028	0.195
34031/34032	195.738	11	33.0955	162.905	5.420	0.036	0.165
41026/41131	4.621	13	67.9679	-62.9679	-2.020	0.056	0.040
41133/59012	5.547	13	67.9679	-61.9679	-1.987	0.056	0.038
34031/34032	119.824	9	19.4581	100.542	3.205	0.021	0.035
34031/34032	116.804	13	67.9679	49.0321	1.568	0.056	0.024
13033	19.516	13	67.9679	-47.9679	-1.533	0.056	0.023
16092	33.704	13	67.9679	-33.9679	-1.083	0.056	0.012
20014	11.658	12	46.9333	-34.9333	-1.107	0.043	0.009
13081	61.665	5	14.8332	47.1668	1.479	0.018	0.007
13081	61.915	9	22.7978	39.2022	1.232	0.026	0.007
37013	8.663	11	36.4352	-27.4352	-0.871	0.048	0.006
09101/09042	19.209	12	46.9333	-27.9333	-0.884	0.043	0.006
20014	4.760	11	33.0955	-28.0955	-0.886	0.036	0.005
34031/34032	56.410	9	19.4581	36.5419	1.145	0.021	0.005
34031/34032	58.933	5	11.4935	47.5065	1.484	0.012	0.004
41033	18.040	11	36.4352	-18.4352	-0.585	0.048	0.003
41131	11.970	11	33.0955	-21.0955	-0.665	0.036	0.003
41131	14.728	11	33.0955	-18.0955	-0.570	0.036	0.002
34031/34032	41.908	7	14.8126	27.1874	0.848	0.015	0.002
03111/03112	1.699	5	8.10107	-6.10107	-0.204	0.145	0.001
16021	39.774	10	24.4949	15.5051	0.487	0.028	0.001
16021	21.908	11	33.0955	-11.0955	-0.350	0.036	0.001
13081	4.847	9	19.4581	-14.4581	-0.452	0.021	0.001
34031/34032	32.091	7	14.8126	17.1874	0.536	0.015	0.001
16092	22.339	5	7.18885	14.8111	0.463	0.019	0.001
13081	44.701	11	36.4352	8.56484	0.271	0.048	0.001
41029	1.708	8	16.5977	-14.5977	-0.455	0.016	0.001
01052	2.606	6	16.6272	-13.6272	-0.425	0.018	0.001
16092	32.452	9	19.4581	12.5419	0.392	0.021	0.001
13033	12.000	9	22.7978	-10.7978	-0.338	0.026	0.001
47013/47014	0.555	7	14.8126	-13.8126	-0.430	0.015	0.000
13033	12.805	9	22.7978	-9.79776	-0.307	0.026	0.000
47013/47014	8.740	9	19.4581	-10.4581	-0.327	0.021	0.000
47013/47014	6.537	7	18.1523	-11.1523	-0.348	0.018	0.000
41133/59012	1.787	4	12.5273	-10.5273	-0.329	0.018	0.000
41026/41131	1.799	4	12.5273	-10.5273	-0.329	0.018	0.000

Control Section	DI	Age	Model Prediction	Residual	T-Statistics from Outlier Test	Leverage	Cook's Distance
13033	5.767	8	16.5977	-10.5977	-0.331	0.016	0.000
13033	1.800	6	13.2875	-11.2875	-0.352	0.014	0.000
41033	1.819	6	13.2875	-11.2875	-0.352	0.014	0.000
09101/09042	29.031	8	19.9374	9.06259	0.283	0.020	0.000
33083/33084	10.504	9	19.4581	-8.45806	-0.264	0.021	0.000
47013/47014	8.922	7	18.1523	-9.15226	-0.286	0.018	0.000
47013/47014	2.738	6	13.2875	-10.2875	-0.320	0.014	0.000
41033	2.769	6	13.2875	-10.2875	-0.320	0.014	0.000
33084	0.564	3	9.75262	-8.75262	-0.273	0.018	0.000
33083/33084	3.532	4	12.5273	-8.52725	-0.266	0.018	0.000
34031/34032	3.621	4	12.5273	-8.52725	-0.266	0.018	0.000
41029	0.661	5	11.4935	-10.4935	-0.327	0.012	0.000
25092	0.731	5	11.4935	-10.4935	-0.327	0.012	0.000
16032	0.744	5	11.4935	-10.4935	-0.327	0.012	0.000
47013/47014	18.133	10	24.4949	-6.49487	-0.204	0.028	0.000
13033	3.635	6	13.2875	-9.28749	-0.289	0.014	0.000
13081	9.919	7	18.1523	-8.15226	-0.254	0.018	0.000
41033	24.915	8	16.5977	8.40229	0.262	0.016	0.000
17062	20.595	5	11.4935	9.50654	0.296	0.012	0.000
16021	1.914	5	11.4935	-9.49346	-0.295	0.012	0.000
16021	1.958	5	11.4935	-9.49346	-0.295	0.012	0.000
41131	4.991	4	12.5273	-7.52725	-0.235	0.018	0.000
16092	19.742	4	12.5273	7.47275	0.233	0.018	0.000
17062	26.816	8	19.9374	7.06259	0.221	0.020	0.000
41033	5.009	6	13.2875	-8.28749	-0.258	0.014	0.000
41131	5.026	6	13.2875	-8.28749	-0.258	0.014	0.000
33084	6.613	7	14.8126	-7.81256	-0.243	0.015	0.000
37014	0.000	2	6.83856	-6.83856	-0.214	0.019	0.000
41026/41131	0.000	2	6.83856	-6.83856	-0.214	0.019	0.000
41013	2.789	5	11.4935	-8.49346	-0.264	0.012	0.000
09101/09042	7.644	5	14.8332	-6.83316	-0.213	0.018	0.000
03112	2.799	3	9.75262	-6.75262	-0.211	0.018	0.000
34031/34032	2.875	1	-3.24389	6.24389	0.195	0.020	0.000
09101/09042	23.378	6	16.6272	6.37281	0.199	0.018	0.000
37014	2.884	6	8.98288	-5.98288	-0.187	0.020	0.000
70024	2.910	6	8.98288	-5.98288	-0.187	0.020	0.000
03111/03112	0.003	4	9.18755	-9.18755	-0.285	0.009	0.000
61171	0.014	4	9.18755	-9.18755	-0.285	0.009	0.000
37014	0.015	4	9.18755	-9.18755	-0.285	0.009	0.000
33083/33084	9.968	8	16.5977	-6.59771	-0.206	0.016	0.000

Control Section	DI	Age	Model Prediction	Residual	T-Statistics from Outlier Test	Leverage	Cook's Distance
13081	7.968	7	14.8126	-6.81256	-0.212	0.015	0.000
17062	3.681	5	11.4935	-7.49346	-0.233	0.012	0.000
47013/47014	3.767	5	11.4935	-7.49346	-0.233	0.012	0.000
37014	0.760	2	6.83856	-5.83856	-0.182	0.019	0.000
41033	0.780	2	6.83856	-5.83856	-0.182	0.019	0.000
41013	0.877	2	6.83856	-5.83856	-0.182	0.019	0.000
41131	8.940	5	14.8332	-5.83316	-0.182	0.018	0.000
20014	9.153	5	14.8332	-5.83316	-0.182	0.018	0.000
41131	0.918	4	9.18755	-8.18755	-0.254	0.009	0.000
16092	20.925	7	14.8126	6.18744	0.193	0.015	0.000
33084	6.719	6	13.2875	-6.28749	-0.196	0.014	0.000
41013	6.913	6	13.2875	-6.28749	-0.196	0.014	0.000
33083/33084	2.023	1	-3.24389	5.24389	0.164	0.020	0.000
25092	5.034	5	11.4935	-6.49346	-0.202	0.012	0.000
70013	3.881	6	8.98288	-4.98288	-0.156	0.020	0.000
09101/09042	12.834	7	18.1523	-5.15226	-0.161	0.018	0.000
16092	2.115	4	9.18755	-7.18755	-0.223	0.009	0.000
41029	2.131	4	9.18755	-7.18755	-0.223	0.009	0.000
47013/47014	2.153	4	9.18755	-7.18755	-0.223	0.009	0.000
37014	0.023	4	4.88294	-4.88294	-0.152	0.017	0.000
03111/03112	0.027	4	4.88294	-4.88294	-0.152	0.017	0.000
33084	5.083	3	9.75262	-4.75262	-0.148	0.018	0.000
41131	5.093	3	9.75262	-4.75262	-0.148	0.018	0.000
41026/41131	4.033	2	-0.805754	4.80575	0.150	0.018	0.000
70013	0.027	1	4.40042	-4.40042	-0.138	0.021	0.000
56021	0.031	1	4.40042	-4.40042	-0.138	0.021	0.000
41033	19.466	9	22.7978	-3.79776	-0.119	0.026	0.000
09101/09042	31.159	10	27.8346	3.16543	0.100	0.036	0.000
41131	6.023	5	11.4935	-5.49346	-0.171	0.012	0.000
74012	21.420	6	16.6272	4.37281	0.136	0.018	0.000
41131	2.959	5	7.18885	-4.18885	-0.131	0.019	0.000
03112	2.983	4	9.18755	-6.18755	-0.192	0.009	0.000
37013	10.766	5	7.18885	3.81115	0.119	0.019	0.000
70024	0.929	4	4.88294	-3.88294	-0.121	0.017	0.000
16032	6.047	3	9.75262	-3.75262	-0.117	0.018	0.000
03111/03112	0.958	1	4.40042	-3.40042	-0.106	0.021	0.000
20014	9.262	4	12.5273	-3.52725	-0.110	0.018	0.000
33083/33084	0.032	1	-3.24389	3.24389	0.101	0.020	0.000
74073	0.035	1	-3.24389	3.24389	0.101	0.020	0.000
74073	0.035	1	-3.24389	3.24389	0.101	0.020	0.000
70024	0.036	1	-3.24389	3.24389	0.101	0.020	0.000

Control Section	DI	Age	Model Prediction	Residual	T-Statistics from Outlier Test	Leverage	Cook's Distance
41026/41131	0.050	1	-3.24389	3.24389	0.101	0.020	0.000
37014	0.054	3	6.41292	-6.41292	-0.199	0.005	0.000
61171	0.067	3	6.41292	-6.41292	-0.199	0.005	0.000
01052/04031	4.157	2	6.83856	-2.83856	-0.089	0.019	0.000
70024	5.131	4	9.18755	-4.18755	-0.130	0.009	0.000
37014	10.005	6	13.2875	-3.28749	-0.102	0.014	0.000
70024	10.014	6	13.2875	-3.28749	-0.102	0.014	0.000
03112	2.300	4	4.88294	-2.88294	-0.090	0.017	0.000
41033	2.381	4	4.88294	-2.88294	-0.090	0.017	0.000
34031/34032	21.496	7	18.1523	2.84774	0.089	0.018	0.000
41133/59012	0.966	3	6.41292	-5.41292	-0.168	0.005	0.000
41029	1.000	3	6.41292	-5.41292	-0.168	0.005	0.000
74012	1.020	3	6.41292	-5.41292	-0.168	0.005	0.000
13081	12.952	4	9.18755	3.81245	0.118	0.009	0.000
33084	2.483	1	4.40042	-2.40042	-0.075	0.021	0.000
16092	12.136	7	14.8126	-2.81256	-0.088	0.015	0.000
47013/47014	6.115	4	9.18755	-3.18755	-0.099	0.009	0.000
37014	6.262	4	9.18755	-3.18755	-0.099	0.009	0.000
13033	15.762	7	18.1523	-2.15226	-0.067	0.018	0.000
37013	0.118	3	2.10831	-2.10831	-0.066	0.017	0.000
41033	3.318	4	4.88294	-1.88294	-0.059	0.017	0.000
37013	4.178	3	2.10831	1.89169	0.059	0.017	0.000
41013	1.022	2	-0.805754	1.80575	0.056	0.018	0.000
41033	1.030	2	-0.805754	1.80575	0.056	0.018	0.000
41131	8.055	3	9.75262	-1.75262	-0.055	0.018	0.000
13033	14.863	6	16.6272	-1.62719	-0.051	0.018	0.000
16092	18.212	9	19.4581	-1.45806	-0.046	0.021	0.000
41013	9.309	3	6.41292	2.58708	0.080	0.005	0.000
03112	4.227	3	6.41292	-2.41292	-0.075	0.005	0.000
41131	4.244	3	6.41292	-2.41292	-0.075	0.005	0.000
16032	12.382	6	13.2875	-1.28749	-0.040	0.014	0.000
16092	6.403	4	4.88294	1.11706	0.035	0.017	0.000
13033	10.333	6	8.98288	1.01712	0.032	0.020	0.000
25092	16.179	7	14.8126	1.18744	0.037	0.015	0.000
03112	1.065	3	2.10831	-1.10831	-0.035	0.017	0.000
41013	1.074	3	2.10831	-1.10831	-0.035	0.017	0.000
74012	8.059	6	8.98288	-0.98288	-0.031	0.020	0.000
03111/03112	0.134	2	3.49886	-3.49886	-0.108	0.001	0.000
33083/33084	0.145	2	3.49886	-3.49886	-0.108	0.001	0.000
74012	0.160	2	3.49886	-3.49886	-0.108	0.001	0.000
33083/33084	4.292	4	4.88294	-0.88294	-0.028	0.017	0.000

Control Section	DI	Age	Model Prediction	Residual	T-Statistics from Outlier Test	Leverage	Cook's Distance
47013/47014	8.071	5	7.18885	0.811149	0.025	0.019	0.000
01052/04031	0.178	2	-0.805754	0.805754	0.025	0.018	0.000
41033	0.225	2	-0.805754	0.805754	0.025	0.018	0.000
37014	0.265	2	-0.805754	0.805754	0.025	0.018	0.000
33083/33084	0.309	2	-0.805754	0.805754	0.025	0.018	0.000
16021	0.368	2	-0.805754	0.805754	0.025	0.018	0.000
33084	5.220	3	6.41292	-1.41292	-0.044	0.005	0.000
37014	6.480	2	3.49886	2.50114	0.077	0.001	0.000
33083/33084	1.121	2	3.49886	-2.49886	-0.077	0.001	0.000
70024	1.141	2	3.49886	-2.49886	-0.077	0.001	0.000
17062	1.251	2	3.49886	-2.49886	-0.077	0.001	0.000
33084	1.287	2	3.49886	-2.49886	-0.077	0.001	0.000
01052	1.316	2	3.49886	-2.49886	-0.077	0.001	0.000
16092	16.290	6	16.6272	-0.62719	-0.020	0.018	0.000
74073	13.715	6	13.2875	0.712512	0.022	0.014	0.000
33084	13.310	4	12.5273	0.47275	0.015	0.018	0.000
16032	5.256	2	3.49886	1.50114	0.046	0.001	0.000
16021	5.371	2	3.49886	1.50114	0.046	0.001	0.000
47013/47014	8.360	5	8.10107	-0.10107	-0.003	0.145	0.000
17062	28.063	10	27.8346	0.165429	0.005	0.036	0.000
03111/03112	3.426	1	1.06072	1.93928	0.060	0.000	0.000
13081	18.475	7	18.1523	-0.15226	-0.005	0.018	0.000
03112	3.437	2	3.49886	-0.49886	-0.015	0.001	0.000
41131	5.493	4	4.88294	0.11706	0.004	0.017	0.000
09101/09042	2.490	3	2.10831	-0.10831	-0.003	0.017	0.000
41026/41131	0.435	1	1.06072	-1.06072	-0.033	0.000	0.000
41013	0.467	1	1.06072	-1.06072	-0.033	0.000	0.000
13033	0.491	1	1.06072	-1.06072	-0.033	0.000	0.000
16032	1.328	1	1.06072	-0.06072	-0.002	0.000	0.000
41029	1.402	1	1.06072	-0.06072	-0.002	0.000	0.000
13033	1.438	1	1.06072	-0.06072	-0.002	0.000	0.000