

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH
DIVISION

Experimental Study ND 03-01

**Comparison of Rehabilitation Strategies on
Long Term Ride Performance**

3rd Evaluation Report

Projects NH-6-081(053)192 &
NH-6-081(055)204

December 2013

Prepared by:

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
BISMARCK, NORTH DAKOTA
Website: <http://www.dot.nd.gov>

INTERIM DIRECTOR
Grant Levi, P.E.

MATERIALS AND RESEARCH DIVISION
Ron Horner, P.E.

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& NH-6-081(055)204

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Written by
Jared Loegering
Andy Mastel
John Wolf
Rebecca Espinoza

Disclaimer

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EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT	EXPERIMENTAL PROJECT NO.					CONSTRUCTION PROJ NO		LOCATION			
	1	STATE ND	YEAR 2003	NUMBER 01	SURF	NH-6-081(053)192 NH-6-081(055)204		Walsh and Pembina 28 County			
	EVALUATION FUNDING					NEEP NO.	PROPRIETARY FEATURE?				
	48	1	HP&R	3	DEMONSTRATION		Yes				
		2	CONSTRUCTION	4	IMPLEMENTATION	49	51	X No			
SHORT TITLE	TITLE 52 Comparison of Rehabilitation Strategies on Long Term Ride Performance										
THIS FORM	DATE	MO.	YR.	REPORTING							
	140	October	--	2010	1	INITIAL	2	X	ANNUAL	3	FINAL
KEY WORDS	KEY WORD 1					KEY WORD 2					
	145 Rehabilitation Strategies					167 Asphalt pavement					
	KEY WORD 3					KEY WORD 4					
	189 Performance					211 Structural Overlay					
	UNIQUE WORD					PROPRIETARY FEATURE NAME					
	233					255					
CHRONOLOGY	Date Work Plan Approved		Date Feature Constructed:		Evaluation Scheduled Until:		Evaluation Extended Until:		Date Evaluation Terminated:		
	3/2003		11/2005		11/2025				293		
	277		281		285		289				
QUANTITY AND COST	QUANTITY OF UNITS (ROUNDED TO WHOLE NUMBERS)				UNITS				UNIT COST (Dollars, Cents)		
					1 LIN. FT		5 TON				
					2 SY		6 LBS				
					3 SY-IN		7 EACH				
					4 CY		8 X LUMP SUM				
	297				305				306		
AVAILABLE EVALUATION REPORTS	CONSTRUCTION			PERFORMANCE			FINAL				
	x			x							
	245										
EVALUATION	CONSTRUCTION PROBLEMS					PERFORMANCE					
	1	NONE				1	EXCELLENT				
	2	X SLIGHT				2	GOOD				
	3	MODERATE				3	X SATISFACTORY				
	4	SIGNIFICANT				4	MARGINAL				
	5	SEVERE				5	UNSATISFACTORY				
	318					319					
APPLICATION	1	ADOPTED AS PRIMARY STD.			4	x PENDING		(Explain in remarks if 3, 4, 5, or 6 is checked)			
	2	PERMITTED ALTERNATIVE			5	REJECTED					
	3	ADOPTED CONDITIONALLY			6	NOT CONSTRUCTED					
REMARKS	321 The roadway did not show any signs of distresses in the pavement section shortly after construction. There were isolated areas where the pneumatic tire roller was picking up pavement, and some stretches needed blade patching where the paver automatic height adjusters were malfunctioning. Results from this ongoing study indicate that the pavement condition is continuing to deteriorate over time. Distresses in the roadway for all three sections have increased since construction. The IRI for the NB lane in Section 3 decreased in IRI since 2008 while the IRI on everything else has increased from initial construction. Section 2 and Section 3 have similar ride quality which is better than the ride quality in Section 1. Overall, the 3.5" AC overlay section has more visual distresses than the 5.0" overlay section which has more than the mine and blend section. The 4 th evaluation will take place in 2014 and 2015 with the next report being written in the fall of 2015.										

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3rd Evaluation Report

Comparison of Rehabilitation Strategies on Long Term Ride Performance

ND 2003-01

Purpose and Need

The NDDOT typically designs flexible pavements using a 20 year design life. Due to the types of materials used, environmental conditions, changes in traffic volumes, etc., not all pavements last 20 years. Some pavements will last longer than 20 years while other pavements fall short of their design life, which essentially becomes its effective service life. Whenever the pavement reaches the end of its service life, existing distresses in the pavement, safety concerns, and subgrade strengths will dictate the course of corrective action to be taken in order to maintain adequate ride quality while lowering maintenance cost.

Several rehabilitation strategies are available depending on the existing pavement condition. For pavements that are severely distressed, mine and blend or reconstruction is usually the best option to pursue. Some pavement sections are considered borderline as to the severity of the distresses, and the subsequent rehabilitation option that should be pursued. A question has been raised as to whether a mine and blend or reconstruction is necessary, or could a less costly HBP overlay be used to extend the service life of the roadway.

Hot Bituminous Pavement (HBP) overlays have been a standard rehabilitation method used by virtually all State Highway Agencies, including the NDDOT for numerous years. However, in choosing the overlay option, existing distresses in the pavement may reoccur in several years after the overlay is constructed. The primary distress that occurs in the overlay comes from cracks that reflect through from the existing pavement structure. These cracks can degrade the ride quality after several years as well as increase maintenance costs. It has been proposed that overlays thicker than the standard 20 year design life maybe an effective and economical approach to extend the service life of flexible pavements.

Objective

This study will evaluate the use of various rehabilitation strategies for extending the effective service life of NDDOT roadways. The objective of this study is to determine which rehabilitation strategy is most effective in correcting existing roadway distresses. The objective will be met by selecting a roadway exhibiting distresses that are deemed borderline as to which rehabilitation strategy to pursue, and construct multiple sections based on the rehabilitation options in question.

Scope

To compare rehabilitation strategies, sections of the roadway will be rehabilitated using the following designs:

- 20-year design for Mine and Blend with HBP overlay
- 20-year design for HBP overlay
- HBP overlay greater than the standard 20-year overlay design

The projects will be evaluated over a 20 year period or until failure with the possibility of extending the evaluations based on the performance after 20 years. The items that will be monitored and evaluated are as follows:

- Distresses (cracks, rutting, etc.)
- Ride (IRI)
- Construction and maintenance costs (from RIMS)

Location

Two projects were selected for evaluation. They are NH-6-081(053)192 and NH-6-081(055)204, with the projects being built in 2005 and 2008 respectively. The projects are located in Pembina and Walsh Counties on US Highway 81 from RP 192.427 to RP 218.476. The projects start north of Grafton and proceeds to the junction of ND 5 at Hamilton. Refer to Figure 1 for the location of the research sections.

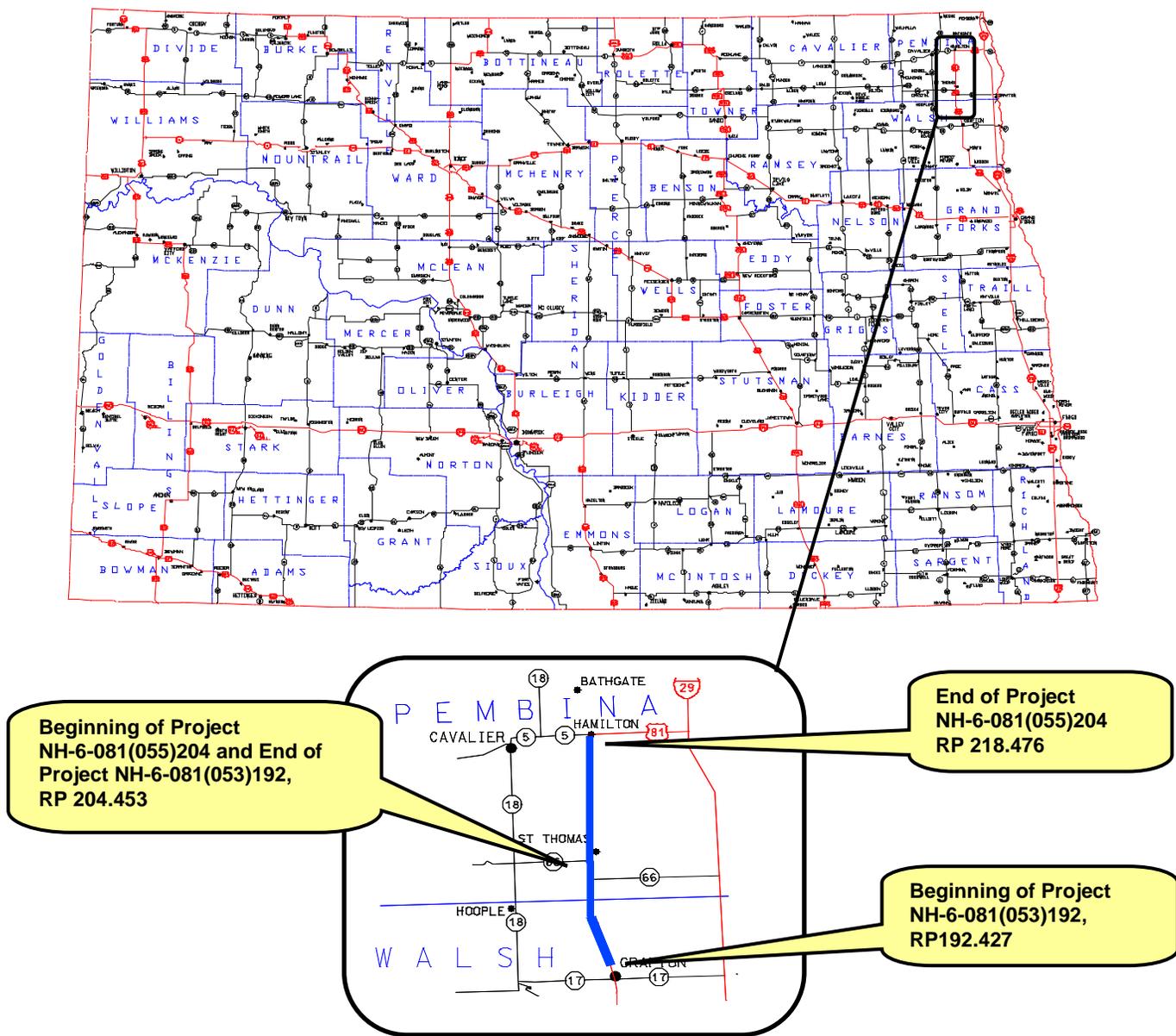


Figure 1 - Project Location.

Project History

RIMS Data

The existing roadway section in RIMS is as follows:

RP 192.3135		NORTH URBAN LIMITS TO COUNTY LINE			7.8415 Miles		
Surface Components	Left Shld.	Roadway Width	Right Shld.	Year	Material	Depth	
Grade		36'		1940			
Stabilized Base		32'		1944		6.0"	
Cold Bituminous Pavement		22'		1944	MC-3	1.5"	
Hot Bit Pavement		32'		1958	150-200	1.5"	
Hot Bit Pavement		24'		1958	120-150	2.0"	
Hot Bit Pavement		24'		1975	200-300	2.0"	
Hot Bit Pavement	1.5'		1.5'	1975	200-300	2.0"	
Reclamite				1977			
Contract Chip Seal		24'		1989	MC-3000		
Int Cont Patch-1.5"		24'		1993	120-150		
Comments: PCN 12201 widened shoulders and placed Class 5 Aggr. on widened part of shoulder, also installed right and left turn lanes.							

RP 200.2680		CO LN N TO N JCT 66 ST THOMAS			4.1917 Miles		
Surface Components	Left Shld.	Roadway Width	Right Shld.	Year	Material	Depth	
Grade		36'		1947			
Aggregate Base		26'		1947		2.5"	
Aggregate Base		33'		1948		5.0"	
Stabilized Base		32'		1948		2.0"	
Hot Bit Pavement		22'		1948	120-150	2.0"	
Hot Bit Pavement		24'		1975	200-300	2.0"	
Hot Bit Pavement	1.5'		1.5'	1975	200-300	2.5"	
Reclamite				1977			
Contract Chip Seal		24'		1989	MC-3000		
Int Cont Patch-1.5"		24'		1993	120-150		
Comments: PCN 12201 widened shoulders and placed Class 5 Aggr. on widened part of shoulder, also installed right and left turn lanes.							

The traffic data for the two projects involved in this research project is listed in Table 1 below.

Year	Project	Project Limits	Passenger Car	Truck	Total	30 th Max Hr	Two-way Flex ESALs
2000	NH-6-081(053)192	RP192.427-204.453	1,850	350	2,200	220	280
2005	NH-6-081(055)204	RP204.453-215.672	685	140	825	85	105

Table 1: Traffic Data

Design Summary

NH-6-081(053)192

The 1993 AASHTO Design Guide was used to calculate the required 20 year design life overlay thickness and the required mine and blend section. The recommended overlay thickness is 3.5" of Class 31 HBP. The recommended thickness for the mine and blend section is 18" of total base with 7" of Class 31 HBP. It is proposed that the project be broken into segments of a 3.5" HBP overlay, 5.0" HBP overlay, and the mine and blend recommendation. These sections were chosen to determine the following; how soon reflective cracking will appear (within the overlay sections), which section will maintain the desired ride quality, which section will reach or surpass the desired design life, and also to compare the maintenance costs.

The 3.5" overlay will be from RP 192.427 to RP 196.000, the 5.0" overlay will be from RP 196.000 to RP 203.000, and the mine and blend section will be from RP 203.000 to RP 204.453. The proposed typical sections are located in Appendix A.

NH-6-081(055)204

The 1993 AASHTO Design Guide was used to calculate the required 20 year design life overlay thickness and the required mine and blend section. The recommended overlay thickness is 2.5" of Class 31 HBP. The recommended thickness for the mine and blend section is 18" of total base with 6.5" of Class 31 HBP. It is proposed that the project be broken into segments of a 2.5" HBP overlay, 3.5" HBP overlay, 5.0" HBP overlay, and the mine and blend recommendation. These sections were chosen to determine the following; how soon reflective cracking will appear (within the overlay sections), which section will maintain the desired ride quality, which section will reach or surpass the desired design life, and also compare the maintenance costs.

Construction Summary

NH-6-081(053)192

This project included widening the existing roadway, aggregate shoulders, culvert replacements and turn lanes. This project was constructed in the summer of 2005, and the prime contractor was Northstar Materials and the project engineer was Caleb Christman of the Grand Forks District. The cost of the project was \$3,131,856.

The project was broken into the following sections:

Section 1 – 3.5” overlay from RP 192.427 to 196.000

Section 2 – 5.0” overlay from RP 196.000 to 202.957

Section 3 – Mine & Blend from RP 202.957 to 204.453

The first lift of the overlay sections was placed as a leveling course, and placed by blade leveling. The remaining lifts were placed with a paver equipped with automatic height adjustment. An overview of Section 1 is show in Photo 1.



Photo 1 – Overview of Section 1

There were three areas of patching over the length of the project. These patches span from reference points 194.119 to 194.383, 194.497 to 194.516, and 197.452 to 197.471. The patches were results of a malfunction of the automatic height adjust on the paver during the final lift of paving. The patches were needed to achieve the minimum pavement thickness. All of the patches were in the southbound lane. An area that required blade patching after the final paver lift is shown below in Photo 2.



Photo 2 – Blade patching after final paver lift.

The southbound lane also had areas where the pneumatic tire roller had picked up asphalt from RP 193.0 to 194.5. This section of roadway was paved on an afternoon that was unseasonable cold and windy, which made it difficult to maintain a consistent temperature on the roller tires. There were no other surface deformations present at the time of the evaluation.



Photo 3 – Area where pneumatic roller tires picked up asphalt

On September 21, 2005 Materials and Research collected IRI data, using a light weight inertial profiler, over the entire length of the project. This information is listed in Appendix B. The IRI data was then broken down for Sections 1 through 3 listed below. Table 2 summarizes the data for the northbound and southbound lanes. It should be noted that on the afternoon the IRI data was collected there was some mud and asphalt paddies on the driving surface that may have had some small effect on the recorded IRI.

Location	RP	Rehab Strategy	Average IRI (9/21/05)	
			NB	SB
Section 1	192.427-196.000	3.5" AC overlay	50.7	60.1
Section 2	196.000-202.957	5.0" AC overlay	49.2	48.0
Section 3	202.957-204.468	Mine & Blend	41.8	55.7

Table 2: Average IRI values for each research section

Project NH-6-081(053)192 was otherwise completed as designed, and apart from the isolated areas that experienced problems during paving, the roadway does not show any conspicuous signs of distress in the pavement section. The initial IRI data shows

that Section 1 has the highest IRI values in both the northbound and southbound lanes of the three sections. Areas between RP 193.0 and 194.5 in the southbound lane where the pavement was being picked up by the pneumatic roller did seem to increase the IRI numbers in the southbound lane of Section 1. These problems that were experienced during paving should not affect the overall performance of the pavement.

This project will be monitored and evaluated every two years for 20 years, or until the effective service life has been met and the roadway requires rehabilitation.

NH-6-081(055)204

This project is to begin in the spring of 2007 with widening, culvert replacement and misc. The mine and blend, base, and surfacing will be completed in the fall of 2008.

Evaluation of project NH-6-081(055) 204 will commence after construction begins on this project and shall be included in the first evaluation of project NH-6-081(053)192.

First Evaluation-2008

Pavement Condition

On November 25, 2008 Materials and Research personnel traveled to the Highway 81 rehabilitation strategy test sections between RP 192.427-215.672. Project NH-6-081(053)192 is positioned between RP 192.427-204.453 and project NH-6-081(055)204 lies between RP 204.453-215.672. However, project NH-6-081(055)204 was delayed until summer 2008, at which point the entire length was reconstructed as a mine and blend project. For this reason, research concerning this section has been terminated.

Section 1, 3.5" AC Overlay:

No rutting was observed in this section of roadway. 129 transverse cracks were counted in this section, or 36 cracks/mile.

Section 2, 5.0" AC Overlay:

No rutting was observed in this section of roadway. 190 transverse cracks were counted in this section, or 27 cracks/mile.

Section 3, Mine and Blend:

No rutting was observed in this section of roadway. 2 transverse cracks were counted in this section, or 1.4 cracks/mile.

Roadway Profile

The roadway profile was collected by Materials and Research personnel with an Ames Engineering Model 6200 "LISA" roline laser profiler. The profile data is summarized below for each rehab strategy.

Section 1, 3.5" AC Overlay:

It was found that the IRI had increased from the 2005 data in the NB lane from 50.7 to 53.3, but decreased in the SB lane from 60.1 to 49.3. This decrease in IRI in the SB lane could be attributed to the fact that on the afternoon the IRI data was collected in 2005 there were some mud and asphalt paddies on the driving surface that may have had some small effect on the recorded IRI.

Section 2, 5.0" AC Overlay:

It was found that the IRI increased from the 2005 data in the NB lane from 49.2 to 54.8 and in the SB lane from 48.0 to 50.3.

Section 3, Mine and Blend:

It was found that the IRI increased from the 2005 data in the NB lane from 41.8 to 61.5, but decreased in the SB lane from 55.7 to 50.5. This decrease in IRI in the SB lane could be attributed to the fact that on the afternoon the IRI data was collected in 2005 there were some mud and asphalt paddies on the driving surface that may have had some small effect on the recorded.

It was found that Section 3 has the highest overall IRI followed by Section 2 and the best ride quality is the 3.5" AC overlay in Section 1. The data used to obtain these averages is located in Appendix D.

Second Evaluation-2010

Pavement Condition

The second evaluation was conducted in the fall of 2010 by Materials and Research Personnel. Cracks were counted and rutting was checked. It was observed that distresses on the roadway increased for all three segments, with the mine and blend section having the least amount of cracks per mile followed by the 5.0" AC overlay and then the 3.5" AC overlay sections.

Section 1, 3.5" AC Overlay:

No rutting was observed in this section of roadway. 307 transverse cracks were counted in this section, or 86 cracks/mile. This was an increase compared to the 2008 evaluation, which had 129 transverse cracks, or 36 cracks/mile.

Section 2, 5.0" AC Overlay:

No rutting was observed in this section of roadway. 307 transverse cracks were counted in this section, or 44 cracks/mile. This was an increase compared to the 2008 evaluation, which had 190 transverse cracks, or 27 cracks/mile.

Section 3, Mine and Blend:

No rutting was observed in this section of roadway. 9 transverse cracks were counted in this section, or 6 cracks/mile. This was an increase compared to the 2008 evaluation, which had 2 transverse cracks, or 1.4 cracks/mile.

Roadway Profile

There was no roadway profile collected for the 2010 evaluation.

Third Evaluation-2013

Pavement Condition

The third evaluation was conducted in the winter/spring of 2013 by Materials and Research Personnel. Cracks were counted and rutting was checked on February 26, 2013. It was observed that distresses on the roadway increased for all three segments, with the mine and blend section having the least amount of cracks per mile followed by the 5.0" AC overlay and then the 3.5" AC overlay sections. All of the transverse cracks were sealed.

Section 1, 3.5" AC Overlay:

No rutting was observed in this section of roadway. 358 transverse cracks were counted in this section, or 100 cracks/mile. This was an increase compared to the 2010 evaluation, which had 307 transverse cracks, or 86 cracks/mile. Some of the transverse cracks in this section were over an inch wide and were also starting to break up some along the edges of the cracks. Photo 3 below shows one of these transverse cracks:



Photo 4 – Transverse Crack in Section 1

Section 2, 5.0" AC Overlay:

No rutting was observed in this section of roadway. 389 transverse cracks were counted in this section, or 56 cracks/mile. This was an increase compared to the 2010 evaluation, which had 307 transverse cracks, or 44 cracks/mile. Some the transverse cracks in section 2 were almost an inch wide. Photo 5 below shows one these cracks:



Photo 5, Transverse Crack in Section 2

Section 3, Mine and Blend:

No rutting was observed in this section of roadway. 14 transverse cracks were counted in this section, or 9.6 cracks/mile. This was an increase compared to the 2008 evaluation, which had 9 transverse cracks, or 6 cracks/mile. It was observed in the mine and blend section that there seemed to be some minor forms of block cracking beginning in this section. Photo 5 below shows this cracking:



Photo 6, Block Cracking in Section 3

Roadway Profile

The roadway profile was collected by Materials and Research personnel with an Ames Engineering Model 6200 "LISA" roline laser profiler on June 27, 2013. The profile data is summarized below for each rehab strategy.

Section 1, 3.5" AC Overlay:

It was found that the IRI had increased from the 2008 data in the NB lane from 53.3 to 65.48 and in the SB lane from 49.3 to 81.99.

Section 2, 5.0" AC Overlay:

It was found that the IRI increased from the 2008 data in the NB lane from 54.8 to 57.57 and in the SB lane from 50.3 to 61.76.

Section 3, Mine and Blend:

It was found that the IRI decreased from the 2008 data in the NB lane from 61.5 to 51.01 and increased in the SB lane from 50.5 to 65.86.

It was found that Section 1 has the highest overall IRI followed by similar ride quality in Section 2 and Section 3. The data used to obtain these averages is located in Appendix E.

Summary

Project NH-6-081(055)204 was delayed until summer 2008, at which point the entire length was reconstructed as a mine and blend project. For this reason, research concerning this section has been terminated.

Project NH-6-081(053)192 which runs from RP 192.427 to 204.453 was constructed as specified in the design portion of this report. The contractor was Northstar Material Inc. and the cost was \$3,131,856.

Pavement Condition

The roadway is showing some distresses since initial construction. The results from the latest testing can be found below for each section and rehab strategy.

Section 1, 3.5" AC Overlay:

No rutting was observed in this section of roadway. 358 transverse cracks were counted in this section during the 2013 evaluation, or 100 cracks/mile. This was an increase compared to the 2010 evaluation, which had 307 transverse cracks, or 86 cracks/mile. Some of the transverse cracks in this section were over an inch wide and were also starting to break up some along the edges of the cracks.

Section 2, 5.0" AC Overlay:

No rutting was observed in this section of roadway. 389 transverse cracks were counted in this section during the 2013 evaluation, or 56 cracks/mile. This was an increase compared to the 2010 evaluation, which had 307 transverse cracks, or 44 cracks/mile. Some the transverse cracks in section 2 were almost an inch wide.

Section 3, Mine and Blend:

No rutting was observed in this section of roadway. 14 transverse cracks were counted in this section during the 2013 evaluation, or 9.6 cracks/mile. This was an increase compared to the 2008 evaluation, which had 9 transverse cracks, or 6 cracks/mile. It was observed in the mine and blend section that there seemed to be some minor forms of block cracking beginning in this section.

Overall, pavement distresses have increased in each section of roadway from initial construction. Table 3 below summarizes the distresses observed for the different sections of roadway over the course of the evaluation periods:

Section	Length	2008	2010	2013
Section 1 3.5" AC Overlay	3.573 Miles	Transverse Cracks=129 Cracks/Mile=36 Rutting=N/A	Transverse Cracks=307 Cracks/Mile=86 Rutting= N/A	Transverse Cracks=358 Cracks/Mile=100 Rutting=N/A
Section 2 5.0" AC Overlay	7.000 Miles	Transverse Cracks=190 Cracks/Mile=27 Rutting=N/A	Transverse Cracks=307 Cracks/Mile=44 Rutting=N/A	Transverse Cracks= 389 Cracks/Mile= 56 Rutting= N/A
Section 3 Mine and Blend	1.453 Miles	Transverse Cracks=2 Cracks/Mile= 1.4 Rutting=N/A	Transverse Cracks=9 Cracks/Mile=6 Rutting= N/A	Transverse Cracks=14 Cracks/Mile=9.6 Rutting=N/A

Table 3: Distresses located in each research section

Section 3 has the least amount of pavement stresses at this time with 9.6 cracks/mile. Section 2 is the next best performing section with 56 cracks/mile followed by Section 1, which has 100 cracks/mile. There was no rutting observed in any of the sections during the 2013 evaluation.

Updated traffic data was collected from 2000, 2008, 2010, 2011 and 2012 and is shown below in Table 4 for each test section:

	2000	2008	2010	2011	2012
Section	Two-Way Flexible ESALs				
1	280	70	155	510	170
2	280	135	320	540	195
3	280	215	240	465	205

Table 4, Traffic Data

From the traffic data it can be seen that the traffic has decreased after initial construction, increased in 2011 and then decreased in 2012.

Roadway Profile

The roadway profile was collected by Materials and Research personnel using an Ames Engineering Model 6200 "LISA" lightweight profiler and also an Ames high speed profiler. The average IRI for both the NB and SB lanes are shown below in Table 5:

Section 1, 3.5" AC Overlay					
9/21/2005		11/25/2008		6/27/2013	
Average IRI		Average IRI		Average IRI	
NB	SB	NB	SB	NB	SB
50.7	60.1	53.3	49.3	65.48	81.99
Section 2, 5.0" AC Overlay					
9/21/2005		11/25/2008		6/27/2013	
Average IRI		Average IRI		Average IRI	
NB	SB	NB	SB	NB	SB
49.2	48	54.8	50.3	57.57	61.76
Section 3, Mine and Blend					
9/21/2005		11/25/2008		6/27/2013	
Average IRI		Average IRI		Average IRI	
NB	SB	NB	SB	NB	SB
41.8	55.7	61.5	50.5	51.01	65.86

Table 5: Average IRI Values for Each Research Section

The profiler shows that there has been mixed results regarding the ride quality from initial construction. The IRI for the SB lanes in Section 1 and 3 initially increased in ride quality in 2008 from construction but then decreased in ride quality in 2013. The IRI for the NB lane in Section 3 initially decreased in ride quality in 2008 but then increased in ride quality in 2013. All of the other sections have decreased in ride quality from initial construction. The decrease in the IRI in the SB lanes for Section 1 and 3 in 2008 could possibly be attributed to the fact that on the afternoon the IRI data was collected in 2005 there were some mud and asphalt paddies on the driving surface that may have had some small effect on the recorded IRI in the SB lane. The variation of the IRI can also be attributed to not being able to pass over the same profile as the previous years.

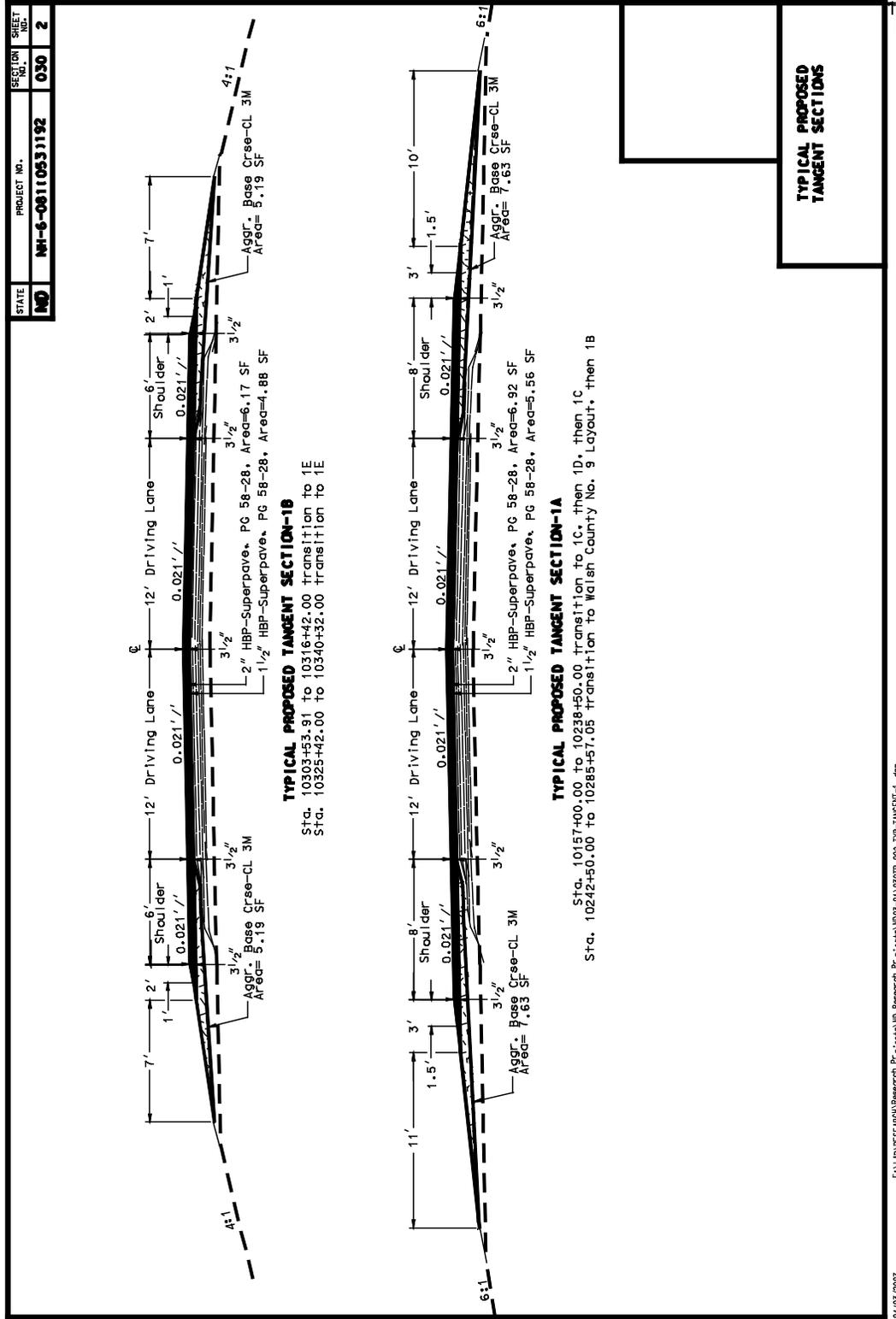
Results from this ongoing study indicate:

- The pavement condition is continuing to deteriorate over time. Distresses in the roadway for all three sections have increased since construction.
- The IRI for the NB lane in Section 3 decreased in IRI since 2008 while the IRI on everything else has increased from initial construction.
- Section 2 and Section 3 have similar ride quality which is better than the ride quality in Section 1.
- Overall, the 3.5" AC overlay section has more visual distresses than the 5.0" overlay section which had more than the mine and blend section.

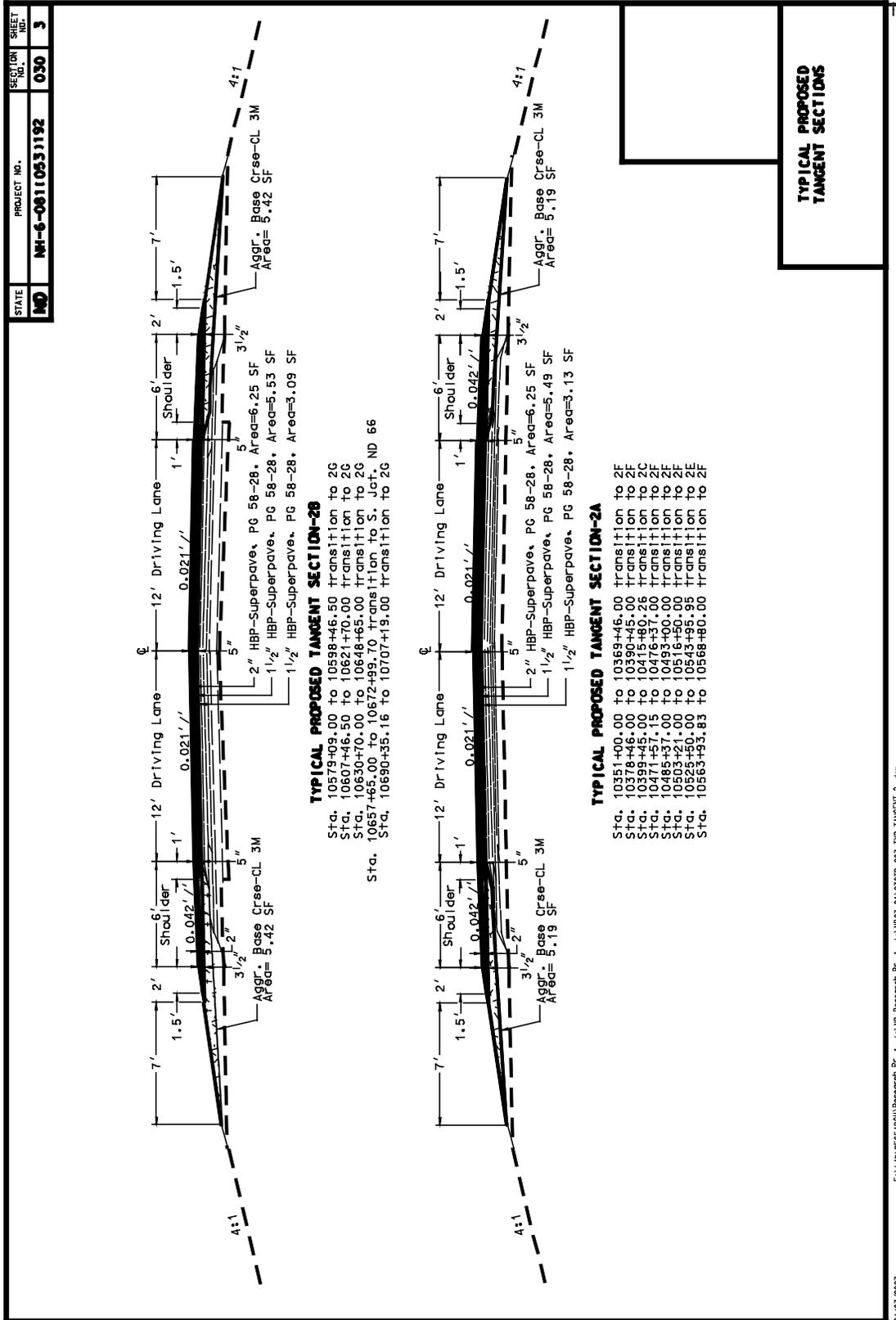
Materials and Research will evaluate these sections until 2025 or until failure. An evaluation will be conducted again in 2014 and 2015 with a report being published in 2015. The evaluations will consist of measuring the ride with the profiler and recording the visual distresses in the asphalt.

Appendix A, Typical Sections

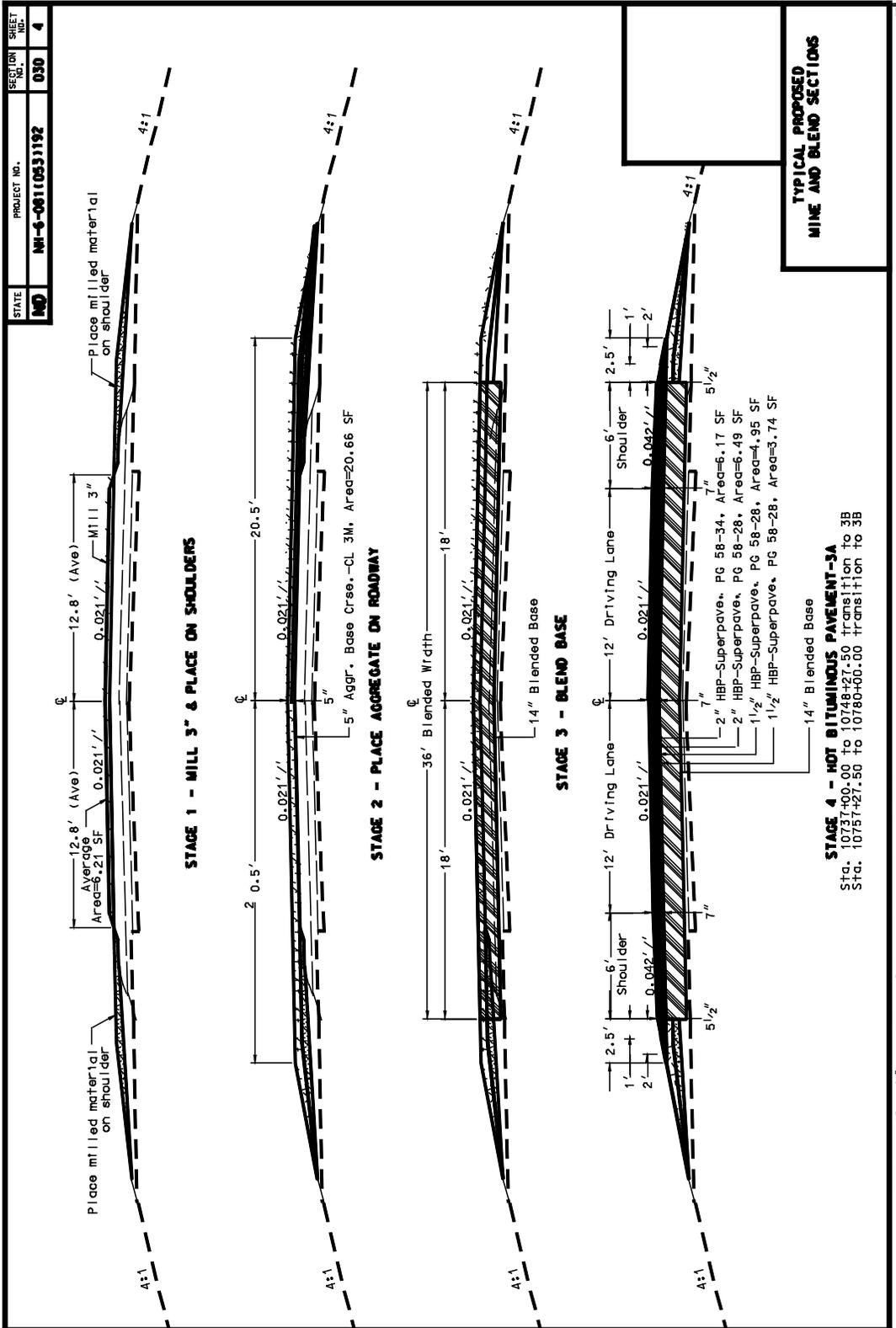
Proposed Typical Sections



04/03/2007 F:\LUB\RESEARCH\Research Pr-jects\ND Research Pr-jects\1003-01\030TP-002_TIP-TANGENT-1.dgn



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04/03/2007

Appendix B, IRI Data

IRI Data

Northbound Roadway								
From	To	Average IRI(in/mi)	From	To	Average IRI(in/mi)	From	To	Average IRI(in/mi)
0+00	5+28	67.45	248+16	253+44	67.11	496+32	501+60	43.59
5+28	10+56	51.68	253+44	258+72	46.82	501+60	506+88	44.22
10+56	15+84	46.71	258+72	264+00	50.81	506+88	512+16	42.48
15+84	21+12	41.14	264+00	269+28	51.13	512+16	517+44	54.49
21+12	26+40	36.86	269+28	274+56	55.02	517+44	522+72	64.24
26+40	31+68	48.54	274+56	279+84	62.73	522+72	528+00	65.15
31+68	36+96	55.54	279+84	285+12	44.03	528+00	533+28	51.07
36+96	42+24	47.51	285+12	290+40	58.79	533+28	538+56	46.88
42+24	47+52	50.86	290+40	295+68	63.3	538+56	543+84	47.29
47+52	52+80	44.46	295+68	300+96	71.07	543+84	549+12	40.31
52+80	58+08	36.38	300+96	306+24	83.34	549+12	554+40	53.2
58+08	63+36	47.65	306+24	311+52	70.18	554+40	559+68	47.61
63+36	68+64	51.25	311+52	316+80	60.02	559+68	564+96	41.17
68+64	73+92	44.28	316+80	322+08	37.88	564+96	570+24	41.37
73+92	79+20	44.57	322+08	327+36	41.59	570+24	575+52	54.88
79+20	84+48	50.98	327+36	332+64	39.5	575+52	580+80	37.92
84+48	89+76	45.63	332+64	337+92	46.55	580+80	586+08	37.68
89+76	95+04	39.5	337+92	343+20	45.46	586+08	591+36	45.52
95+04	100+32	40.07	343+20	348+48	39.45	591+36	596+64	36.15
100+32	105+60	44.47	348+48	353+76	37.61	596+64	601+92	42.66
105+60	110+88	53.02	353+76	359+04	41.07	601+92	607+20	36.08
110+88	116+16	42.51	359+04	364+32	51.33	607+20	612+48	36.25
116+16	121+44	58.92	364+32	369+60	43.03	612+48	617+76	36.73
121+44	126+72	40.04	369+60	374+88	46.82	617+76	623+04	40.25
126+72	132+00	53.75	374+88	380+16	51.56	623+04	628+32	40.61
132+00	137+28	62.04	380+16	385+44	49.93	628+32	633+60	55.18
137+28	142+56	65.48	385+44	390+72	48.29	633+60	634+32	86.77
142+56	147+84	56.81	390+72	396+00	53.6			
147+84	153+12	69.3	396+00	401+28	43.06		Proj Avg	48.68
153+12	158+40	48.22	401+28	406+56	51.46			
158+40	163+68	59.08	406+56	411+84	34.95			
163+68	168+96	65.26	411+84	417+12	41.16			
168+96	174+24	53.12	417+12	422+40	43.85			
174+24	179+52	49.77	422+40	427+68	42.49			
179+52	184+80	49.81	427+68	432+96	45.85			
184+80	190+08	50.85	432+96	438+24	38.3			
190+08	195+36	52.23	438+24	443+52	46.57			
195+36	200+64	50.91	443+52	448+80	41.17			
200+64	205+92	46.24	448+80	454+08	48.71			
205+92	211+20	48.93	454+08	459+36	41.88			
211+20	216+48	45.11	459+36	464+64	41.62			
216+48	221+76	57.9	464+64	469+92	49.64			
221+76	227+04	48.5	469+92	475+20	50.18			
227+04	232+32	44.52	475+20	480+48	40.07			
232+32	237+60	46.53	480+48	485+76	41.97			
237+60	242+88	52.21	485+76	491+04	52.77			
242+88	248+16	50.46	491+04	496+32	42.15			

Southbound Roadway								
From	To	Average IRI(in/mi)	From	To	Average IRI(in/mi)	From	To	Average IRI(in/mi)
0+00	5+28	69.96	248+16	253+44	49.08	496+32	501+60	76.93
5+28	10+56	52.78	253+44	258+72	37.55	501+60	506+88	74.84
10+56	15+84	50.34	258+72	264+00	37.37	506+88	512+16	63.3
15+84	21+12	51.41	264+00	269+28	38.47	512+16	517+44	58.91
21+12	26+40	52.54	269+28	274+56	46.39	517+44	522+72	61.73
26+40	31+68	59.21	274+56	279+84	37.6	522+72	528+00	74.17
31+68	36+96	50.29	279+84	285+12	34.8	528+00	533+28	69.21
36+96	42+24	66.43	285+12	290+40	40.38	533+28	538+56	45.94
42+24	47+52	58.46	290+40	295+68	38.33	538+56	543+84	50.6
47+52	52+80	60.27	295+68	300+96	41.32	543+84	549+12	58.14
52+80	58+08	51.43	300+96	306+24	39.58	549+12	554+40	64.3
58+08	63+36	46.33	306+24	311+52	49.85	554+40	559+68	59.51
63+36	68+64	51.68	311+52	316+80	41.09	559+68	564+96	61.26
68+64	73+92	55.15	316+80	322+08	49.87	564+96	570+24	58.7
73+92	79+20	56.68	322+08	327+36	50.02	570+24	575+52	72.1
79+20	84+48	63.42	327+36	332+64	63.34	575+52	580+80	52.18
84+48	89+76	42.16	332+64	337+92	51.06	580+80	586+08	87.3
89+76	95+04	45.94	337+92	343+20	48	586+08	591+36	61.96
95+04	100+32	53.39	343+20	348+48	54.23	591+36	596+64	53.39
100+32	105+60	49.99	348+48	353+76	59.27	596+64	601+92	50.06
105+60	110+88	55.77	353+76	359+04	61.69	601+92	607+20	81.58
110+88	116+16	70.14	359+04	364+32	45.63	607+20	612+48	48.07
116+16	121+44	59.23	364+32	369+60	81.54	612+48	617+76	53.76
121+44	126+72	45.26	369+60	374+88	64.79	617+76	623+04	59.41
126+72	132+00	38.68	374+88	380+16	40.3	623+04	628+32	58.74
132+00	137+28	40.34	380+16	385+44	41.56	628+32	633+12	68.34
137+28	142+56	61.95	385+44	390+72	62.65			
142+56	147+84	43.16	390+72	396+00	51.54			
147+84	153+12	40.03	396+00	401+28	55.09		Proj Avg	52.55
153+12	158+40	40.67	401+28	406+56	55.24			
158+40	163+68	42.08	406+56	411+84	47.23			
163+68	168+96	37.94	411+84	417+12	52.11			
168+96	174+24	35.74	417+12	422+40	52.6			
174+24	179+52	44.77	422+40	427+68	47.96			
179+52	184+80	43.36	427+68	432+96	58.78			
184+80	190+08	41.41	432+96	438+24	60.66			
190+08	195+36	45.43	438+24	443+52	57.76			
195+36	200+64	38.05	443+52	448+80	44.68			
200+64	205+92	45.21	448+80	454+08	57.18			
205+92	211+20	36.42	454+08	459+36	43.21			
211+20	216+48	46.19	459+36	464+64	49.57			
216+48	221+76	46.56	464+64	469+92	44.8			
221+76	227+04	38.5	469+92	475+20	58.71			
227+04	232+32	39.09	475+20	480+48	60.56			
232+32	237+60	43.56	480+48	485+76	44.06			
237+60	242+88	49.18	485+76	491+04	66.77			
242+88	248+16	54.1	491+04	496+32	58.53			

Note: Stations do not correspond to typical sections.

Appendix C, Pavement Distress and IRI Data

Pavement Distress and Ride Data

The table below shows data collected with the pathways van in the northbound lane of Hwy 81. Data from RP 192 to 204 was taken after construction.

Northbound Lane 2006														
RP	Ride	Date Coll	IRI in/mi	Dis Scr	Avg Rut (in)	PRPI	A C	B L D	L C	T C	B C	R W	B P	R T
192.000	3.42	9/27/05	87	88	0.08	Good	0	0	4	7	0	0	0	0
193.000	4.29	9/27/05	48	99	0.01	Excl	0	0	0	0	0	0	0	0
194.000	4.28	9/27/05	48	99	0.02	Excl	0	0	0	0	0	0	0	0
195.000	4.06	9/27/05	58	99	0.06	Good	0	0	0	0	0	0	0	0
196.000	4.20	9/27/05	52	99	0.08	Good	0	0	0	0	0	0	0	0
197.000	4.01	9/27/05	60	99	0.09	Good	0	0	0	0	0	0	0	0
198.000	4.26	9/27/05	49	99	0.09	Excl	0	0	0	0	0	0	0	0
199.000	4.27	9/27/05	49	99	0.07	Excl	0	0	0	0	0	0	0	0
200.000	4.36	9/27/05	45	99	0.07	Excl	0	0	0	0	0	0	0	0
201.000	4.35	9/27/05	45	99	0.08	Excl	0	0	0	0	0	0	0	0
202.000	4.25	9/27/05	50	99	0.06	Excl	0	0	0	0	0	0	0	0
203.000	4.42	9/27/05	42	99	0.04	Excl	0	0	0	0	0	0	0	0
204.000	3.11	9/27/05	102	99	0.10	Good	0	0	0	0	0	0	0	0
205.000	1.19	9/27/05	216	47	0.21	Poor	14	0	7	7	6	0	14	4
206.000	1.59	9/27/05	186	69	0.15	Fair	6	0	7	7	0	2	8	0
207.000	2.12	9/27/05	153	87	0.20	Fair	0	0	1	1	0	0	6	4
208.000	1.53	9/27/05	190	51	0.19	Poor	10	0	7	8	7	0	12	4
209.000	2.17	9/27/05	150	58	0.19	Fair	10	0	7	7	5	0	8	4
210.000	1.58	9/27/05	186	63	0.23	Poor	6	0	7	7	4	0	8	4
211.000	2.04	9/27/05	157	58	0.19	Fair	10	0	7	7	5	0	8	4
212.000	1.78	9/27/05	173	63	0.14	Poor	10	0	7	7	4	0	8	0
213.000	1.38	9/27/05	200	55	0.22	Poor	10	0	7	7	6	0	10	4
214.000	0.91	9/27/05	245	55	0.25	Poor	10	0	7	7	6	0	10	4
215.000	1.22	9/27/05	213	56	0.25	Poor	10	0	7	7	5	0	10	4
216.000	1.28	9/27/05	208	56	0.24	Poor	10	0	7	7	5	0	10	4
217.000	1.22	9/27/05	213	54	0.24	Poor	12	0	7	7	3	0	12	4
218.000	2.00	9/27/05	160	56	0.17	Poor	10	0	7	7	3	0	12	4

The table below shows data collected with the pathways van in the southbound lane of Hwy 81. Data from RP 192 to 204 was not recorded because data was collected during construction.

Southbound Lane 2005														
RP	Ride	Date Coll	IRI in/mi	Dis Scr	Avg Rut (in)	PRPI	A C	B L D	L C	T C	B C	R W	B P	R T
192.0 to 203.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
204.000	2.13	9/22/04	152	61	0.20	Fair	14	0	7	7	4	0	6	0
205.000	1.02	9/22/04	232	47	0.23	Poor	14	0	7	7	6	0	14	4
206.000	1.82	9/22/04	170	69	0.14	Fair	6	0	7	7	6	0	14	4
207.000	1.42	9/22/04	197	63	0.25	Poor	10	0	4	8	2	0	8	4
208.000	1.74	9/22/04	176	51	0.22	Fair	10	0	7	8	7	0	12	4
209.000	1.67	9/22/04	180	58	0.23	Poor	10	0	7	7	5	0	8	4
210.000	1.18	9/22/04	217	63	0.24	Poor	6	0	7	7	4	0	8	4
211.000	1.37	9/22/04	201	58	0.19	Poor	10	0	7	7	5	0	8	4
212.000	1.56	9/22/04	187	59	0.18	Poor	10	0	7	7	4	0	8	4
213.000	0.82	9/22/04	257	55	0.23	Poor	10	0	7	7	6	0	8	4
214.000	0.92	9/22/04	243	55	0.24	Poor	10	0	7	7	6	0	8	4
215.000	0.82	9/22/04	258	56	0.26	Poor	10	0	7	7	5	0	10	4
216.000	1.20	9/22/04	215	55	0.23	Poor	10	0	7	7	6	0	10	4
217.000	1.07	9/22/04	227	54	0.20	Poor	12	0	7	7	3	0	12	4
218.000	2.09	9/22/04	155	56	0.19	Poor	10	0	7	7	3	0	12	4

The table below shows data collected with the pathways van in the northbound lane of Hwy 81. The data was collected before construction.

Northbound Lane 2004														
RP	Ride	Year Coll	IRI in/mi	Dis Scr	Avg Rut (in)	PRPI	A C	B L D	L C	T C	B C	R W	B P	R T
192.000	2.10	2004	154	89	0.11	Fair	2	0	4	4	0	0	0	0
193.000	2.25	2004	145	75	0.10	Fair	2	0	4	7	5	0	6	0
194.000	2.30	2004	143	76	0.08	Fair	2	0	4	7	4	0	6	0
195.000	2.07	2004	156	64	0.28	Fair	2	0	7	7	4	0	6	9
196.000	2.29	2004	143	72	0.28	Fair	2	0	7	7	1	0	6	4
197.000	2.02	2004	159	63	0.15	Fair	8	0	7	7	4	0	6	4
198.000	2.22	2004	147	64	0.23	Fair	4	0	7	8	6	0	6	4
199.000	1.77	2004	174	67	0.27	Fair	2	0	7	7	6	0	6	4
200.000	2.02	2004	159	57	0.36	Fair	2	0	7	7	6	0	6	4
201.000	2.15	2004	151	63	0.28	Fair	12	0	7	7	6	0	0	4
202.000	2.22	2004	147	65	0.29	Fair	10	0	7	7	6	0	0	4
203.000	2.41	2004	137	63	0.33	Good	2	0	7	7	5	0	6	9
204.000	2.35	2004	140	60	0.18	Fair	14	0	4	7	4	0	6	4
205.000	1.65	2004	181	33	0.19	Poor	14	0	7	7	6	0	14	18
206.000	2.08	2004	155	80	0.13	Fair	2	0	4	7	0	0	6	0
207.000	1.96	2004	162	63	0.17	Fair	8	0	7	8	1	0	8	4
208.000	1.86	2004	168	53	0.18	Fair	8	0	7	8	7	0	12	4
209.000	2.04	2004	157	62	0.19	Fair	8	0	7	7	5	0	6	4
210.000	1.99	2004	160	67	0.22	Poor	2	0	7	7	4	0	8	4
211.000	1.82	2004	170	64	0.18	Fair	6	0	7	7	5	0	6	4
212.000	1.85	2004	169	67	0.14	Fair	8	0	7	7	4	0	6	0
213.000	1.89	2004	166	63	0.19	Fair	8	0	7	7	6	0	8	0
214.000	1.81	2004	171	59	0.20	Fair	6	0	7	7	6	0	10	4
215.000	1.99	2004	160	60	0.22	Fair	8	0	7	7	5	0	8	4
216.000	2.07	2004	156	59	0.21	Fair	8	0	7	7	6	0	8	4
217.000	2.11	2004	156	59	0.21	Fair	10	0	7	7	3	0	8	4
218.000	2.14	2004	152	58	0.16	Poor	8	0	7	7	3	0	12	4

The table below shows data collected with the pathways van in the southbound lane of Hwy 81. The data was collected before construction.

Southbound Lane 2003														
RP	Ride	Year Coll	IRI in/mi	Dis Scr	Avg Rut (in)	PRPI	A C	B L D	L C	T C	B C	R W	B P	R T
192.000	2.81	2003	116	95	0.05	Poor	0	0	0	4	0	0	0	0
193.000	3.11	2003	102	75	0.03	Fair	2	0	4	7	5	0	6	0
194.000	3.37	2003	89	79	0.05	Fair	2	0	1	7	4	0	6	0
195.000	3.16	2003	99	73	0.15	Fair	2	0	7	7	4	0	6	0
196.000	2.44	2003	135	76	0.20	Poor	2	0	7	7	1	0	6	0
197.000	3.02	2003	106	86	0.12	Fair	0	0	0	7	0	0	6	0
198.000	3.11	2003	102	68	0.12	Fair	4	0	7	8	6	0	6	0
199.000	2.75	2003	119	71	0.14	Poor	2	0	7	7	6	0	6	0
200.000	3.14	2003	100	66	0.14	Fair	2	0	7	7	9	0	8	0
201.000	2.51	2003	131	70	0.15	Poor	12	0	4	7	6	0	0	0
202.000	2.83	2003	115	69	0.20	Poor	10	0	7	7	6	0	0	0
203.000	3.21	2003	96	80	0.13	Fair	0	0	4	7	2	0	6	0
204.000	2.98	2003	107	80	0.09	Poor	2	0	0	7	4	0	6	0
205.000	2.50	2003	132	66	0.07	Poor	8	0	4	7	6	0	8	0
206.000	3.11	2003	102	83	0.08	Fair	2	0	1	7	0	0	6	0
207.000	3.17	2003	98	67	0.07	Fair	8	0	7	8	1	0	8	0
208.000	3.06	2003	104	57	0.06	Fair	8	0	7	8	7	0	12	0
209.000	3.01	2003	107	66	0.15	Fair	8	0	7	7	5	0	6	0
210.000	2.61	2003	126	71	0.10	Poor	2	0	7	7	4	0	8	0
211.000	2.70	2003	122	68	0.19	Poor	6	0	7	7	5	0	6	0
212.000	2.66	2003	124	67	0.15	Poor	8	0	7	7	4	0	6	0
213.000	2.92	2003	110	63	0.15	Poor	8	0	7	7	6	0	8	0
214.000	2.57	2003	128	67	0.17	Poor	2	0	7	7	6	0	10	0
215.000	3.02	2003	106	64	0.16	Fair	8	0	7	7	5	0	8	0
216.000	2.95	2003	109	63	0.16	Fair	8	0	7	7	6	0	8	0
217.000	3.07	2003	103	64	0.05	Fair	10	0	7	7	3	0	8	0
218.000	3.04	2003	105	62	0.09	Poor	8	0	7	7	3	0	12	0

Appendix D, Ride Data 2008

The table below shows the data collected in November 2008 with an Ames Engineering Model 6200 "LISA" profiler in the northbound lane.

ProVAL Report - 2.73.0032 Untitled

NORTHBOUND RUN

BEGINS @ 192.247

ENDS @ 204.273

Analysis - Ride Statistics at Intervals

Input	Value	Unit
Use Point Reset	No	
Segment Length	528	ft
Apply 250mm Filter	Yes	

SB1 - 0.0 to 62547.0 ft

Interval (ft)	LElev.	RElev.	MRI (in/mi)
	IRI (in/mi)	IRI (in/mi)	
0 to 528	94.8	114.6	104.7
528 to 1,056	70.8	70.7	70.8
1,056 to 1,584	49.1	49.5	49.3
1,584 to 2,112	49.1	60.1	54.6
2,112 to 2,640	45.5	58.7	52.1
2,640 to 3,168	51.3	63.3	57.3
3,168 to 3,696	51	52.2	51.6
3,696 to 4,224	66.1	68.8	67.4
4,224 to 4,752	54	63.3	58.6
4,752 to 5,280	55.2	57.1	56.1
5,280 to 5,808	48.9	52.9	50.9
5,808 to 6,336	49.2	49	49.1
6,336 to 6,864	51	53.3	52.2
6,864 to 7,392	61.1	62.1	61.6
7,392 to 7,920	50.2	58.9	54.6
7,920 to 8,448	61.3	59.1	60.2
8,448 to 8,976	46.2	46.4	46.3
8,976 to 9,504	47.2	48.9	48.1
9,504 to 10,032	53	57.2	55.1
10,032 to 10,560	53.2	52.6	52.9
10,560 to 11,088	69.4	58.9	64.1
11,088 to 11,616	65.4	74.1	69.7
11,616 to 12,144	59.9	62.3	61.1
12,144 to 12,672	46.4	50.7	48.5
12,672 to 13,200	45.3	42	43.6
13,200 to 13,728	38.8	38.6	38.7
13,728 to 14,256	48.7	51	49.9
14,256 to 14,784	52.4	47.5	50
14,784 to 15,312	40.8	43.3	42
15,312 to 15,840	44.3	44.3	44.3
15,840 to 16,368	41.2	45.9	43.6
16,368 to 16,896	38.7	44.7	41.7

Interval (ft)	LElev.	RElev.	MRI (in/mi)
	IRI (in/mi)	IRI (in/mi)	
16,896 to 17,424	38	35.3	36.7
17,424 to 17,952	48.1	46.3	47.2
17,952 to 18,480	47.8	42.6	45.2
18,480 to 19,008	39.9	40.2	40
19,008 to 19,536	51.1	45.6	48.4
19,536 to 20,064	38.9	40.5	39.7
20,064 to 20,592	44.9	40.3	42.6
20,592 to 21,120	35.8	34.2	35
21,120 to 21,648	57.2	56.4	56.8
21,648 to 22,176	53.6	59.8	56.7
22,176 to 22,704	39.6	42.1	40.8
22,704 to 23,232	48.7	44.8	46.7
23,232 to 23,760	44	51.2	47.6
23,760 to 24,288	54.1	59.6	56.8
24,288 to 24,816	55	60.1	57.6
24,816 to 25,344	48.7	51.9	50.3
25,344 to 25,872	42.8	46.2	44.5
25,872 to 26,400	41.1	47.1	44.1
26,400 to 26,928	45.1	45.6	45.4
26,928 to 27,456	48.2	45.1	46.7
27,456 to 27,984	43.8	40.6	42.2
27,984 to 28,512	35	33.8	34.4
28,512 to 29,040	38.8	40.5	39.7
29,040 to 29,568	40.9	42.2	41.6
29,568 to 30,096	45.5	46.4	46
30,096 to 30,624	37.7	42.2	40
30,624 to 31,152	51.3	45.7	48.5
31,152 to 31,680	41.3	47.4	44.3
31,680 to 32,208	50.7	51	50.8
32,208 to 32,736	61.5	59.4	60.4
32,736 to 33,264	58.6	53.6	56.1
33,264 to 33,792	48	55.9	52
33,792 to 34,320	50.9	51.1	51
34,320 to 34,848	54.2	59.8	57
34,848 to 35,376	61.9	70.6	66.2
35,376 to 35,904	60.3	60.5	60.4
35,904 to 36,432	52.7	47	49.8
36,432 to 36,960	67.3	73.4	70.3
36,960 to 37,488	68.1	72.6	70.4
37,488 to 38,016	52.1	56.3	54.2
38,016 to 38,544	51	42.5	46.8
38,544 to 39,072	66.5	71.3	68.9
39,072 to 39,600	51.4	49.8	50.6
39,600 to 40,128	56.3	56.4	56.4
40,128 to 40,656	50	51.1	50.5
40,656 to 41,184	45	47.8	46.4
41,184 to 41,712	45.8	47.2	46.5
41,712 to 42,240	56.5	53.5	55
42,240 to 42,768	43.5	42.8	43.2
42,768 to 43,296	45.6	54.6	50.1
43,296 to 43,824	54.4	54.5	54.5
43,824 to 44,352	50.2	51.1	50.7
44,352 to 44,880	55.9	52.1	54
44,880 to 45,408	52.4	55.7	54

Interval (ft)	LElev.	RElev.	MRI (in/mi)
	IRI (in/mi)	IRI (in/mi)	
45,408 to 45,936	51.1	53.2	52.2
45,936 to 46,464	53.3	53.5	53.4
46,464 to 46,992	51	51.3	51.2
46,992 to 47,520	54.2	56.4	55.3
47,520 to 48,048	64	72.3	68.1
48,048 to 48,576	48	45.5	46.7
48,576 to 49,104	77.7	76.3	77
49,104 to 49,632	76.5	73.3	74.9
49,632 to 50,160	71.9	96.8	84.3
50,160 to 50,688	66.3	79.9	73.1
50,688 to 51,216	67.1	67.3	67.2
51,216 to 51,744	62.2	65.2	63.7
51,744 to 52,272	58.2	58	58.1
52,272 to 52,800	69.4	64.4	66.9
52,800 to 53,328	68.4	59.8	64.1
53,328 to 53,856	73.6	68.7	71.1
53,856 to 54,384	90.6	78.4	84.5
54,384 to 54,912	71.1	68.1	69.6
54,912 to 55,440	78.8	70.5	74.6
55,440 to 55,968	60	59.4	59.7
55,968 to 56,496	61.6	60.7	61.2
56,496 to 57,024	58.5	57.7	58.1
57,024 to 57,552	73.5	67.7	70.6
57,552 to 58,080	51.1	55.8	53.5
58,080 to 58,608	65.1	72.9	69
58,608 to 59,136	60.2	59	59.6
59,136 to 59,664	58.2	56.4	57.3
59,664 to 60,192	52.2	48.7	50.5
60,192 to 60,720	75.1	74.8	75
60,720 to 61,248	57.9	62.1	60
61,248 to 61,776	56.1	49.4	52.8
61,776 to 62,304	62.7	65.2	64
62,304 to 62,547	61.3	74.3	67.8

The table below shows the data collected November 2008 with an Ames Engineering Model 6200 "LISA" profiler in the southbound lane.

ProVAL Report - 2.73.0032 Untitled

SOUTHBOUND RUN

Analysis - Ride Statistics at Intervals

BEGINS @ 204.273

ENDS @ 192.427

Input	Value	Unit
Use Point Reset	No	
Segment Length	528	ft
Apply 250mm Filter	Yes	

NB1 - 0.0 to 62547.0 ft

Interval (ft)	LElev.	RElev.	MRI (in/mi)
	IRI (in/mi)	IRI (in/mi)	
0 to 528	52.3	55.5	53.9
528 to 1,056	45.8	49.4	47.6
1,056 to 1,584	44.6	45.3	45
1,584 to 2,112	55.4	55.8	55.6
2,112 to 2,640	53.8	55.7	54.7
2,640 to 3,168	44.7	47.8	46.3
3,168 to 3,696	52.9	58.1	55.5
3,696 to 4,224	49	49.5	49.3
4,224 to 4,752	46.8	43.9	45.4
4,752 to 5,280	46.5	47.5	47
5,280 to 5,808	54.8	56.9	55.8
5,808 to 6,336	51.1	56.8	54
6,336 to 6,864	48	44.4	46.2
6,864 to 7,392	56.4	58.3	57.3
7,392 to 7,920	64.5	62.4	63.4
7,920 to 8,448	46.2	47	46.6
8,448 to 8,976	42.8	40.4	41.6
8,976 to 9,504	49	44.6	46.8
9,504 to 10,032	55.7	52.3	54
10,032 to 10,560	54.7	61.1	57.9
10,560 to 11,088	50.7	56.2	53.5
11,088 to 11,616	52.6	51	51.8
11,616 to 12,144	62.4	64.3	63.3
12,144 to 12,672	45.4	67.6	56.5
12,672 to 13,200	68.3	79.9	74.1
13,200 to 13,728	58.4	56.4	57.4
13,728 to 14,256	50.4	56.8	53.6
14,256 to 14,784	49.6	54.8	52.2
14,784 to 15,312	49.1	46.6	47.9
15,312 to 15,840	52.3	60.3	56.3
15,840 to 16,368	47.7	54.3	51
16,368 to 16,896	44.2	44.3	44.3
16,896 to 17,424	42	49.2	45.6
17,424 to 17,952	54.7	54	54.4

Interval (ft)	LElev.	RElev.	MRI (in/mi)
	IRI (in/mi)	IRI (in/mi)	
17,952 to 18,480	45	44.8	44.9
18,480 to 19,008	45.3	44.4	44.9
19,008 to 19,536	44.3	45.2	44.7
19,536 to 20,064	40.5	42.4	41.4
20,064 to 20,592	46.8	44.8	45.8
20,592 to 21,120	46.8	49.5	48.2
21,120 to 21,648	48.5	46.5	47.5
21,648 to 22,176	48.4	44.2	46.3
22,176 to 22,704	48.8	42	45.4
22,704 to 23,232	43.9	41.6	42.7
23,232 to 23,760	48.5	54.3	51.4
23,760 to 24,288	63.7	73.9	68.8
24,288 to 24,816	40.4	39.9	40.1
24,816 to 25,344	53.1	55.4	54.2
25,344 to 25,872	55.1	43.7	49.4
25,872 to 26,400	46	45.6	45.8
26,400 to 26,928	58.7	47.9	53.3
26,928 to 27,456	42.6	49.5	46.1
27,456 to 27,984	50.7	54.2	52.5
27,984 to 28,512	55.9	59.8	57.9
28,512 to 29,040	58.4	55.6	57
29,040 to 29,568	66.5	61.1	63.8
29,568 to 30,096	78.3	81.4	79.8
30,096 to 30,624	66.8	71.7	69.3
30,624 to 31,152	39.2	40	39.6
31,152 to 31,680	45.8	44.9	45.3
31,680 to 32,208	46.1	50.7	48.4
32,208 to 32,736	45	45.8	45.4
32,736 to 33,264	49.7	54	51.9
33,264 to 33,792	42.7	39.6	41.2
33,792 to 34,320	40.7	35.8	38.2
34,320 to 34,848	41.4	44.2	42.8
34,848 to 35,376	45.2	44.6	44.9
35,376 to 35,904	47.9	50.8	49.3
35,904 to 36,432	46.4	46.4	46.4
36,432 to 36,960	45.1	46.9	46
36,960 to 37,488	50.4	59.6	55
37,488 to 38,016	50	51.4	50.7
38,016 to 38,544	49.9	52.1	51
38,544 to 39,072	45.7	49.8	47.7
39,072 to 39,600	42.2	48.2	45.2
39,600 to 40,128	45.7	48.7	47.2
40,128 to 40,656	41.9	41.3	41.6
40,656 to 41,184	53.2	48.1	50.7
41,184 to 41,712	48.2	47.9	48.1
41,712 to 42,240	42.7	37.4	40
42,240 to 42,768	41.4	34	37.7
42,768 to 43,296	50.6	50.5	50.6
43,296 to 43,824	49.2	45.9	47.6
43,824 to 44,352	47.6	41.9	44.7
44,352 to 44,880	45.2	39.4	42.3
44,880 to 45,408	47.3	40.3	43.8
45,408 to 45,936	42.6	41	41.8
45,936 to 46,464	47.7	50.3	49

Interval (ft)	LElev.	RElev.	MRI (in/mi)
	IRI (in/mi)	IRI (in/mi)	
46,464 to 46,992	45.4	39.4	42.4
46,992 to 47,520	45	41.2	43.1
47,520 to 48,048	41.8	50.7	46.2
48,048 to 48,576	54.8	51.8	53.3
48,576 to 49,104	39.6	42	40.8
49,104 to 49,632	36.6	41.5	39.1
49,632 to 50,160	45.8	45.7	45.8
50,160 to 50,688	40.4	43.6	42
50,688 to 51,216	89.2	87.6	88.4
51,216 to 51,744	74.7	93.4	84.1
51,744 to 52,272	48.3	59.9	54.1
52,272 to 52,800	57.8	59.2	58.5
52,800 to 53,328	49.4	51.9	50.6
53,328 to 53,856	42.5	38.7	40.6
53,856 to 54,384	50	50.3	50.2
54,384 to 54,912	68.8	56.2	62.5
54,912 to 55,440	40.8	38.9	39.8
55,440 to 55,968	50.1	47.8	49
55,968 to 56,496	53.9	47.4	50.6
56,496 to 57,024	41.9	38.8	40.4
57,024 to 57,552	47.8	40.2	44
57,552 to 58,080	44.9	42.1	43.5
58,080 to 58,608	55.9	52.3	54.1
58,608 to 59,136	47	46	46.5
59,136 to 59,664	38.2	33.3	35.7
59,664 to 60,192	36.2	39.8	38
60,192 to 60,720	44.2	39.6	41.9
60,720 to 61,248	40.7	34.2	37.5
61,248 to 61,776	49	45.7	47.3
61,776 to 62,304	55.4	52.8	54.1
62,304 to 62,547	99.7	75.2	87.5

Appendix E, Ride Data 2013

Analysis: Ride Quality

Inputs

Segment Length (ft): 528.00

Exclude Leave-outs: Yes

Selections

File	Section	Apply 250mm Filter
081.192 NB	Full	Yes
081.192 SB	Full	Yes

NORTHBOUND RUN

BEGINS @

192.247

ENDS @ 204.273

Start Distance (ft)	Stop Distance (ft)	Length (ft)	081.192 NB(in/mi)
0.00	527.99	527.99	71.69
527.99	1,055.98	527.99	58.85
1,055.98	1,583.97	527.99	58.31
1,583.97	2,111.95	527.99	56.98
2,111.95	2,639.94	527.99	56.66
2,639.94	3,167.93	527.99	69.80
3,167.93	3,695.92	527.99	59.30
3,695.92	4,223.91	527.99	72.64
4,223.91	4,751.90	527.99	64.00
4,751.90	5,279.89	527.99	75.05
5,279.89	5,807.87	527.99	57.18
5,807.87	6,335.86	527.99	70.16
6,335.86	6,863.85	527.99	68.34
6,863.85	7,391.84	527.99	56.87
7,391.84	7,919.83	527.99	68.58
7,919.83	8,447.82	527.99	85.31
8,447.82	8,975.81	527.99	60.05
8,975.81	9,503.79	527.99	60.63
9,503.79	10,031.78	527.99	62.82
10,031.78	10,559.77	527.99	70.71
10,559.77	11,087.76	527.99	70.41
11,087.76	11,615.75	527.99	64.89
11,615.75	12,143.74	527.99	59.32
12,143.74	12,671.72	527.99	62.67
12,671.72	13,199.71	527.99	69.57
13,199.71	13,727.70	527.99	90.84
13,727.70	14,255.69	527.99	66.50
14,255.69	14,783.68	527.99	78.03
14,783.68	15,311.67	527.99	65.73
15,311.67	15,839.66	527.99	56.77
15,839.66	16,367.64	527.99	67.88

16,367.64	16,895.63	527.99	63.68
16,895.63	17,423.62	527.99	59.54
17,423.62	17,951.61	527.99	58.44
17,951.61	18,479.60	527.99	60.75
18,479.60	19,007.59	527.99	58.43
19,007.59	19,535.57	527.99	56.63
19,535.57	20,063.56	527.99	47.95
20,063.56	20,591.55	527.99	54.26
20,591.55	21,119.54	527.99	48.50
21,119.54	21,647.53	527.99	55.54
21,647.53	22,175.52	527.99	64.06
22,175.52	22,703.51	527.99	51.10
22,703.51	23,231.49	527.99	56.46
23,231.49	23,759.48	527.99	56.86
23,759.48	24,287.47	527.99	55.81
24,287.47	24,815.46	527.99	80.33
24,815.46	25,343.45	527.99	50.28
25,343.45	25,871.44	527.99	58.41
25,871.44	26,399.43	527.99	54.95
26,399.43	26,927.41	527.99	50.68
26,927.41	27,455.40	527.99	52.24
27,455.40	27,983.39	527.99	58.47
27,983.39	28,511.38	527.99	59.84
28,511.38	29,039.37	527.99	57.50
29,039.37	29,567.36	527.99	62.33
29,567.36	30,095.35	527.99	62.33
30,095.35	30,623.33	527.99	83.63
30,623.33	31,151.32	527.99	76.56
31,151.32	31,679.31	527.99	50.53
31,679.31	32,207.30	527.99	52.14
32,207.30	32,735.29	527.99	52.56
32,735.29	33,263.28	527.99	53.63
33,263.28	33,791.27	527.99	65.96
33,791.27	34,319.25	527.99	55.26
34,319.25	34,847.24	527.99	50.08
34,847.24	35,375.23	527.99	55.07
35,375.23	35,903.22	527.99	56.73
35,903.22	36,431.21	527.99	64.20
36,431.21	36,959.20	527.99	62.28
36,959.20	37,487.18	527.99	59.98
37,487.18	38,015.17	527.99	66.23
38,015.17	38,543.16	527.99	60.00
38,543.16	39,071.15	527.99	46.24
39,071.15	39,599.14	527.99	60.17
39,599.14	40,127.13	527.99	50.94
40,127.13	40,655.12	527.99	55.46
40,655.12	41,183.11	527.99	54.66
41,183.11	41,711.09	527.99	56.08
41,711.09	42,239.08	527.99	56.38
42,239.08	42,767.07	527.99	48.10
42,767.07	43,295.06	527.99	42.56
43,295.06	43,823.05	527.99	56.71
43,823.05	44,351.04	527.99	55.29

44,351.04	44,879.02	527.99	51.11
44,879.02	45,407.01	527.99	49.69
45,407.01	45,935.00	527.99	48.01
45,935.00	46,462.99	527.99	51.85
46,462.99	46,990.98	527.99	55.72
46,990.98	47,518.96	527.99	47.20
47,518.96	48,046.95	527.99	47.18
48,046.95	48,574.95	527.99	47.47
48,574.95	49,102.93	527.99	60.65
49,102.93	49,630.92	527.99	49.79
49,630.92	50,158.91	527.99	42.48
50,158.91	50,686.90	527.99	50.04
50,686.90	51,214.89	527.99	48.67
51,214.89	51,742.88	527.99	87.46
51,742.88	52,270.86	527.99	106.51
52,270.86	52,798.85	527.99	85.56
52,798.85	53,326.84	527.99	67.65
53,326.84	53,854.83	527.99	69.09
53,854.83	54,382.82	527.99	54.17
54,382.82	54,910.80	527.99	61.26
54,910.80	55,438.79	527.99	61.88
55,438.79	55,966.78	527.99	44.43
55,966.78	56,494.77	527.99	48.45
56,494.77	57,022.76	527.99	48.96
57,022.76	57,550.75	527.99	51.49
57,550.75	58,078.74	527.99	50.19
58,078.74	58,606.73	527.99	47.83
58,606.73	59,134.71	527.99	54.65
59,134.71	59,662.70	527.99	51.09
59,662.70	60,190.69	527.99	42.57
60,190.69	60,718.68	527.99	41.29
60,718.68	61,246.67	527.99	42.73
61,246.67	61,774.66	527.99	42.35
61,774.66	62,302.64	527.99	51.22
62,302.64	62,830.63	527.99	66.13
62,830.63	63,140.38	308.95	75.22

SOUTHBOUND RUN

BEGINS @ 204.273

ENDS @ 192.427

Start Distance (ft)	Stop Distance (ft)	Length (ft)	081.192 SB(in/mi)
0.00	527.99	527.99	76.91
527.99	1,055.98	527.99	96.83
1,055.98	1,583.97	527.99	52.75
1,583.97	2,111.95	527.99	60.87
2,111.95	2,639.94	527.99	67.91
2,639.94	3,167.93	527.99	64.39
3,167.93	3,695.92	527.99	60.35
3,695.92	4,223.91	527.99	82.47
4,223.91	4,751.90	527.99	64.21
4,751.90	5,279.89	527.99	69.30
5,279.89	5,807.87	527.99	52.13
5,807.87	6,335.86	527.99	65.56
6,335.86	6,863.85	527.99	54.85
6,863.85	7,391.84	527.99	62.79
7,391.84	7,919.83	527.99	56.65
7,919.83	8,447.82	527.99	69.40
8,447.82	8,975.81	527.99	64.16
8,975.81	9,503.79	527.99	58.23
9,503.79	10,031.78	527.99	67.97
10,031.78	10,559.77	527.99	62.21
10,559.77	11,087.76	527.99	73.85
11,087.76	11,615.75	527.99	83.99
11,615.75	12,143.74	527.99	66.14
12,143.74	12,671.72	527.99	55.02
12,671.72	13,199.71	527.99	47.33
13,199.71	13,727.70	527.99	54.93
13,727.70	14,255.69	527.99	61.42
14,255.69	14,783.68	527.99	48.78
14,783.68	15,311.67	527.99	59.23
15,311.67	15,839.66	527.99	60.38
15,839.66	16,367.64	527.99	50.85
16,367.64	16,895.63	527.99	51.79
16,895.63	17,423.62	527.99	45.01
17,423.62	17,951.61	527.99	58.36
17,951.61	18,479.60	527.99	49.95
18,479.60	19,007.59	527.99	60.82
19,007.59	19,535.57	527.99	61.61
19,535.57	20,063.56	527.99	50.94
20,063.56	20,591.55	527.99	56.63
20,591.55	21,119.54	527.99	45.73
21,119.54	21,647.53	527.99	71.10
21,647.53	22,175.52	527.99	70.37
22,175.52	22,703.51	527.99	62.12
22,703.51	23,231.49	527.99	50.28
23,231.49	23,759.48	527.99	61.99

23,759.48	24,287.47	527.99	70.53
24,287.47	24,815.46	527.99	66.15
24,815.46	25,343.45	527.99	66.25
25,343.45	25,871.44	527.99	54.94
25,871.44	26,399.43	527.99	61.68
26,399.43	26,927.41	527.99	55.49
26,927.41	27,455.40	527.99	56.59
27,455.40	27,983.39	527.99	56.42
27,983.39	28,511.38	527.99	55.25
28,511.38	29,039.37	527.99	62.23
29,039.37	29,567.36	527.99	58.19
29,567.36	30,095.35	527.99	59.48
30,095.35	30,623.33	527.99	52.40
30,623.33	31,151.32	527.99	59.24
31,151.32	31,679.31	527.99	56.02
31,679.31	32,207.30	527.99	64.73
32,207.30	32,735.29	527.99	65.84
32,735.29	33,263.28	527.99	68.40
33,263.28	33,791.27	527.99	49.40
33,791.27	34,319.25	527.99	57.22
34,319.25	34,847.24	527.99	75.94
34,847.24	35,375.23	527.99	80.10
35,375.23	35,903.22	527.99	67.08
35,903.22	36,431.21	527.99	50.22
36,431.21	36,959.20	527.99	96.19
36,959.20	37,487.18	527.99	60.81
37,487.18	38,015.17	527.99	68.94
38,015.17	38,543.16	527.99	64.48
38,543.16	39,071.15	527.99	75.62
39,071.15	39,599.14	527.99	63.84
39,599.14	40,127.13	527.99	67.74
40,127.13	40,655.12	527.99	59.31
40,655.12	41,183.11	527.99	59.25
41,183.11	41,711.09	527.99	61.51
41,711.09	42,239.08	527.99	65.68
42,239.08	42,767.07	527.99	56.45
42,767.07	43,295.06	527.99	62.78
43,295.06	43,823.05	527.99	61.34
43,823.05	44,351.04	527.99	66.75
44,351.04	44,879.02	527.99	69.39
44,879.02	45,407.01	527.99	74.18
45,407.01	45,935.00	527.99	72.85
45,935.00	46,462.99	527.99	75.28
46,462.99	46,990.98	527.99	73.39
46,990.98	47,518.96	527.99	76.76
47,518.96	48,046.95	527.99	75.30
48,046.95	48,574.95	527.99	67.02
48,574.95	49,102.93	527.99	89.61
49,102.93	49,630.92	527.99	100.61
49,630.92	50,158.91	527.99	102.02
50,158.91	50,686.90	527.99	94.51
50,686.90	51,214.89	527.99	77.29
51,214.89	51,742.88	527.99	81.44

51,742.88	52,270.86	527.99	75.25
52,270.86	52,798.85	527.99	80.42
52,798.85	53,326.84	527.99	82.63
53,326.84	53,854.83	527.99	89.60
53,854.83	54,382.82	527.99	92.17
54,382.82	54,910.80	527.99	82.77
54,910.80	55,438.79	527.99	94.96
55,438.79	55,966.78	527.99	74.06
55,966.78	56,494.77	527.99	80.62
56,494.77	57,022.76	527.99	77.29
57,022.76	57,550.75	527.99	82.45
57,550.75	58,078.74	527.99	72.59
58,078.74	58,606.73	527.99	86.96
58,606.73	59,134.71	527.99	74.80
59,134.71	59,662.70	527.99	76.86
59,662.70	60,190.69	527.99	75.90
60,190.69	60,718.68	527.99	93.12
60,718.68	61,246.67	527.99	76.49
61,246.67	61,774.66	527.99	68.29
61,774.66	62,302.64	527.99	80.56
62,302.64	62,830.63	527.99	90.44
62,830.63	63,080.89	249.46	93.31