



TRC1303

**Comparison of Texturing Methods  
Used for  
Highway Construction and Maintenance**

Rick Stanley

Final Report

2016

Arkansas State Highway & Transportation Department

**Transportation Research Committee**

**Final Report**

**TRC 1303**

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Highway Construction and Maintenance

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**Comparison of Texturing Methods Used for Highway Construction and  
Maintenance**

By

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Conducted in Cooperation with the U.S. Department of Transportation  
Federal Highway Administration

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## **Introduction**

The primary purpose of adequate surface texture is to reduce wet-weather crashes and total vehicle crashes. Pavement surfaces must provide enough roughness and skid resistance to allow vehicles to travel safely during wet weather events. Diamond grinding, shot blasting, grooving, tinning, burlap dragging and adding chip seals are all methods of restoring or adding surface friction to pavements. It would be beneficial to know how these methods compare in altering both the microtexture and macrotexture of the pavement surfaces.

Currently there are five methods that the Department utilizes to test texture and skid resistance of pavement surfaces. The Department already utilizes a locked wheel tester “skid truck” (Figure 1) to measure surface resistance during wet conditions. Other options for testing surface texture are a Circular Texture Meter (CTM) (Figure 2), a Dynamic Friction Tester (DFT) (Figure 3), the “Sand patch” (Figure 4) test and an Outflow Meter (Figure 5). Both a CTM and DFT are available for Department use through the Friction, Texture, and Profile Measurement Equipment Loan Program with Federal Highway Administration.

Using this equipment, it was possible to adequately compare different methods for increasing surface texture and determine the most effective way of improving the safety of Arkansas roadways.



**Figure 1**



**Figure 2**



**Figure 3**



**Figure 4**



## Figure 5

### Work Plan

A thorough review of relevant literature was the first task of this research project. The literature review was conducted at the beginning of the project and continued throughout the duration. A search of all relevant journal articles, books, and technical reports was conducted and three of the publications became the primary focus.

Information obtained from the literature review showed there were numerous texturing methods that existed for improving a pavement's macro and micro texture. This review help determine which accurate texturing methods and pre-existing field locations that would be appropriate to use within the state of Arkansas. A wide variety of sites were selected throughout the state and represented the most common surfaces.

All pavement test sections were evaluated on surface friction and micro and macro texture. Several pieces of equipment were utilized in evaluating the pavement's macro and micro texture and surface friction. The equipment that was utilized include the skid truck, sand patch test, outflow meter, CTM, and DFT.

The performance evaluation includes tracking the reduction in crashes and the increase in micro and/or macro texture. The cost effectiveness of these treatments were taken into consideration and documented. Separate evaluations were done for each of the pavement conditions.

This report presents all of the findings of the field trials and gives recommendations on what texturing methods are applicable based on the test results and cost data. Guidelines will be created detailing what texturing method should be used in order to maximize the pavement texture, minimize the cost to Arkansas Highway and Transportation Department (AHTD), and increase the safety of the route.

### **Literature Review**

There were three articles that the review focused on; American Traffic Safety Services Association (ATSSA) "Safety Opportunities in High Friction Surfacing", National Cooperative Highway Research Program (NCHRP) Web-Only Document 108: "Guide for Pavement Friction", and National Transportation Research Center Incorporated (NTRCI) "Assessment of Friction-Based Pavement Methods and Regulations".

A brief overview of “Safety Opportunities in High Friction Surfacing” is the nation’s roadways are of the leading causes of fatalities and major injuries in the United States. Almost half of all fatal crashes occur at intersections or on horizontal curves. This is the case because the speed of the vehicle and the geometry of the curve create a friction demand higher than can be achieved on standard pavement surfaces. A low-cost approach that has been effective is the installation of a High Friction Surface Treatment (HFST). This report defines what HFST’s are and where they can be used. There is a description of materials that are used for HFST areas. There are also case studies presented in the report. The case studies were conducted throughout the United States and they address different crash issues. A section within this report discusses the testing methods that are associated with HFST’s.

For NTRCI’s “Assessment of Friction-Based Pavement Methods and Regulations” a survey was sent out to nine states; Arizona, California, Illinois, Kentucky, Maryland, New York, Texas, Virginia, and Washington. The first contact with the nine states was by email with the survey attached. Each state was asked to fill out the survey and return it. Eight of the nine states responded to the survey. California eventually responded, but it was not in time to be included within the report. Out of all the states interviewed none of them were willing to

discuss minimum acceptable friction numbers that are related to remedial actions for their state due to possible liability issues. Kentucky tightly controls aggregate properties by testing the aggregates before approving the vendor for bidding. The results of the test are only shared with the quarry that is supplying the aggregate. Kentucky is also not willing to publish these research findings because of the potential of litigation. Maryland has the firm belief that environmental conditions impact the friction more than any other factor.

NCHRP “Guide for Pavement Friction” covers pavement friction for past and on-going research along with the current state-of-practice for pavement friction. This report developed a practical policy and a how-to guidance for State Highway Agencies (SHA’s). The policy and guidance was developed by examining the principles and methodologies of every aspect of friction. The importance of pavement friction in highway safety; the fundamental concepts of friction; how friction is measured, reported, and managed in the field; and how friction is incorporated in design via the selection of aggregates and surface textures is covered in the guidance.

### **Determination of texturing methods**

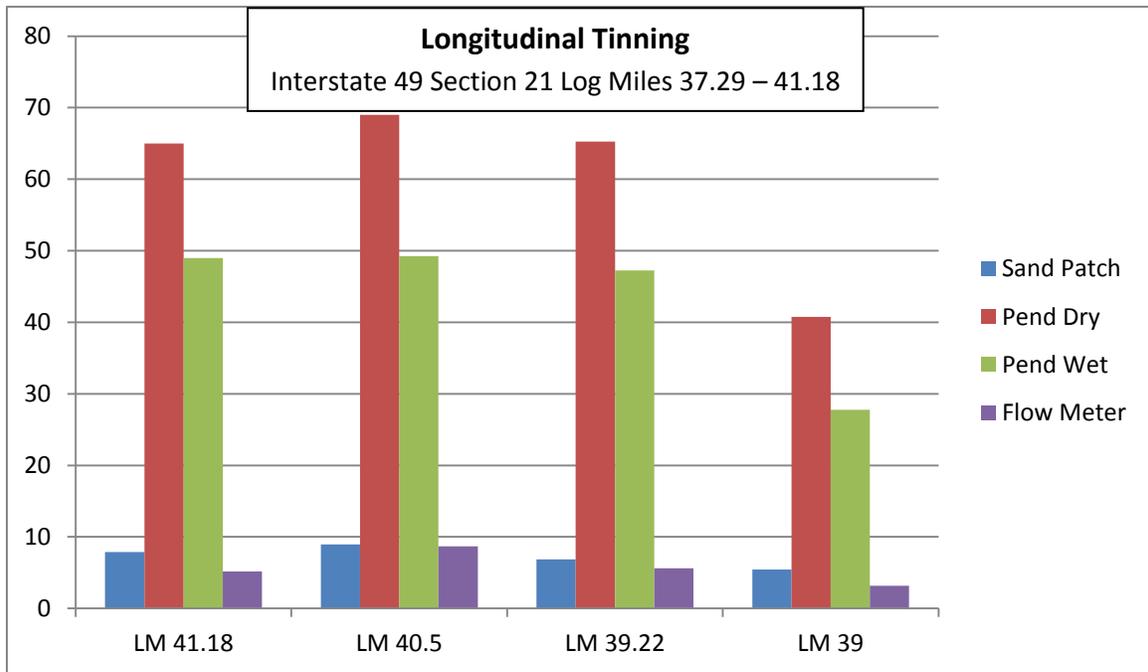
There are many texturing methods that exist for improving a pavement's macro and micro texture. In determining which texturing methods will improve Arkansas' pavement macro and micro textures a variety of pre-existing field locations that represent the most common surfaces throughout the state were selected. The methods that were selected are longitudinal tinning, diamond grinding, chipseal, transverse tinning, lightweight chert chipseal, ultra-thin bonded wearing course, sandstone chipseal, and skidabrader.

### **Field Performance Testing**

Thirteen pre-existing locations around the state were selected for testing purposes. The pre-existing locations were chosen by what the state uses more often in high-skid areas. These locations consisted of diamond grinding, skidabreader, longitudinal tinning, transverse tinning, ultra-thin bonded wearing course, sandstone chipseal, lightweight chert chipseal, chipseal with fabric interlayer, or cold milling.

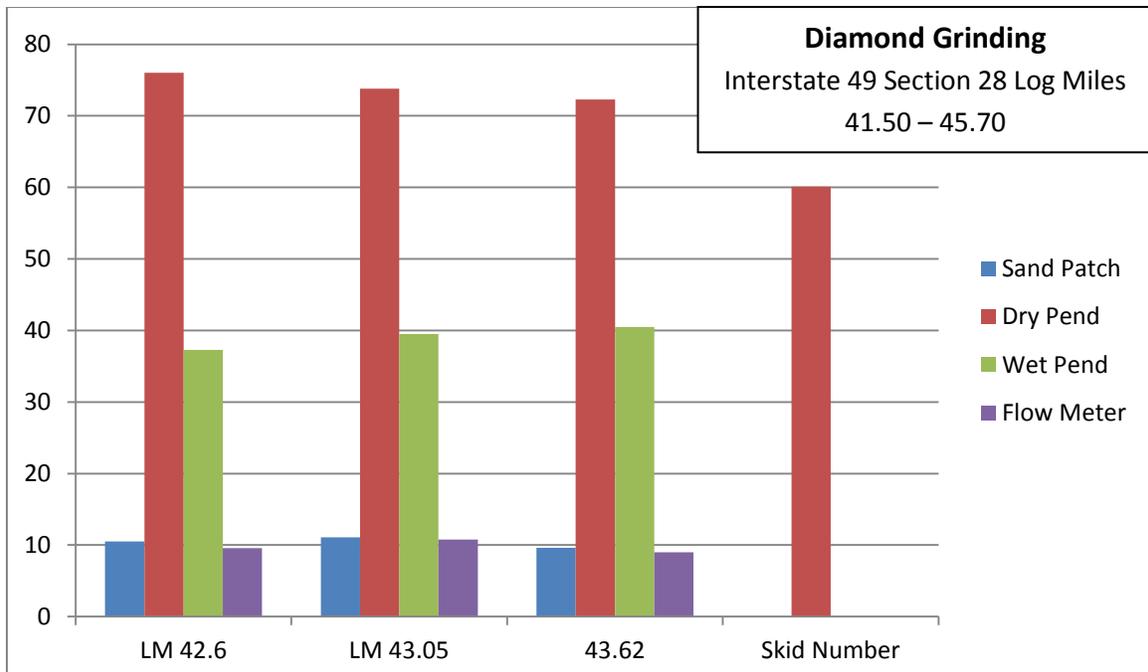
AHTD's District 3 has one site. This site is Interstate 49 Section 21 log mile 41.18 – 37.29 and it is longitudinal tinning. There is also a fabric interlayer at log

mile 40.50. Four sites with four tests of each were completed at this site. The data collected for this site is shown in Figure 6.



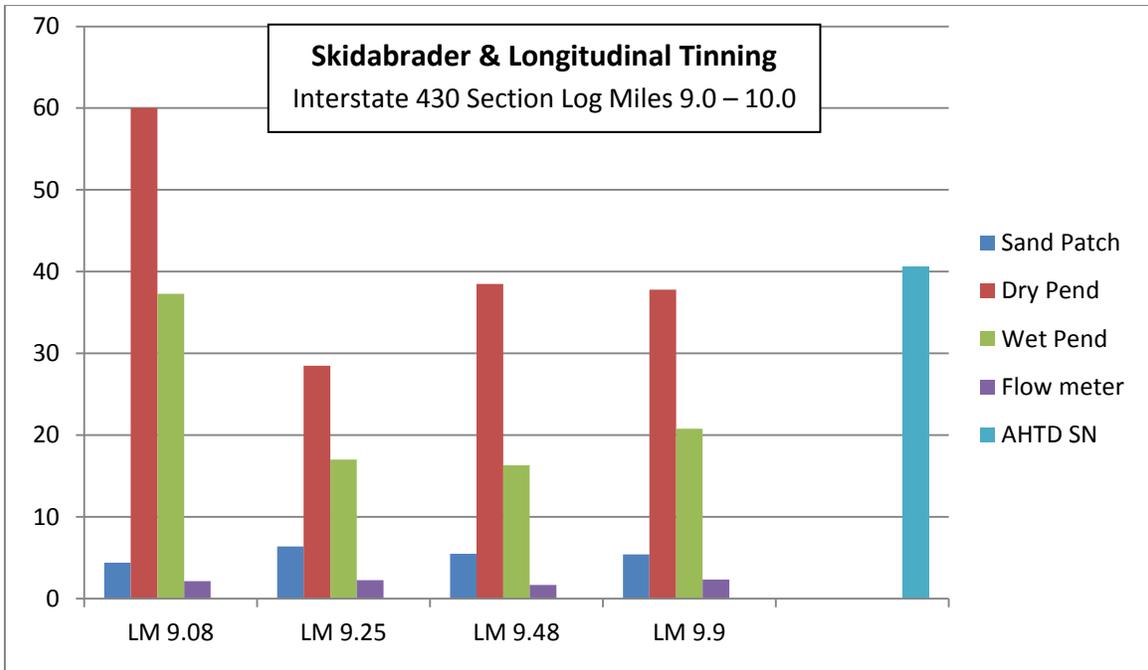
**Figure 6**

One location in District four. It is the diamond ground site on Interstate 49 Section 28 Log mile 41.50 – 45.70. There were three test sites with four tests completed at each site. The data collected for this site is shown in Figure 7.

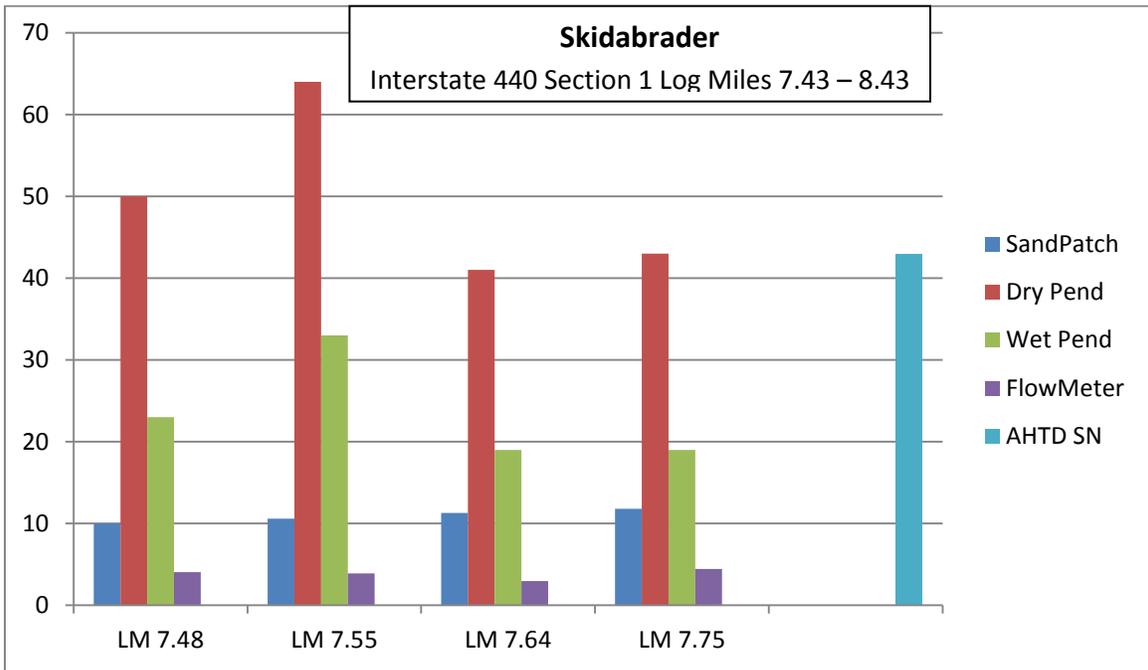


**Figure 7**

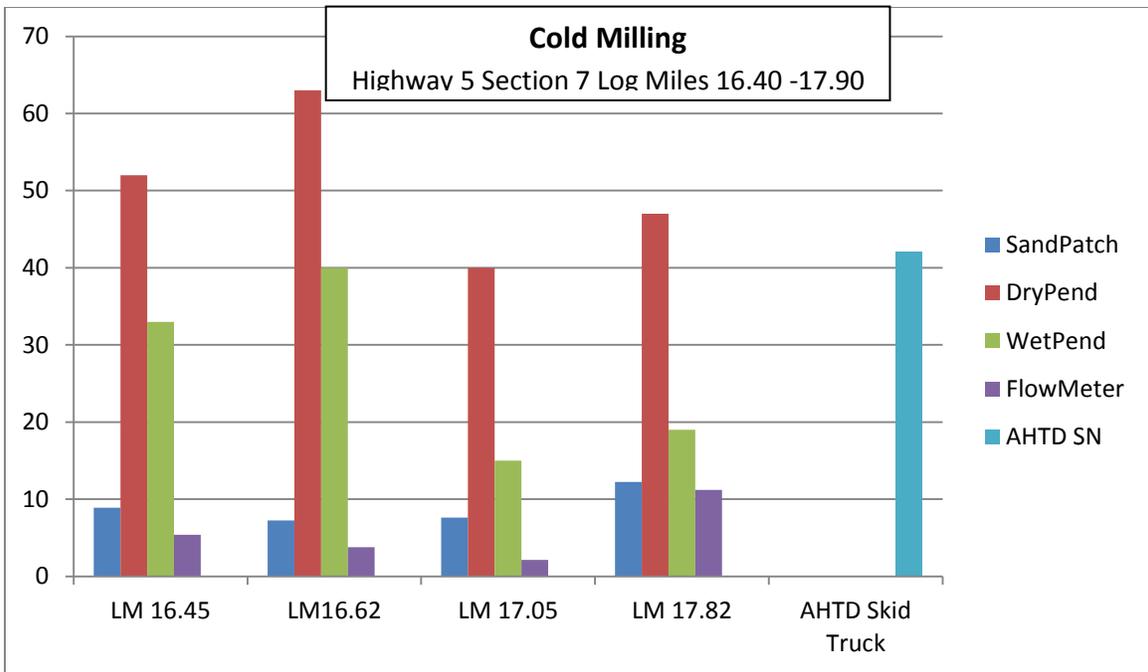
Three locations in District six. The first site is longitudinal tinning and skidabrader. It is on Interstate 430 section 21 log mile 9.0 – 10.0 (Figure 8). There is also skidabrador on Interstate 440 Section 1 Log mile 7.43 -8.43 (Figure 9). The cold milling is on Highway 5 Section 7 Log mile 16.4 – 17.9 (Figure 10).



**Figure 8**

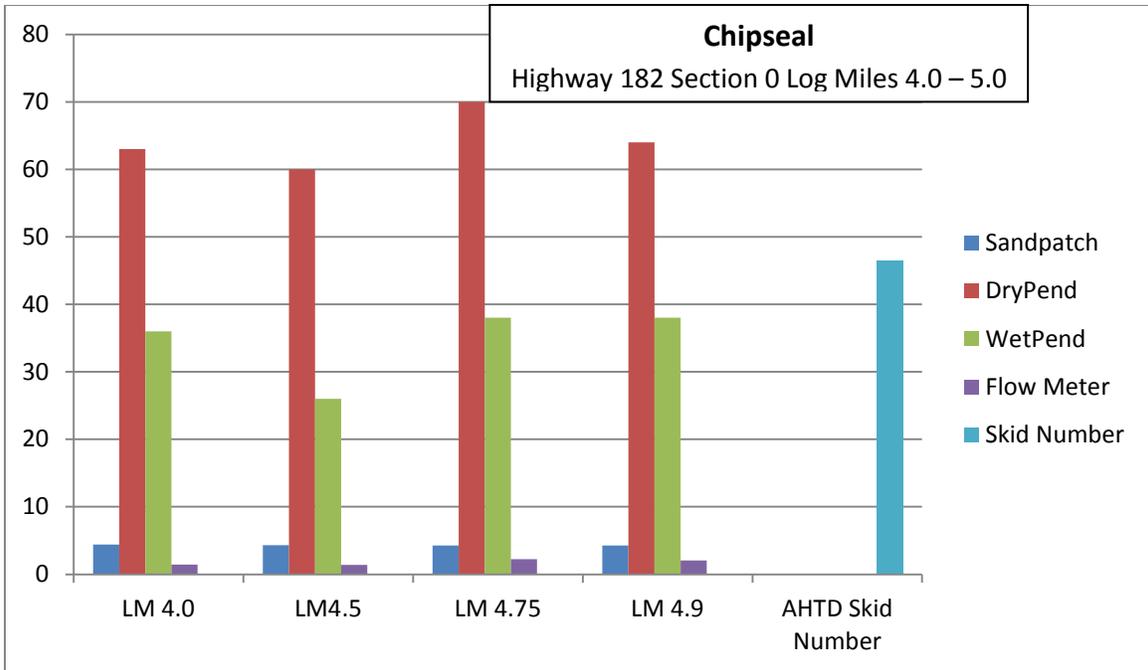


**Figure 9**

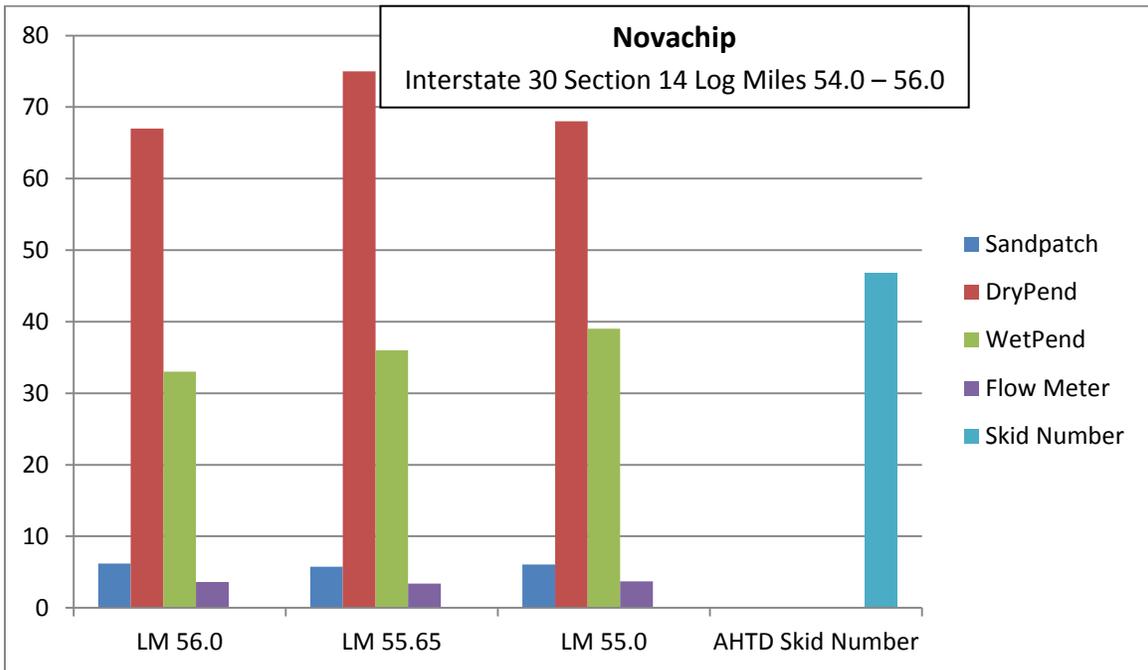


**Figure 10**

There are two locations in District seven. The first site is Highway 182 Section 0 log miles 4.0 – 5.0 and it consists of a chip seal (Figure 11). The other site is Interstate 30 Section 14 log mile 54.0 – 56.0 (Figure 12) and is an ultra-thin bonded wearing course.

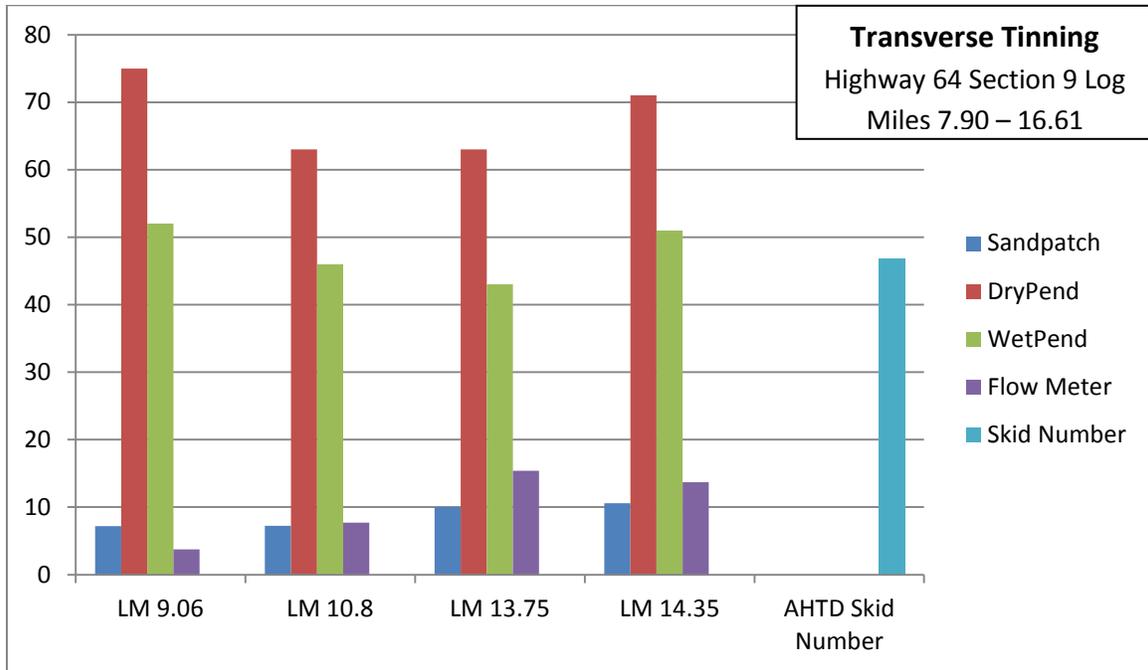


**Figure 11**



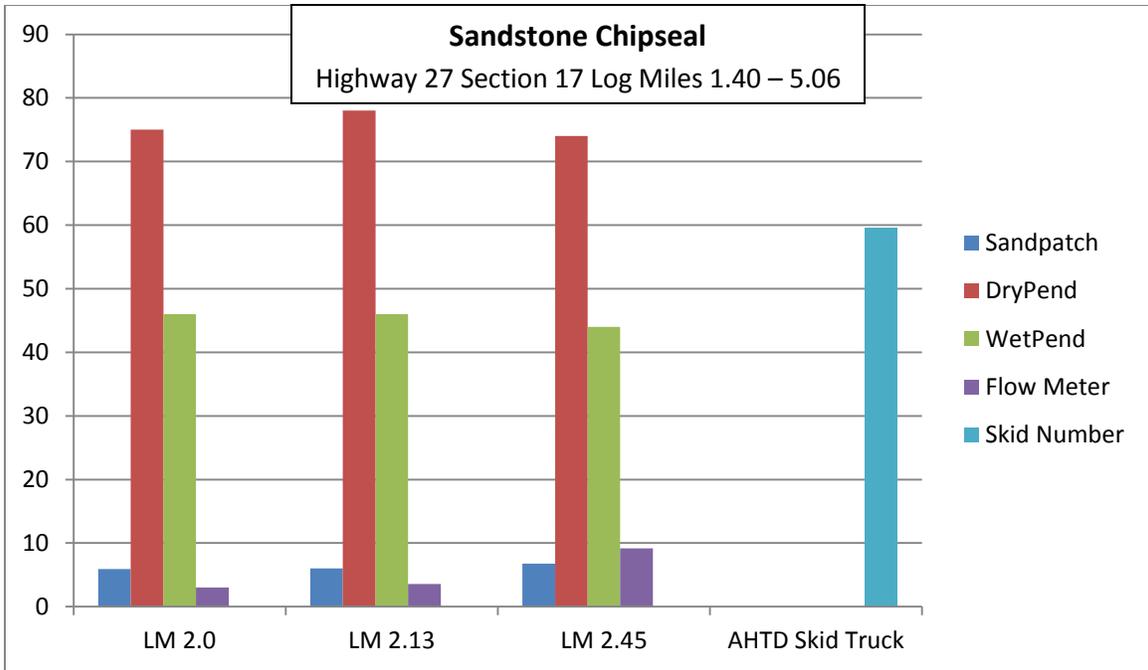
**Figure 12**

District 8 has one site that is transverse tinning. This site is on Highway 64 section 9 from log mile 7.90 to log mile 16.61 (Figure 13).

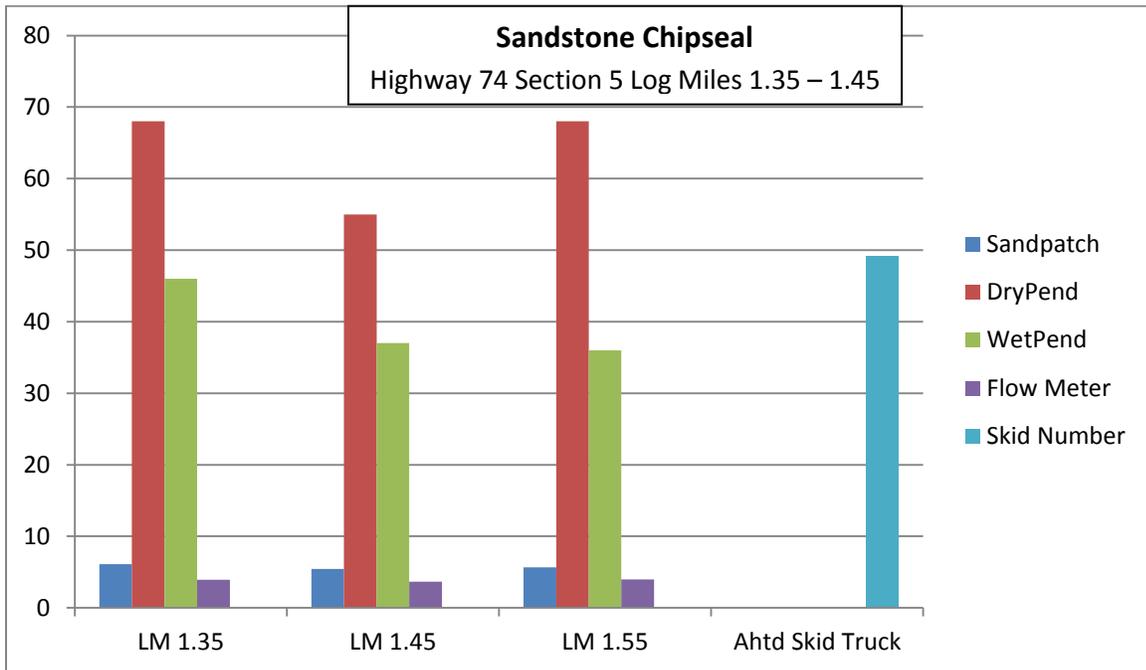


**Figure 13**

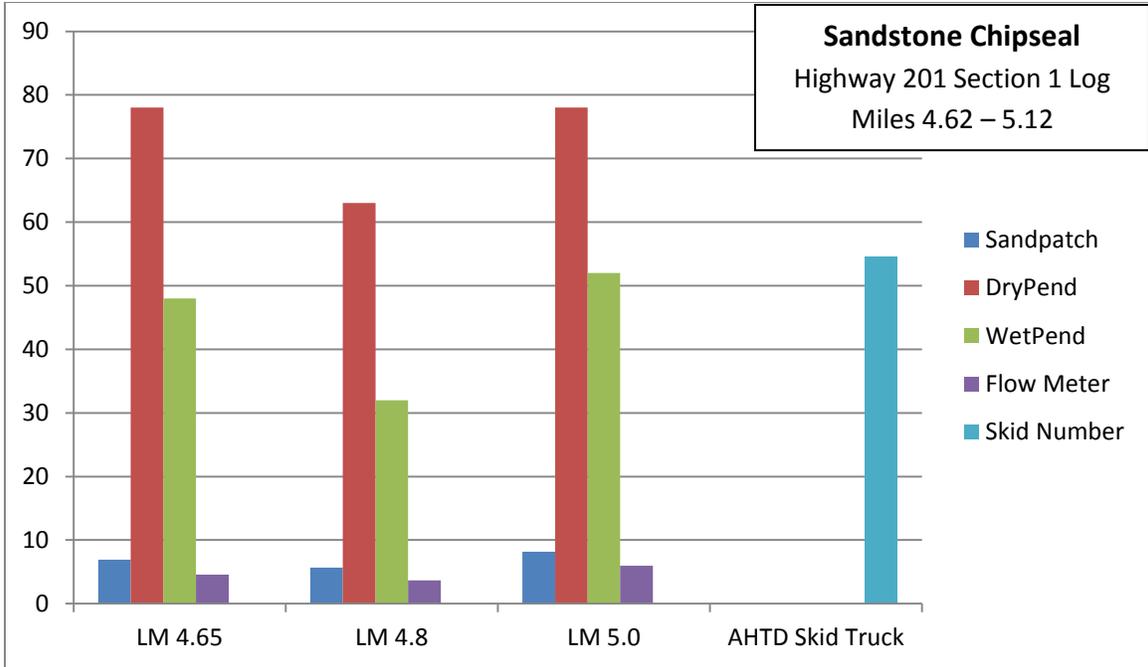
There are four locations in District nine. Three sites that have a sand stone chipseal are Highway 27 Section 17 log mile 1.40 – 5.06 (Figure 14), Highway 74 Section 5 Log mile 1.35 – 1.45 (Figure 15), and Highway 201 Section 1 Log mile 4.62 – 5.12 (Figure 16). The other location in District 9 is a light-weight chert chipseal that is on Highway 72 Section 3 Log mile 3.48 – 3.61 (Figure 17).



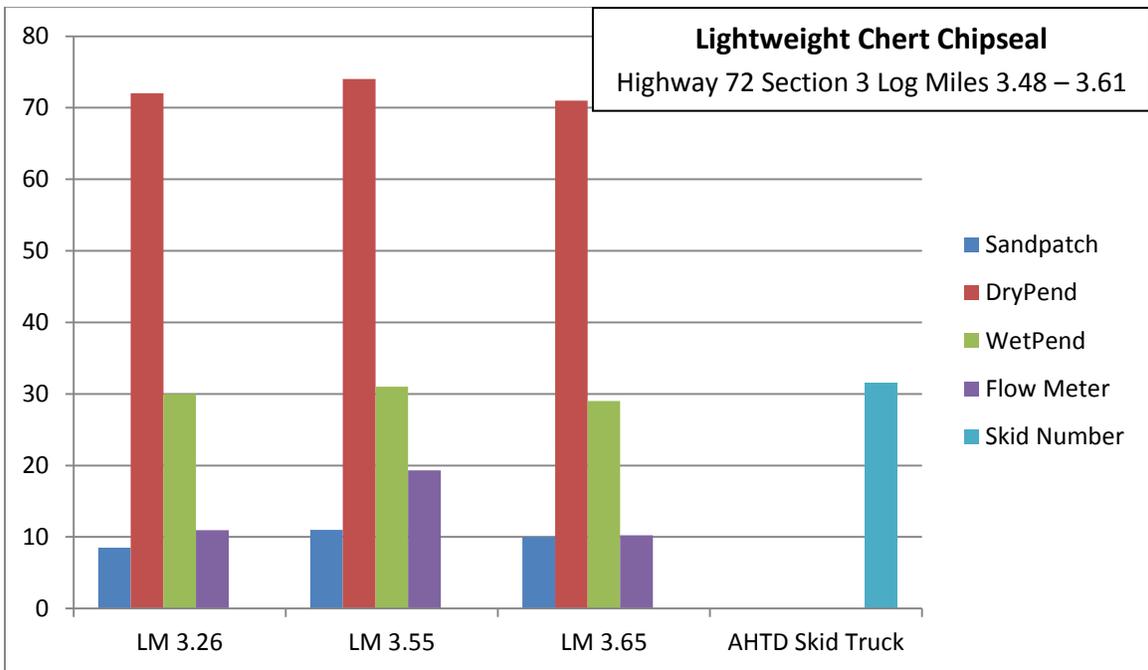
**Figure 14**



**Figure 15**

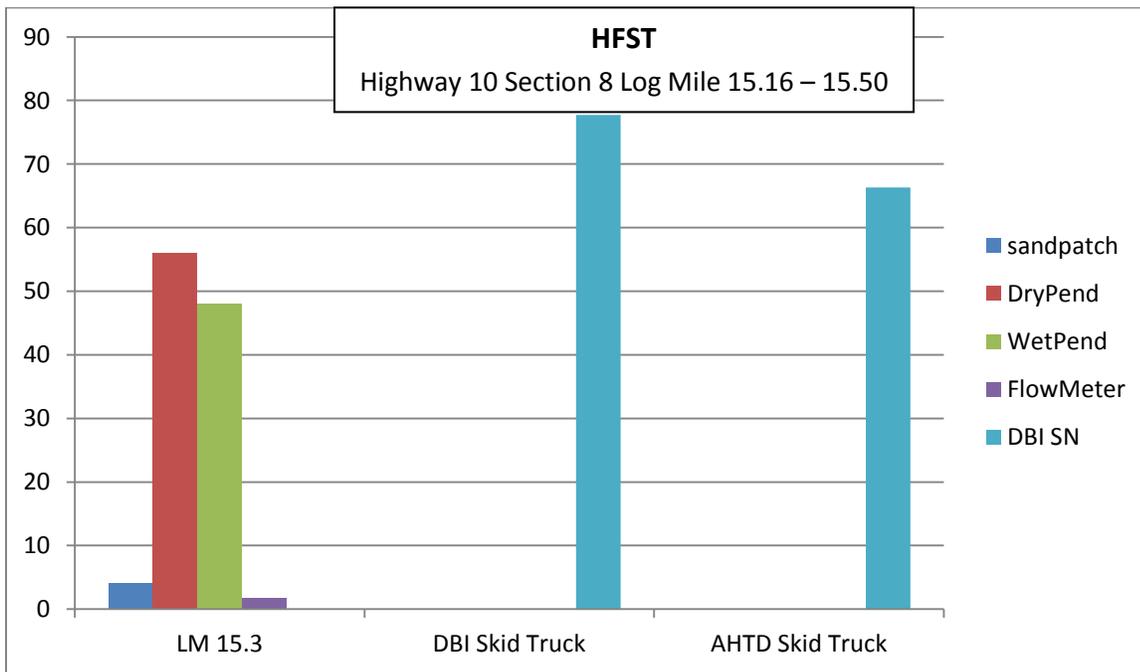


**Figure 16**

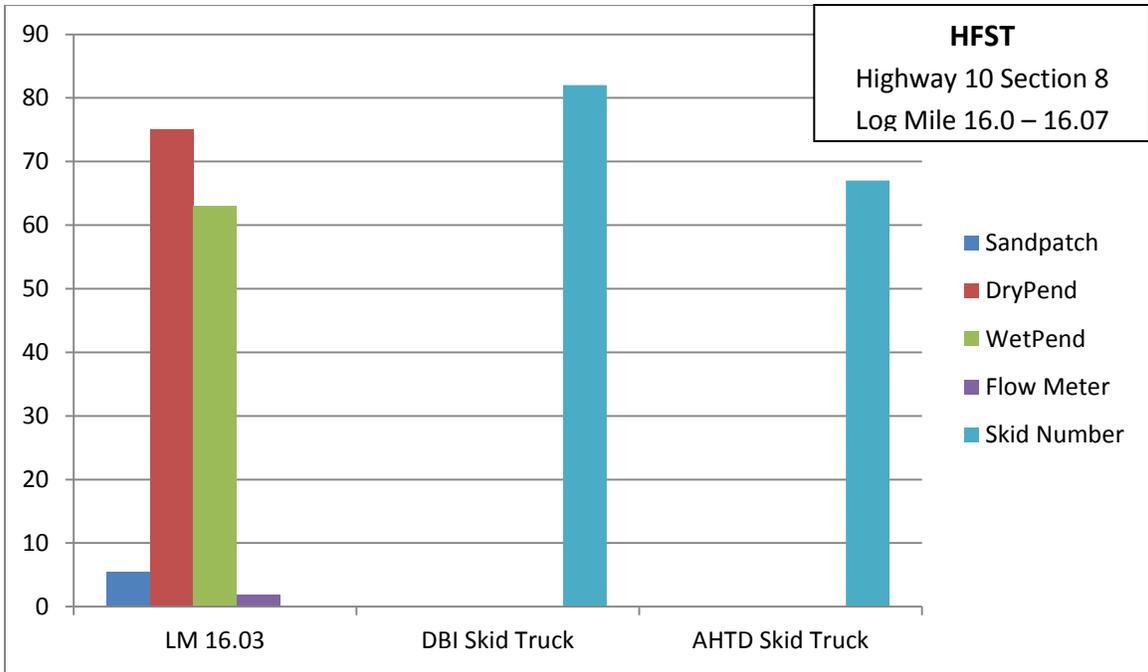


**Figure 17**

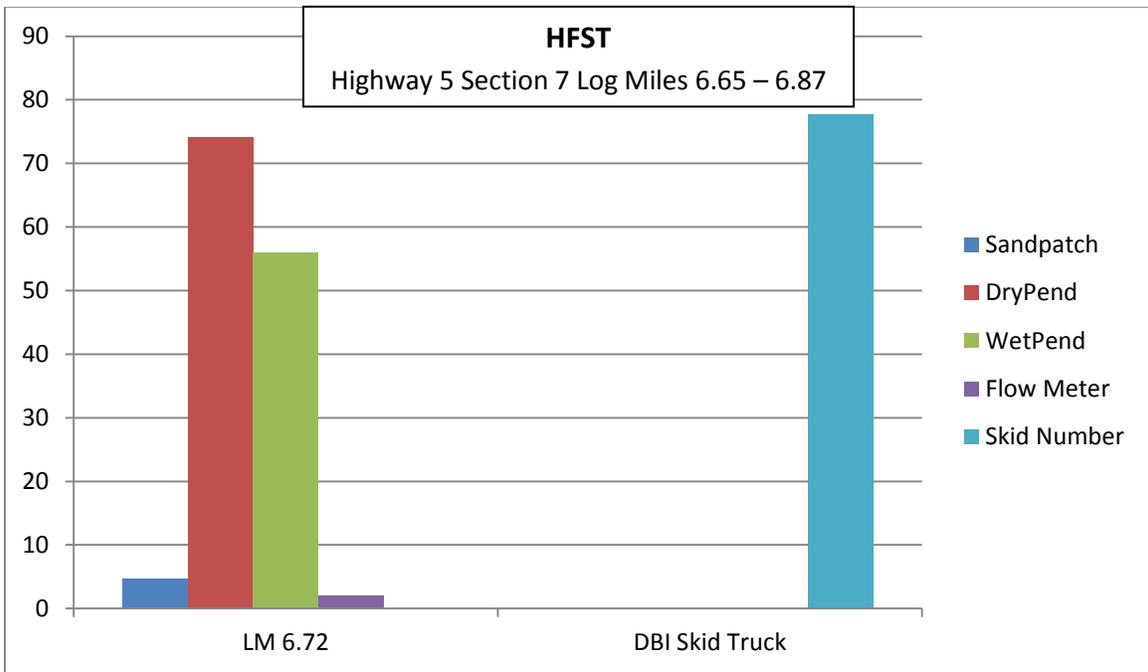
There is High Friction Surface Treatment (HFST) on Highway 10 Section 8 Log mile 15.16 – 15.50 (Figure 18) and 16.0 – 16.07 (Figure 19). Highway 5 Section 7 also has HFST at log mile 6.65 – 6.87 (Figure 20). HFST was also placed on Highway 5 Section 6 at log miles 0.00 – 0.2 (Figure 21) and 3.0 – 3.20 (Figure 22). Highway 270 Section 6 Log mile 6.64 – 6.80 (Figure 23) is the next site the HFST was placed. Highway 7 Section 9 log mile 1.62 – 1.83 (Figure 24) also has HFST. Two more HFST sites in District 6 are on Highway 67 Section 9 at log miles 6.03 -6.11 (Figure 25) and 6.37 – 6.47 (Figure 26). The final HFST in District 6 is Highway 5 Section 12 log mile 6.70 – 7.30 (Figure 27).



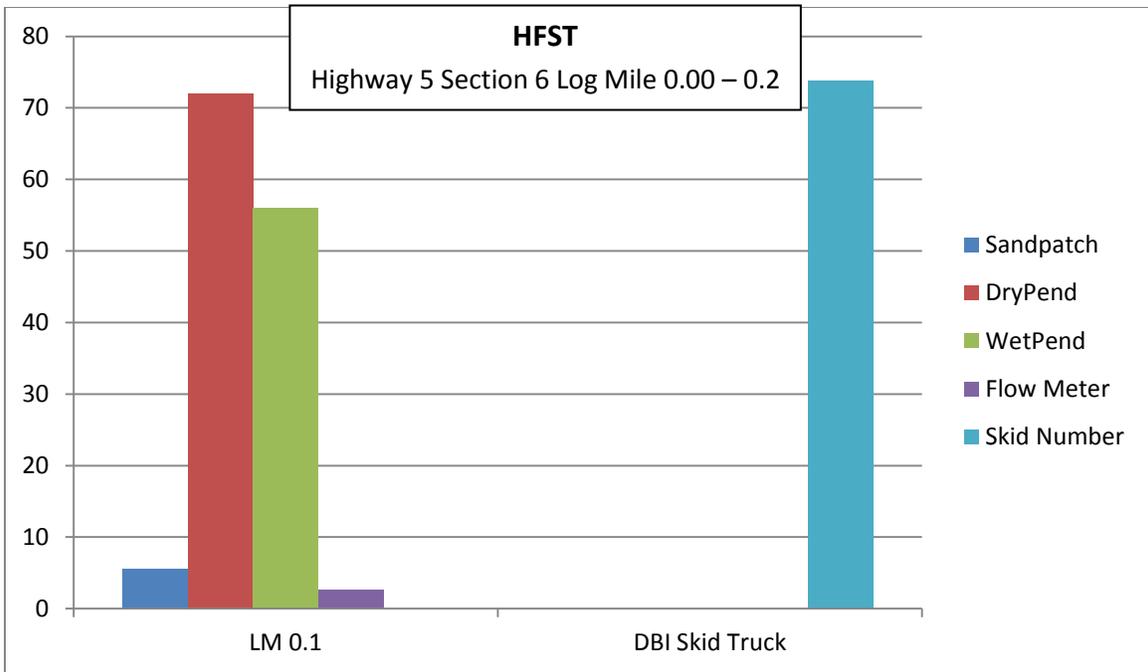
**Figure 18**



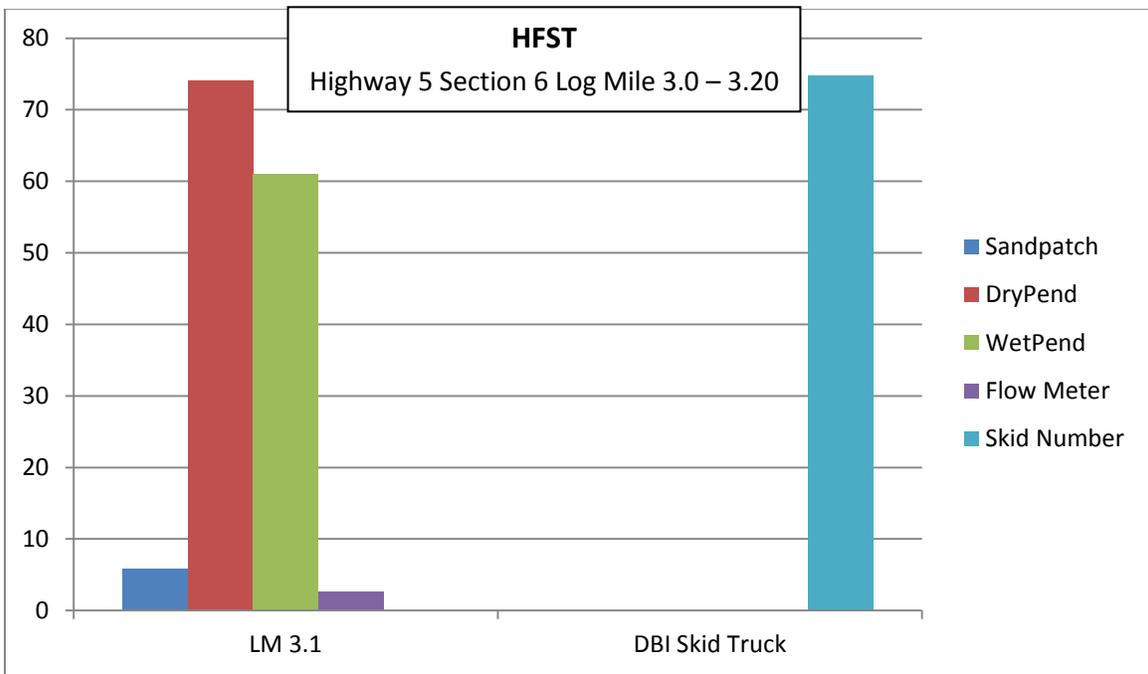
**Figure 19**



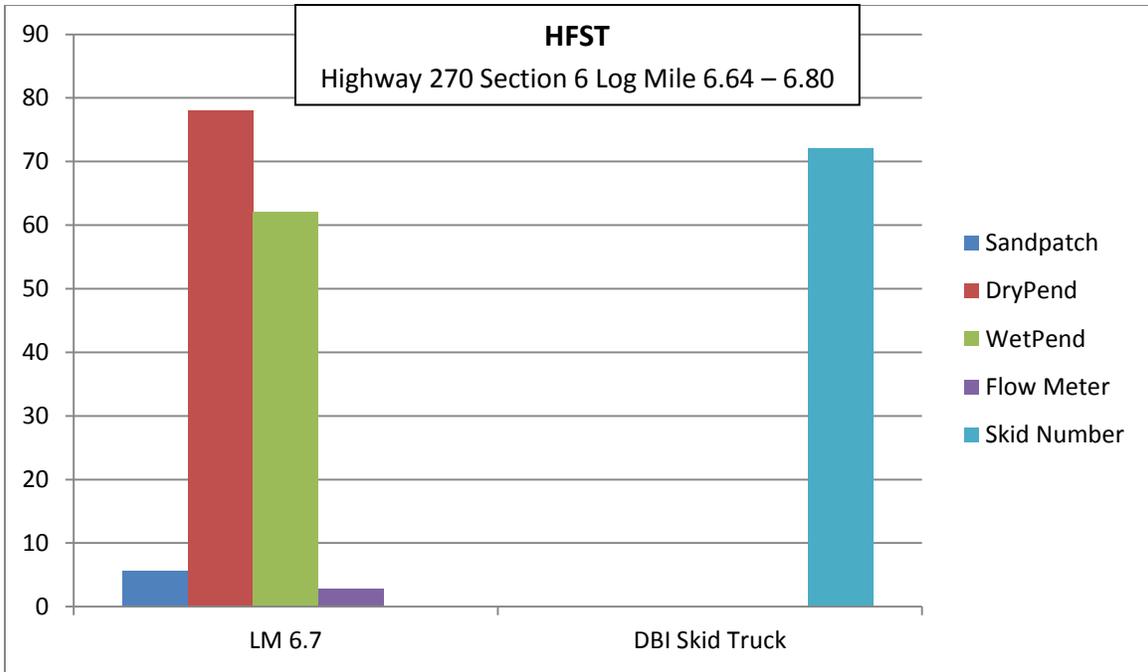
**Figure 20**



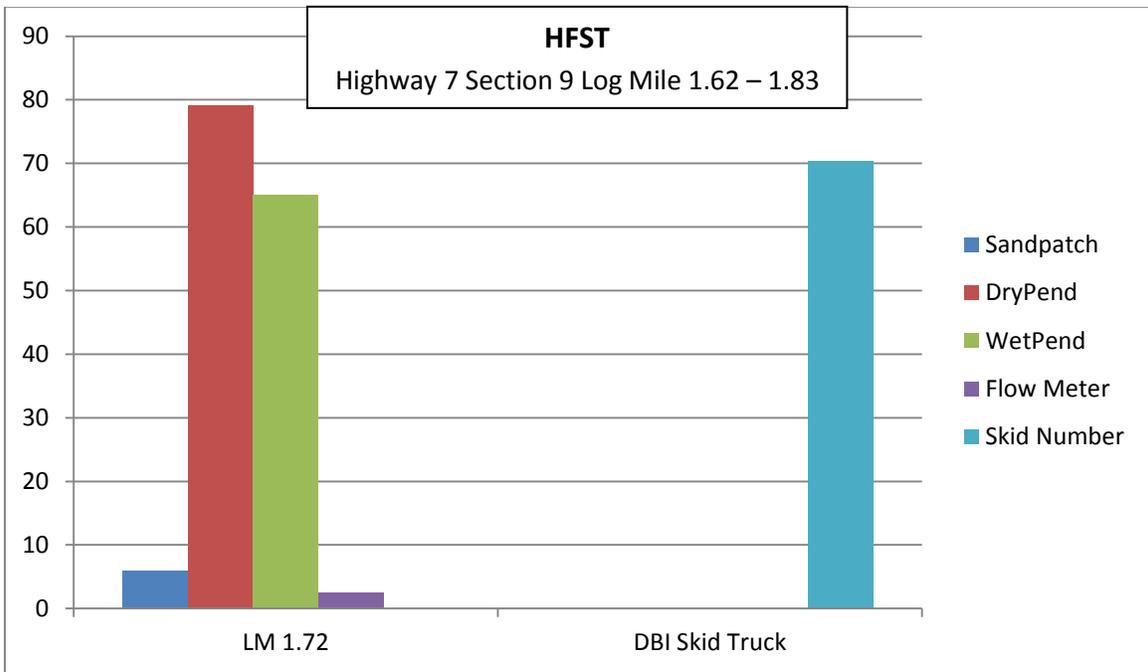
**Figure 21**



**Figure 22**



**Figure 23**



**Figure 24**

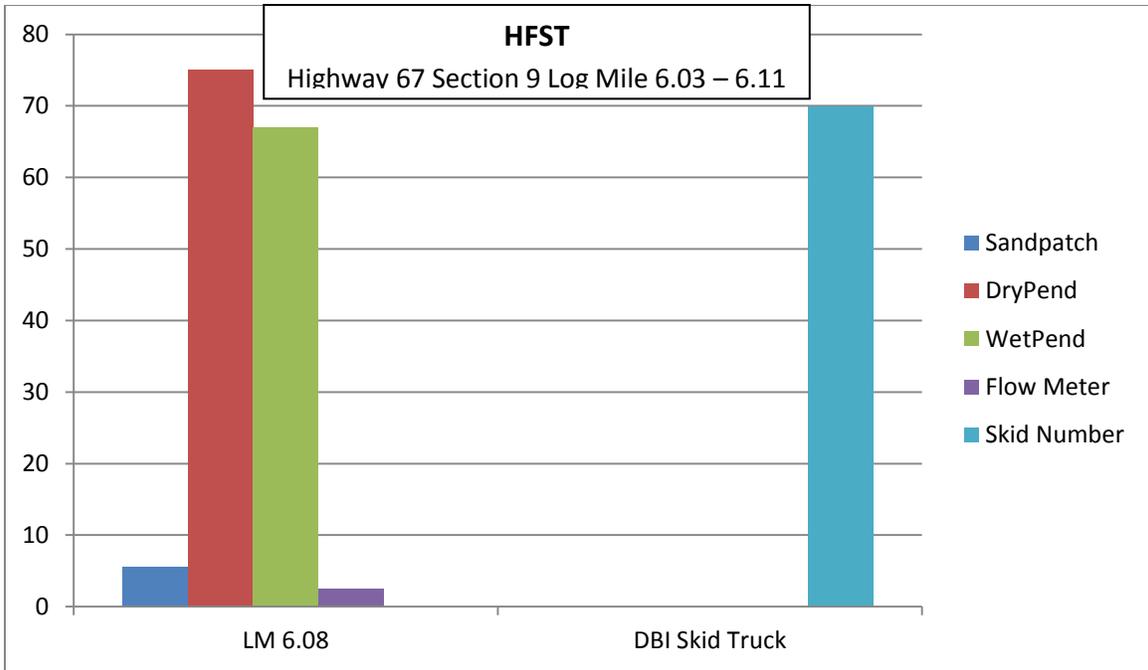


Figure 25

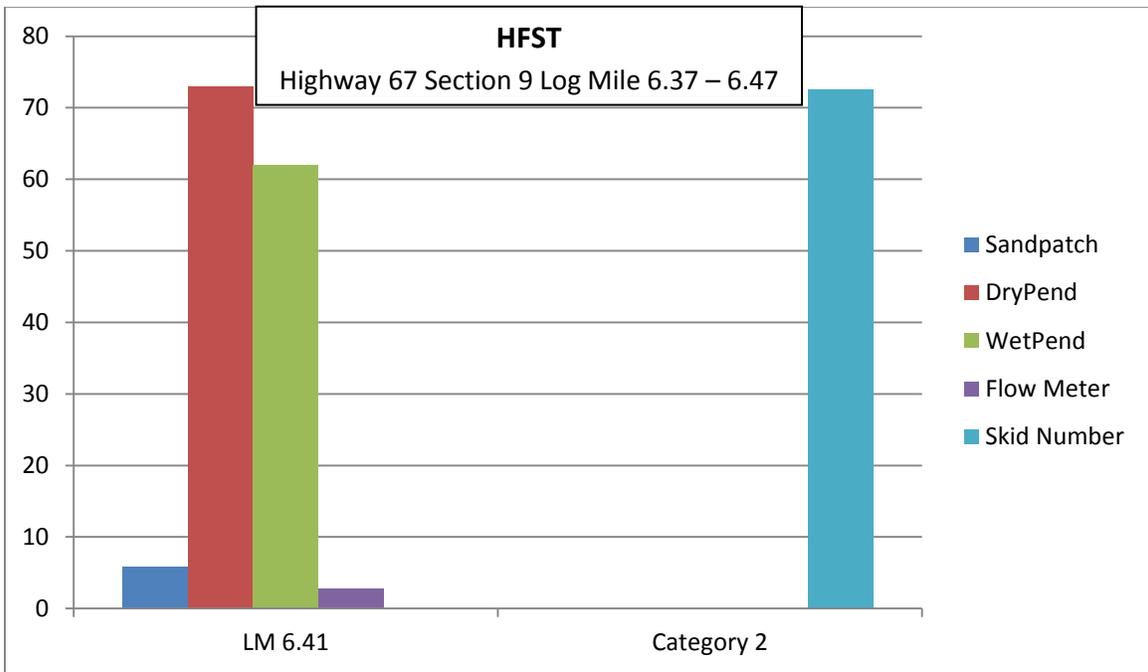
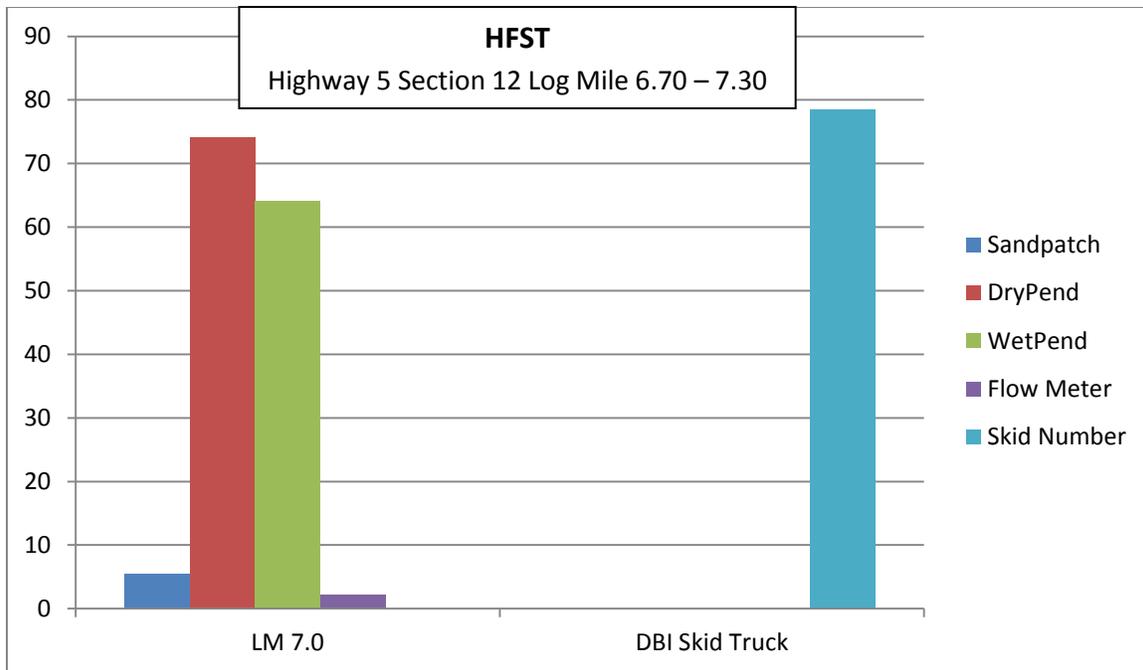


Figure 26

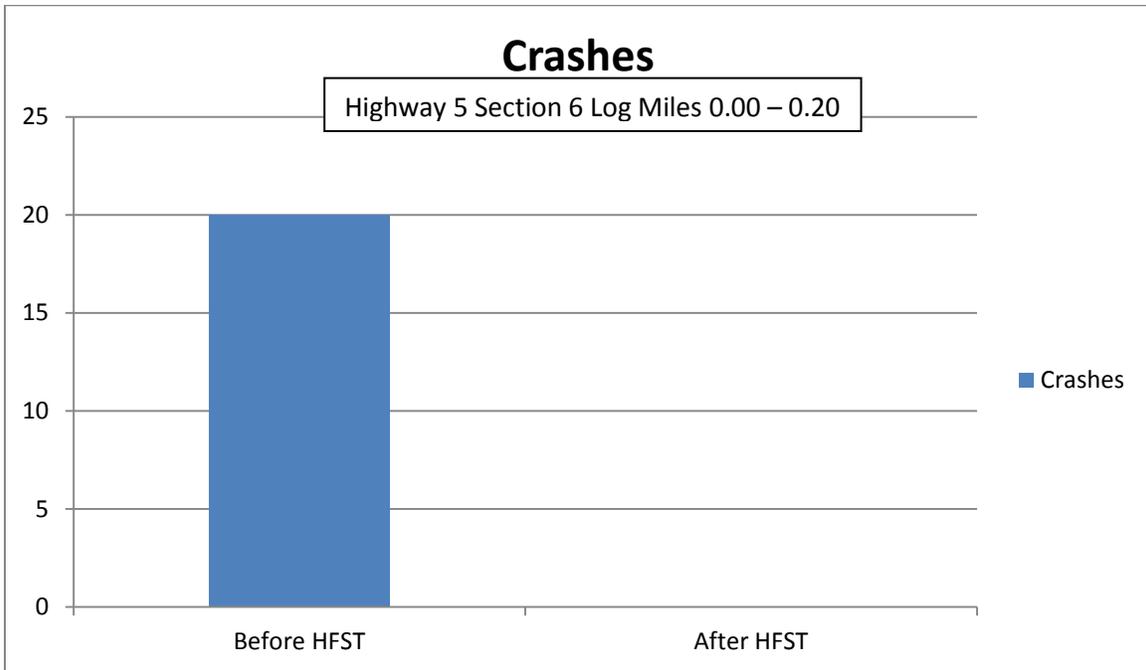


**Figure 27**

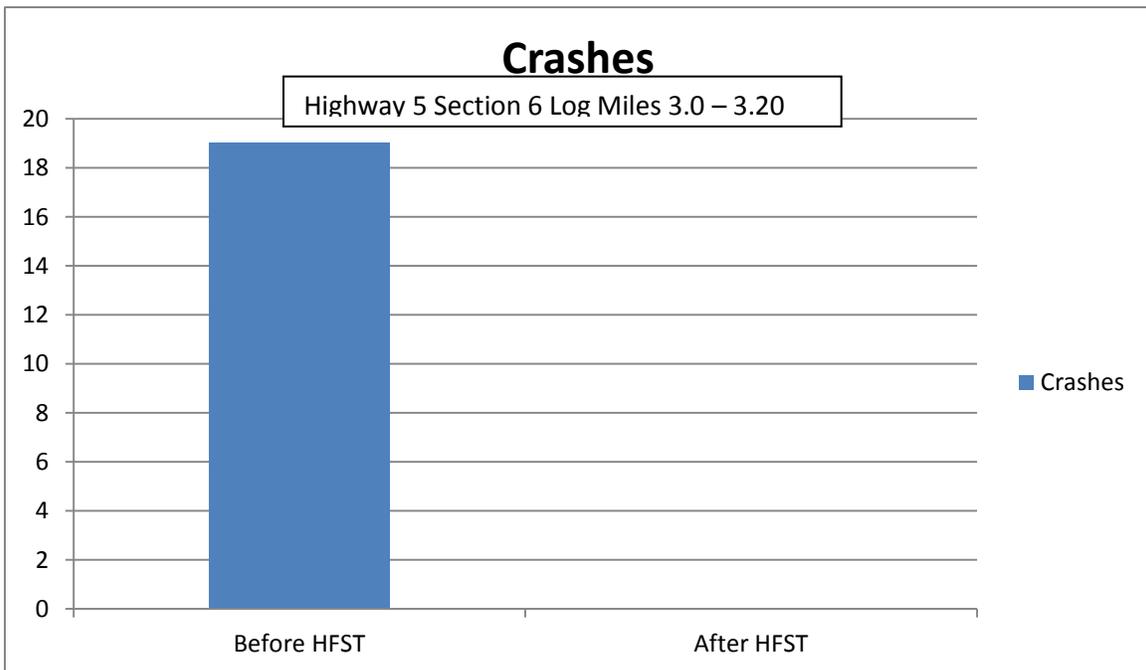
**Performance Evaluation**

Tracking the reduction in crashes and the increase in micro and/or macro texture is included in the performance evaluation. Also in the performance evaluation is the cost effectiveness of each treatment.

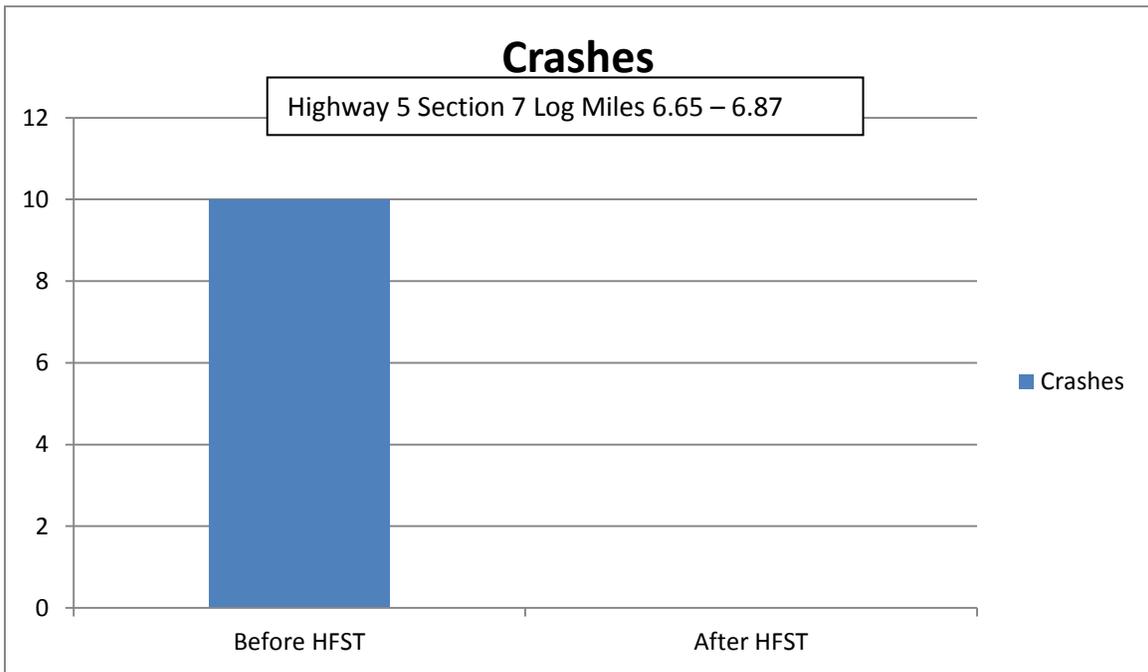
At the time of this report only the crash data before the HFST was placed was available. The crash data for one year after the HFST sites were laid will be available early 2017. Once the crash data is obtained it will be added to this report. The following charts (Figures 28 – 41) contain the crash data from 2010 through 2014, which is before the HFST was applied.



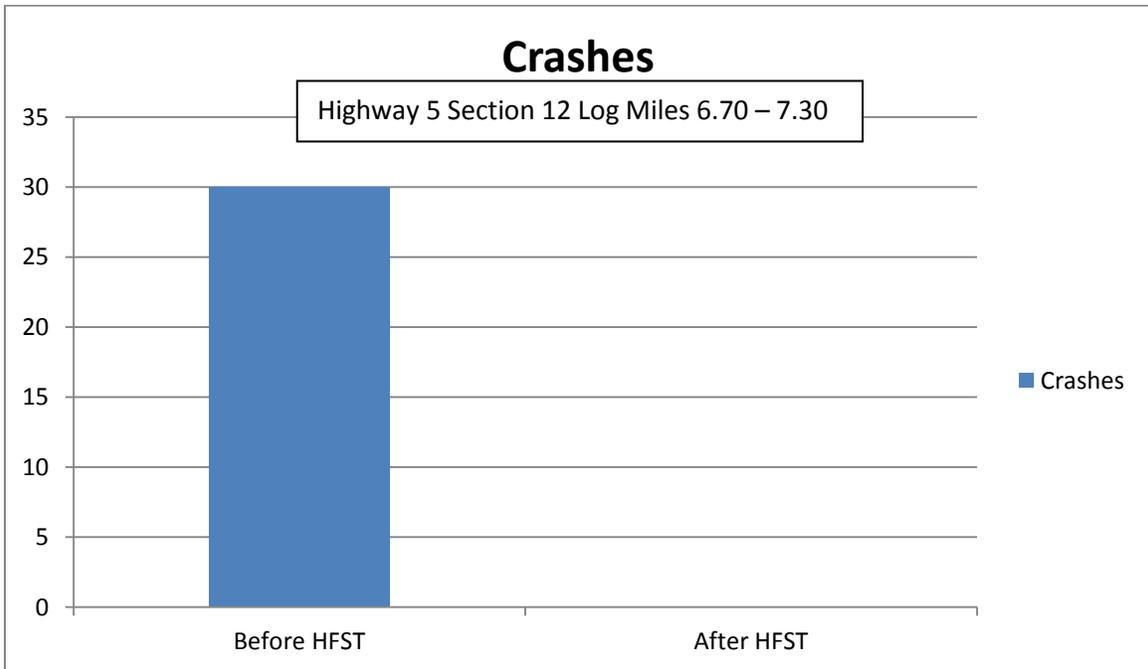
**Figure 28**



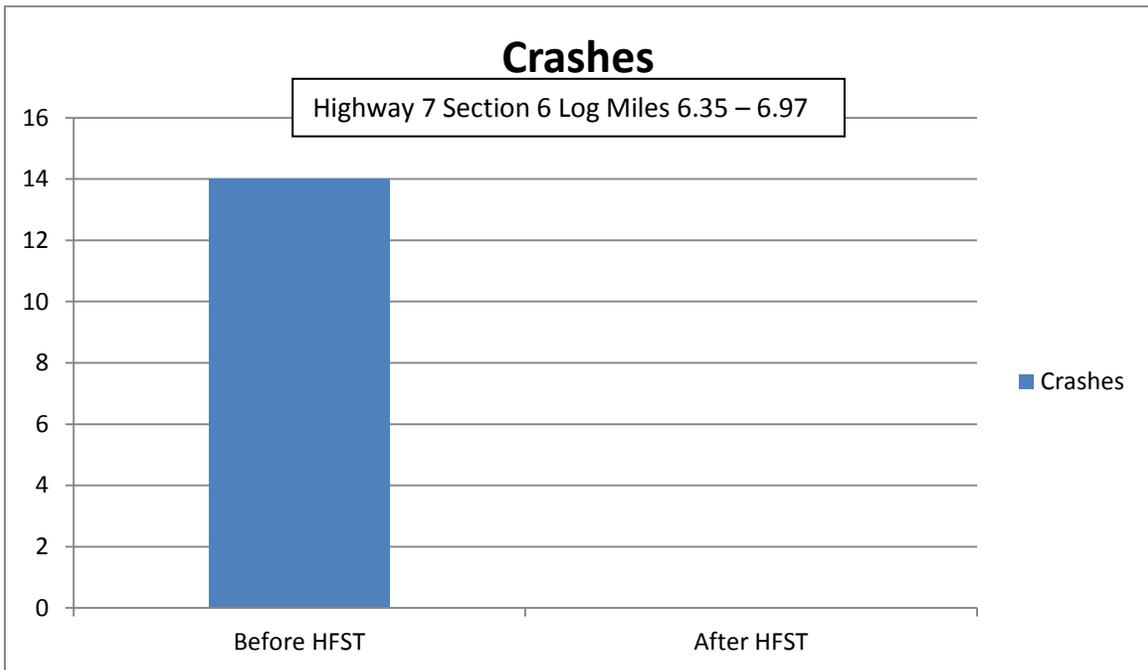
**Figure 29**



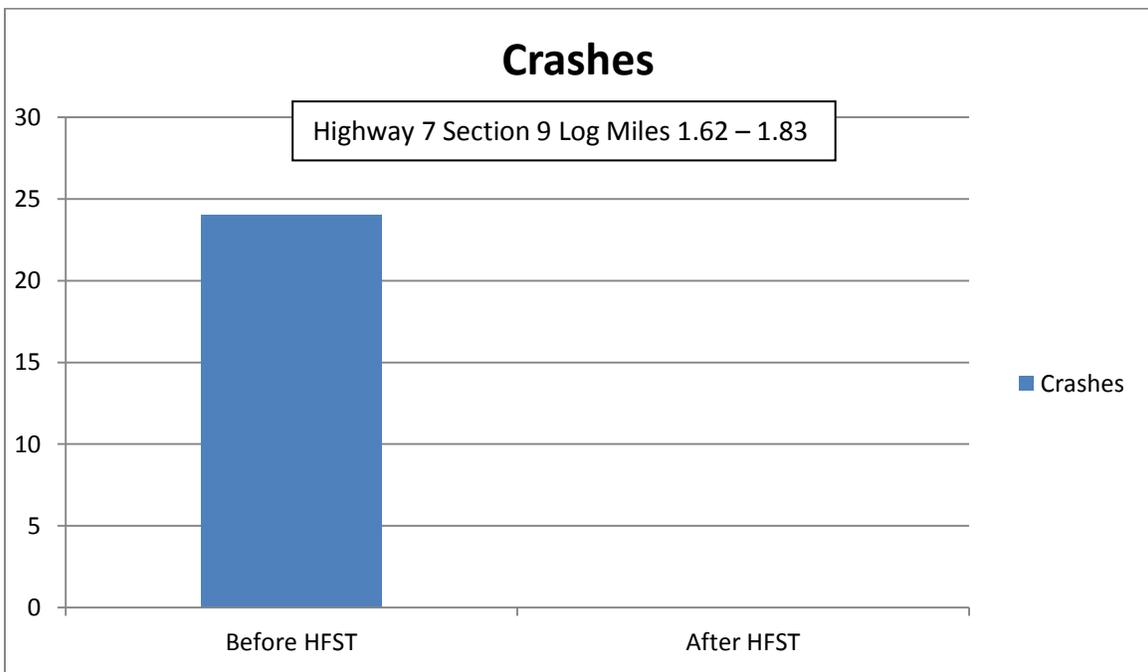
**Figure 30**



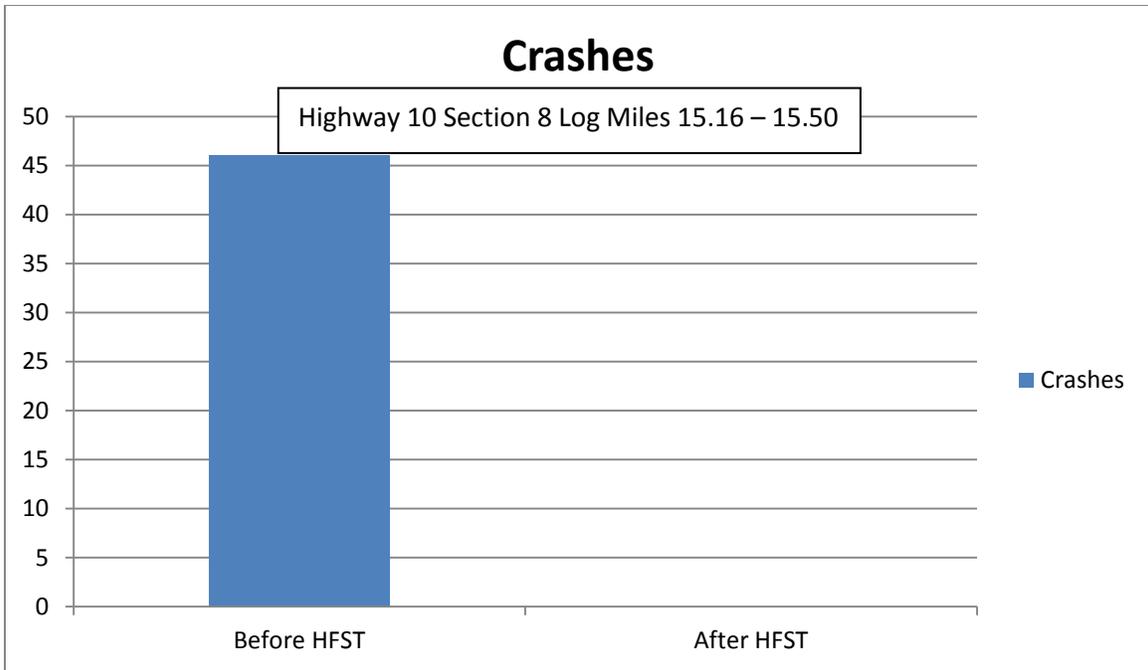
**Figure 31**



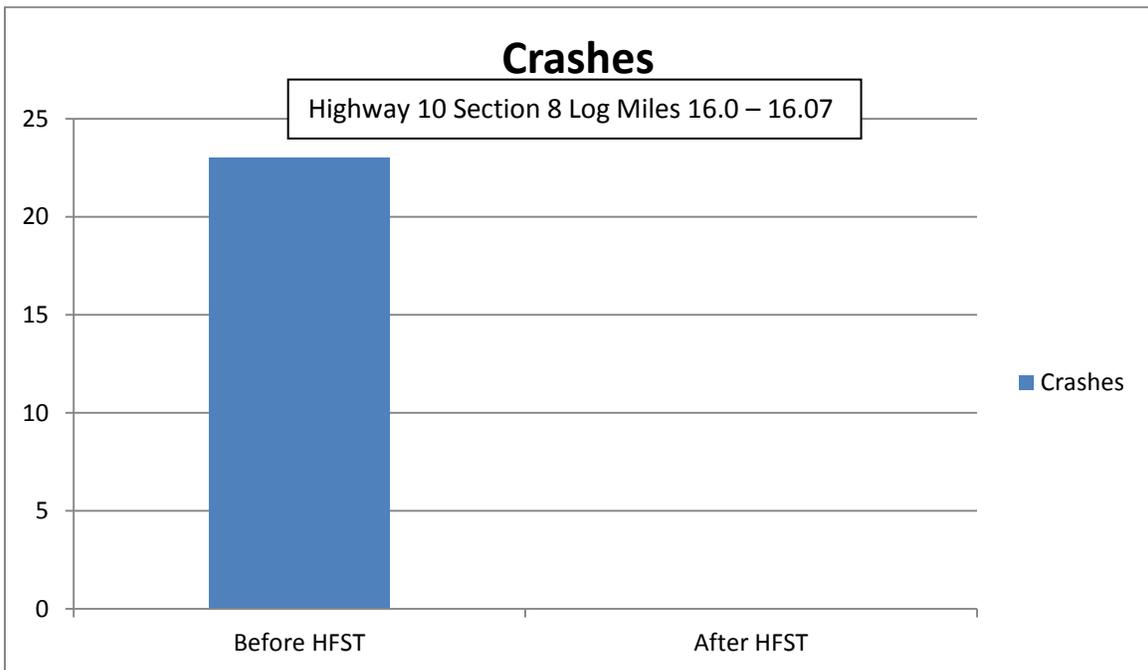
**Figure 32**



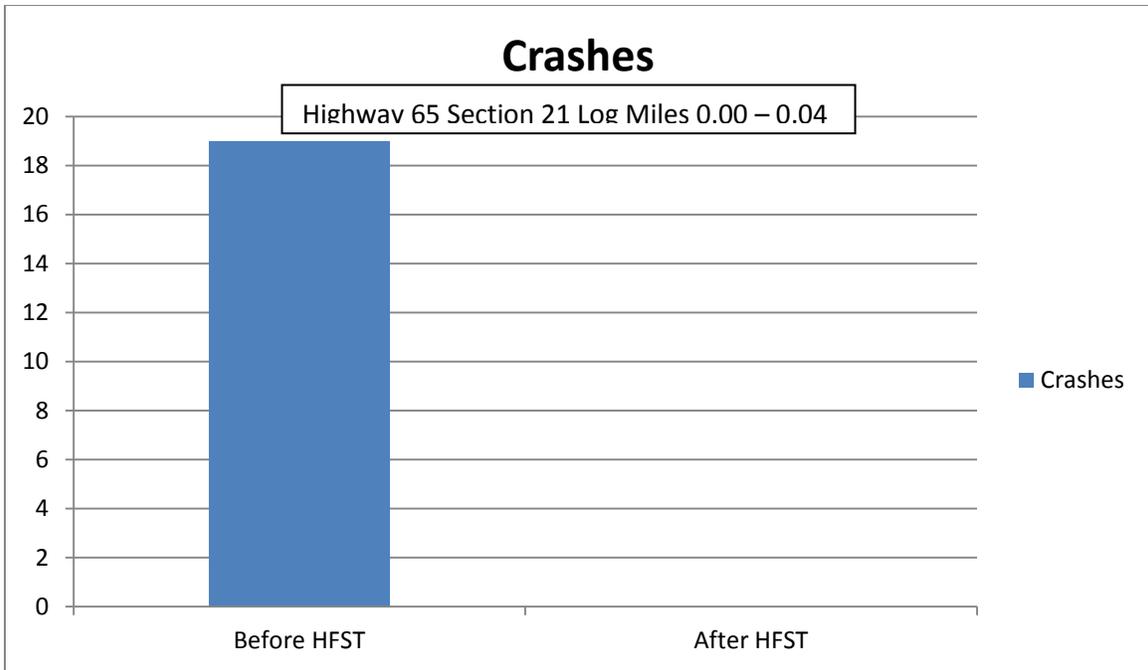
**Figure 33**



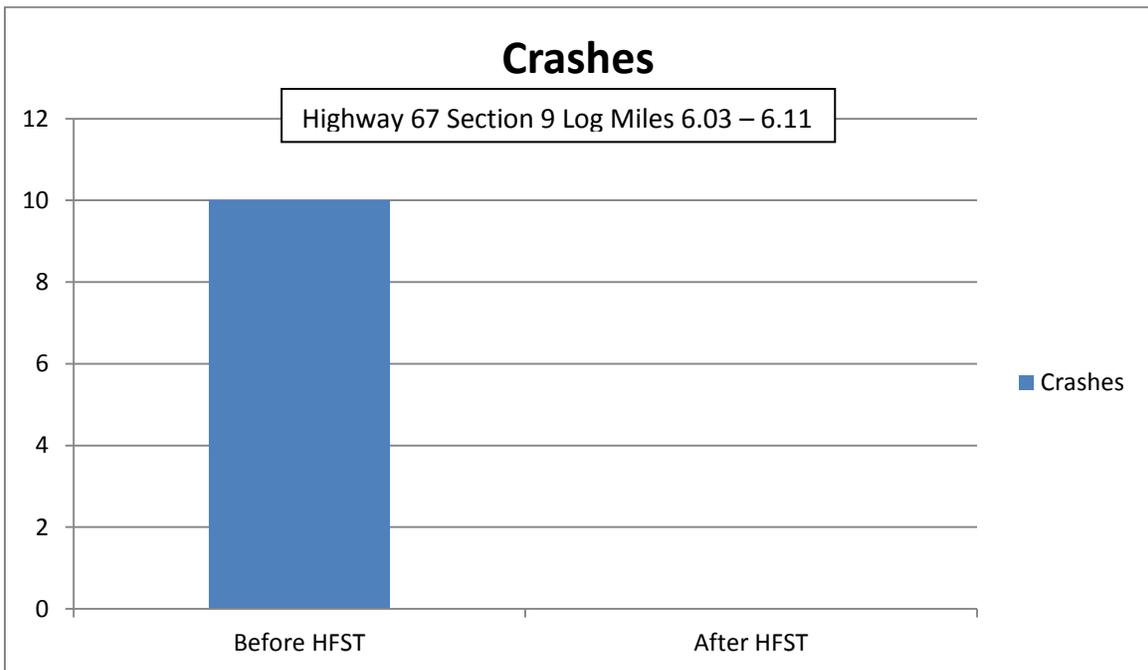
**Figure 34**



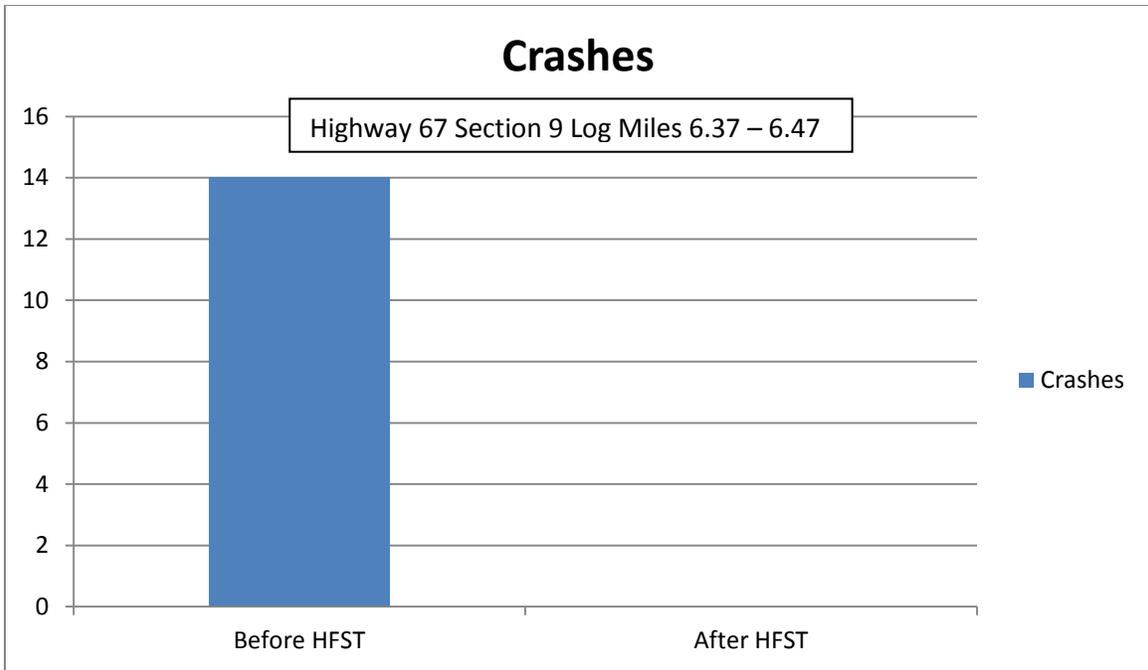
**Figure 35**



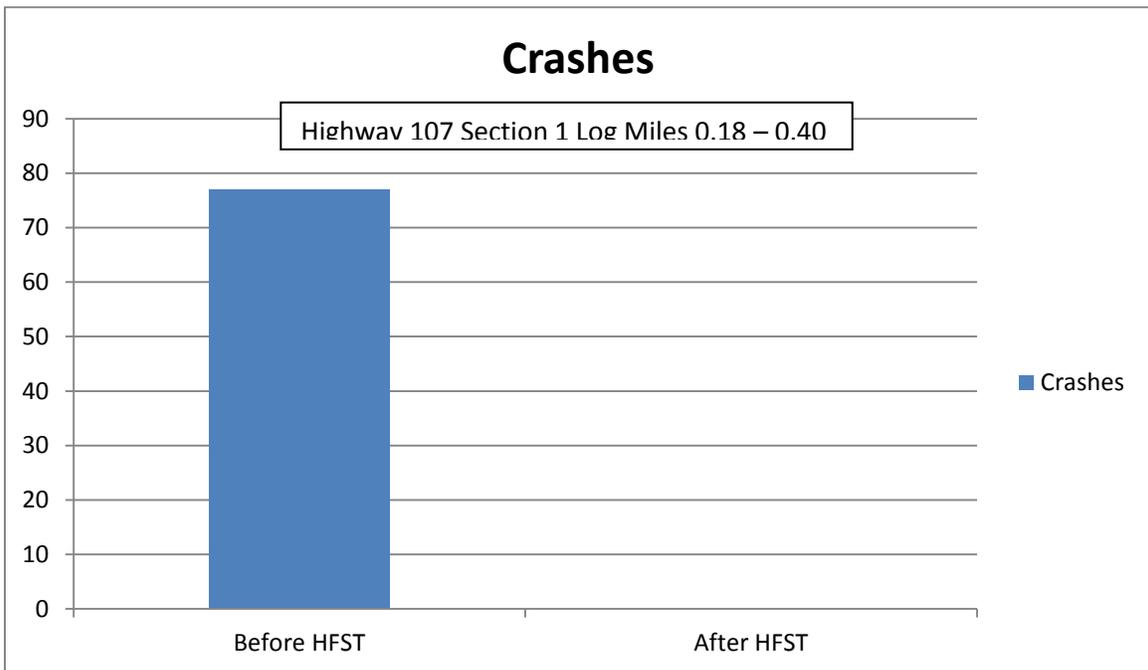
**Figure 36**



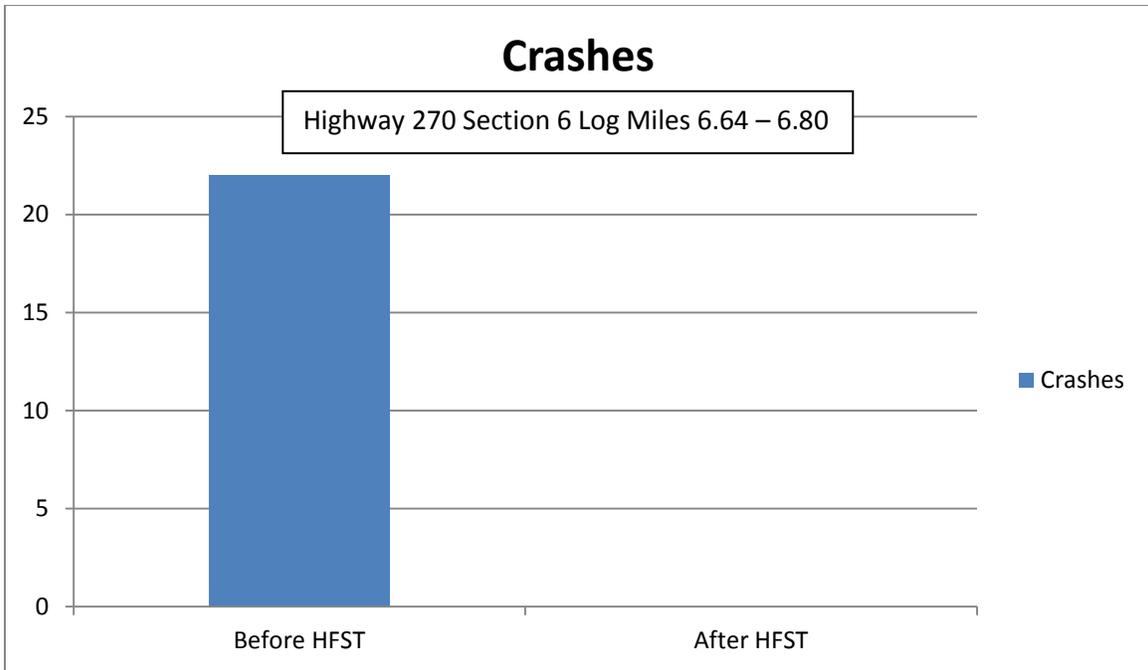
**Figure 37**



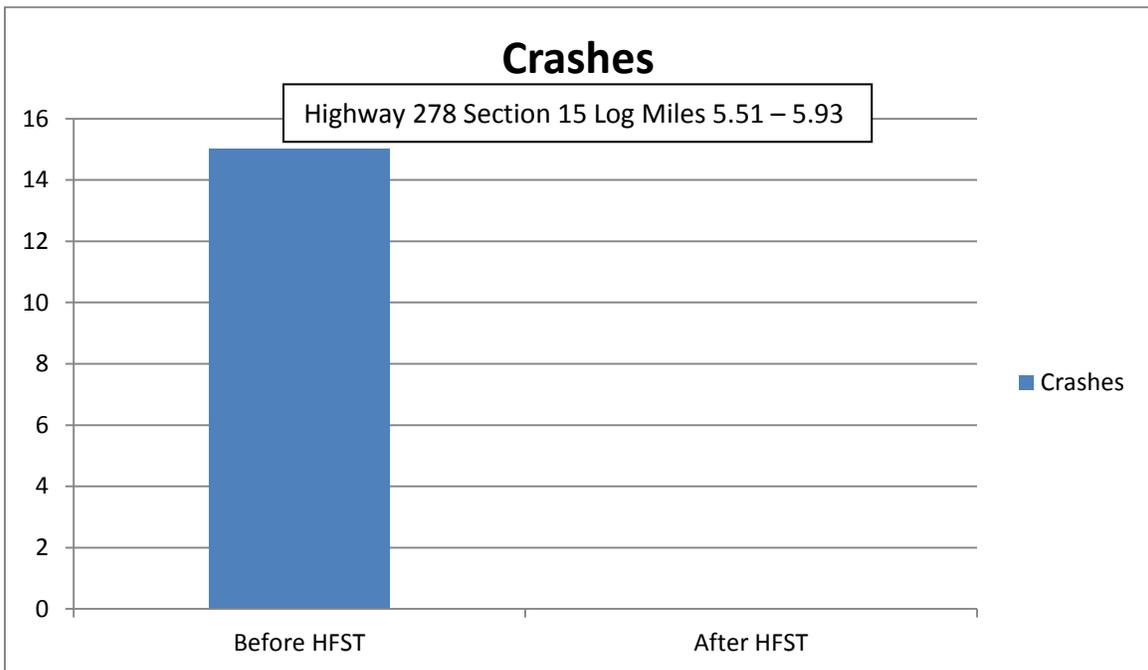
**Figure 38**



**Figure 39**

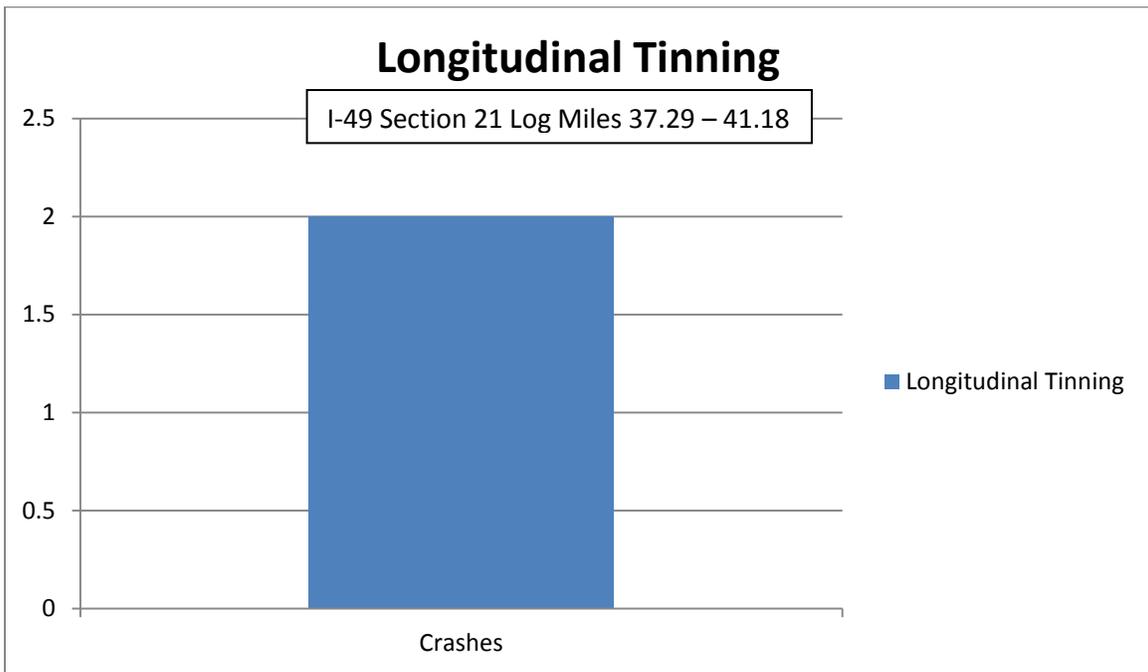


**Figure 40**

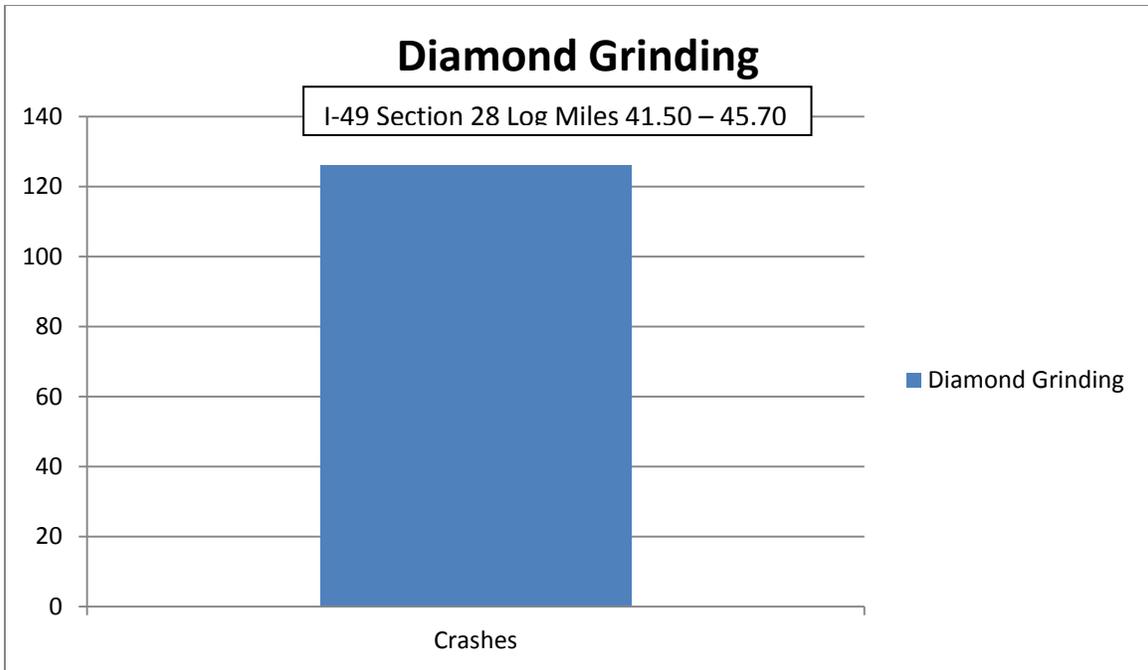


**Figure 41**

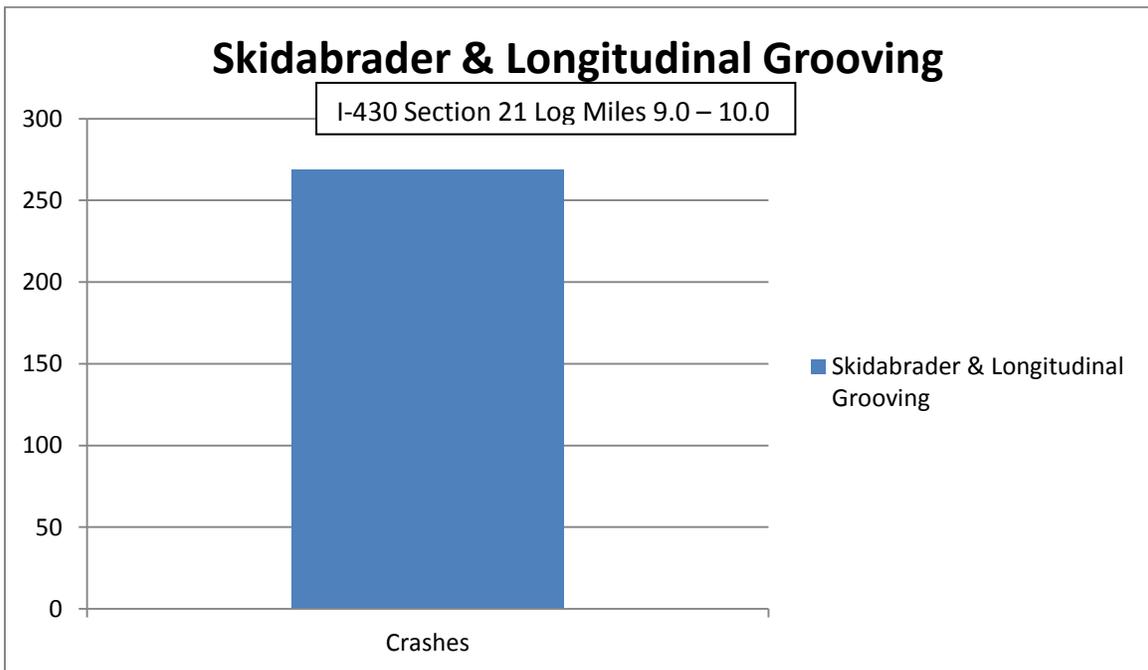
The following charts (Figures 42 – 52) are of crashes that happened on each existing location from 2010 through 2014.



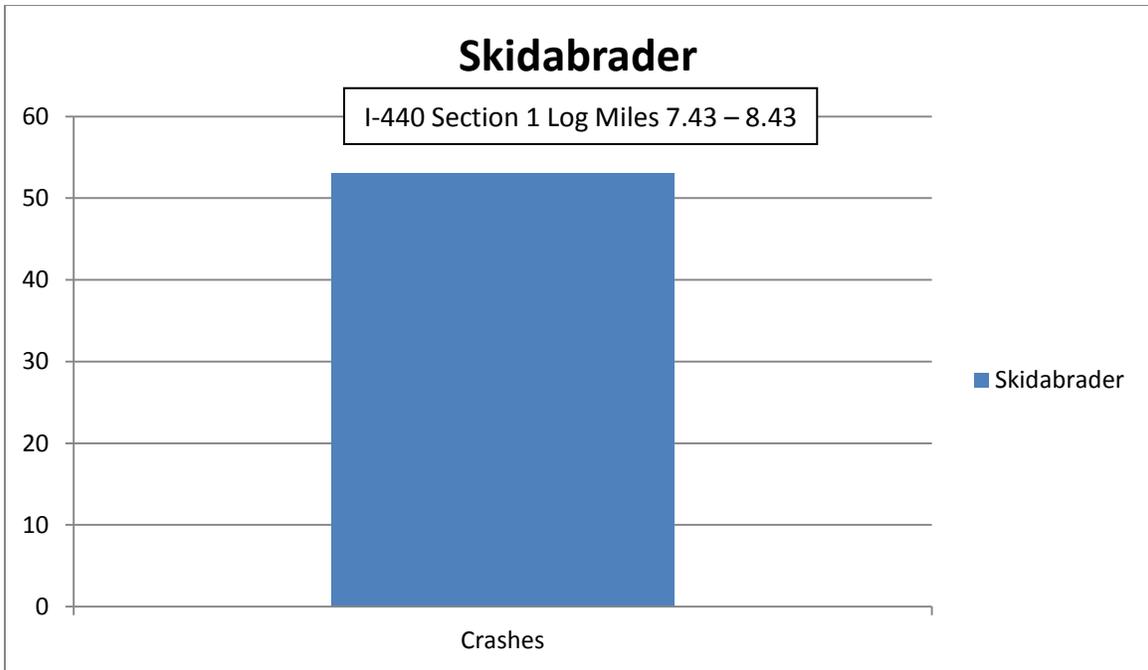
**Figure 42**



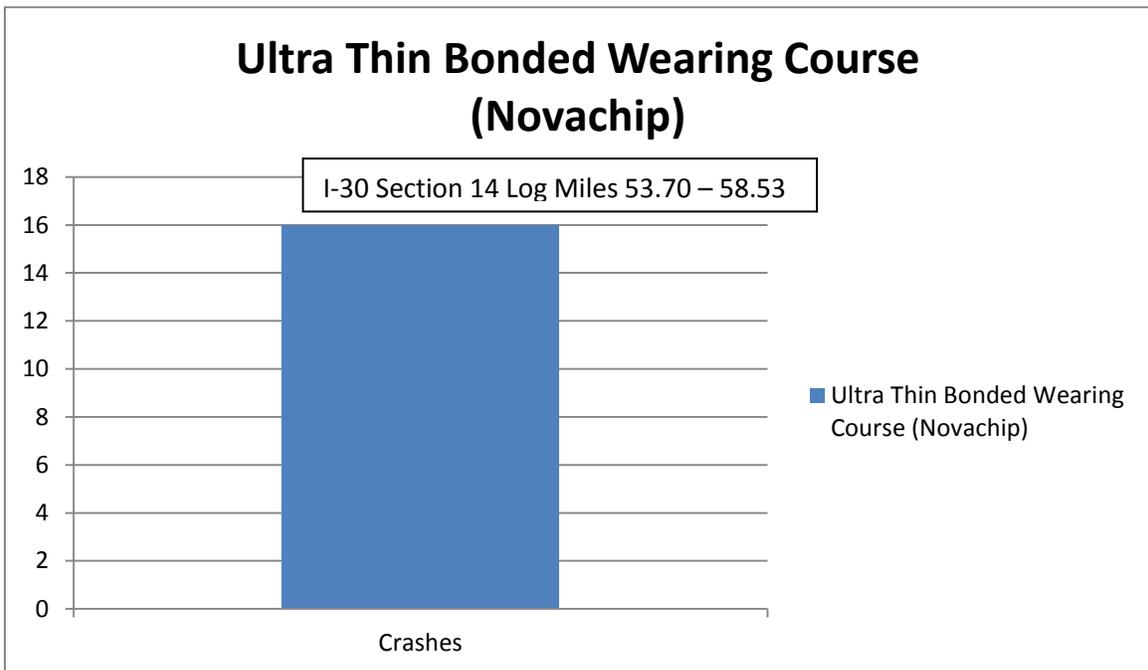
**Figure 43**



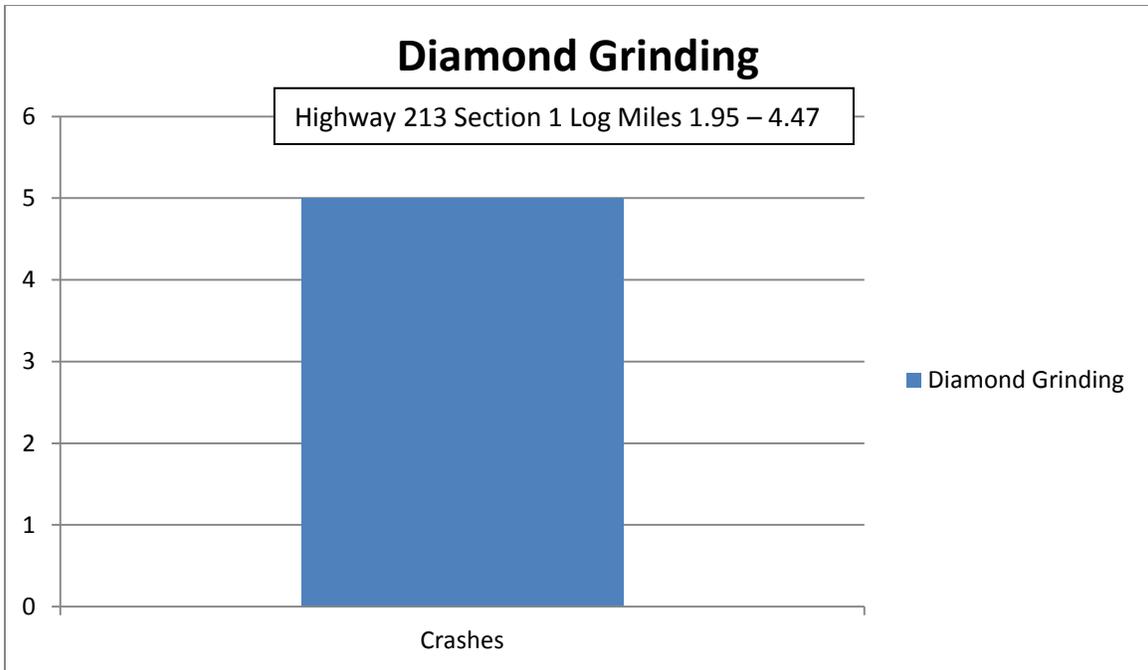
**Figure 44**



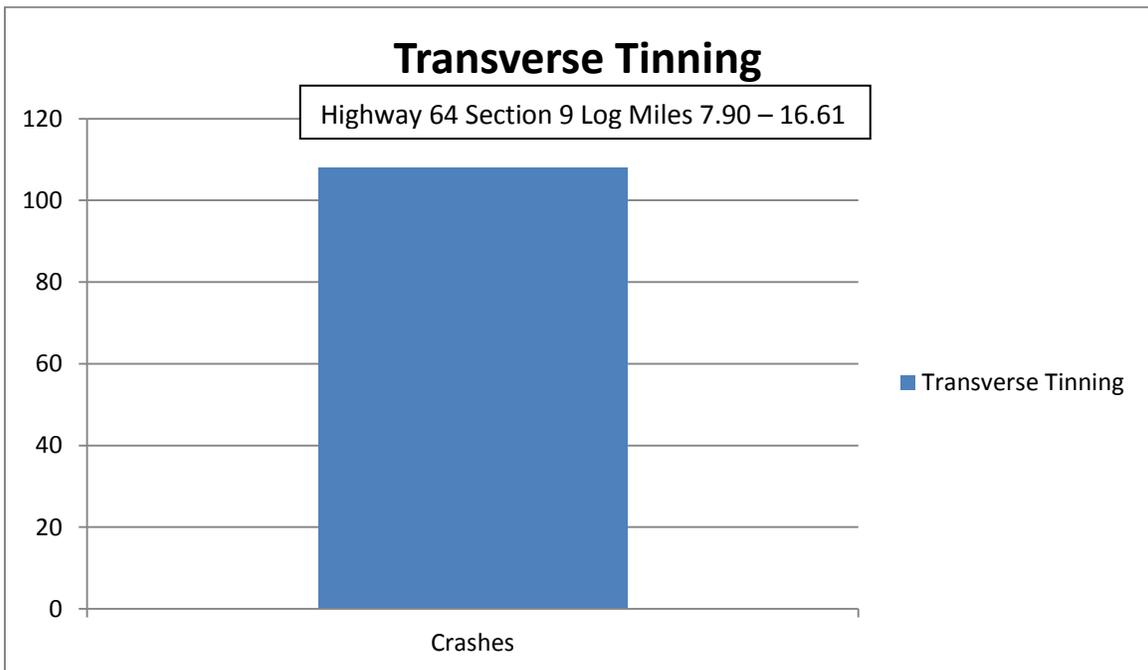
**Figure 45**



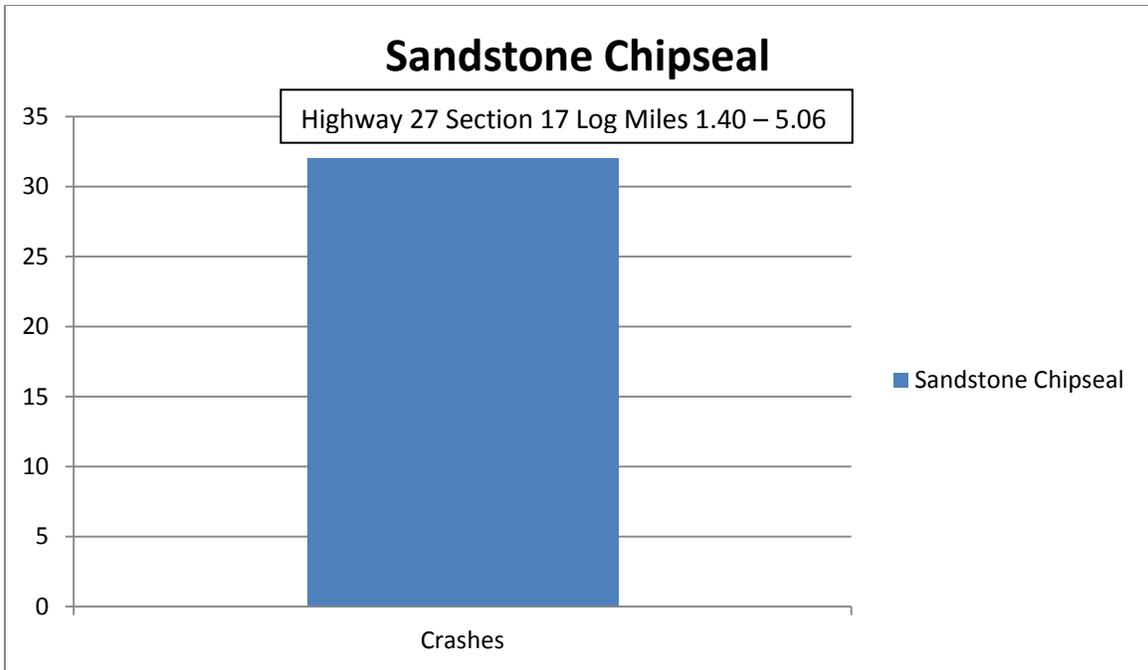
**Figure 46**



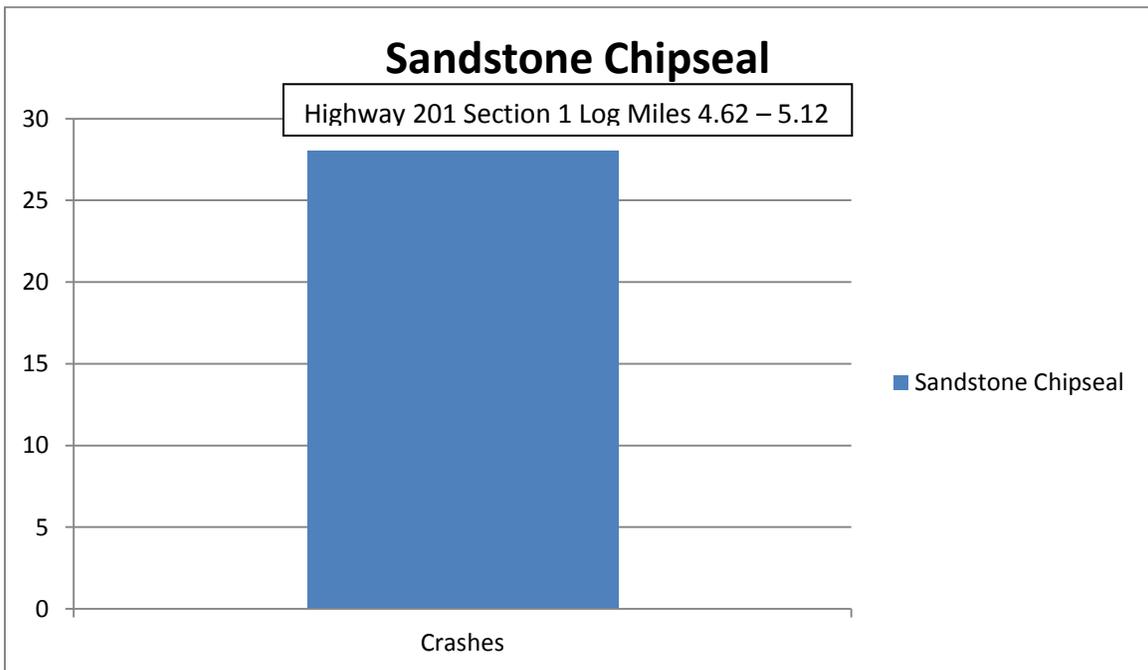
**Figure 47**



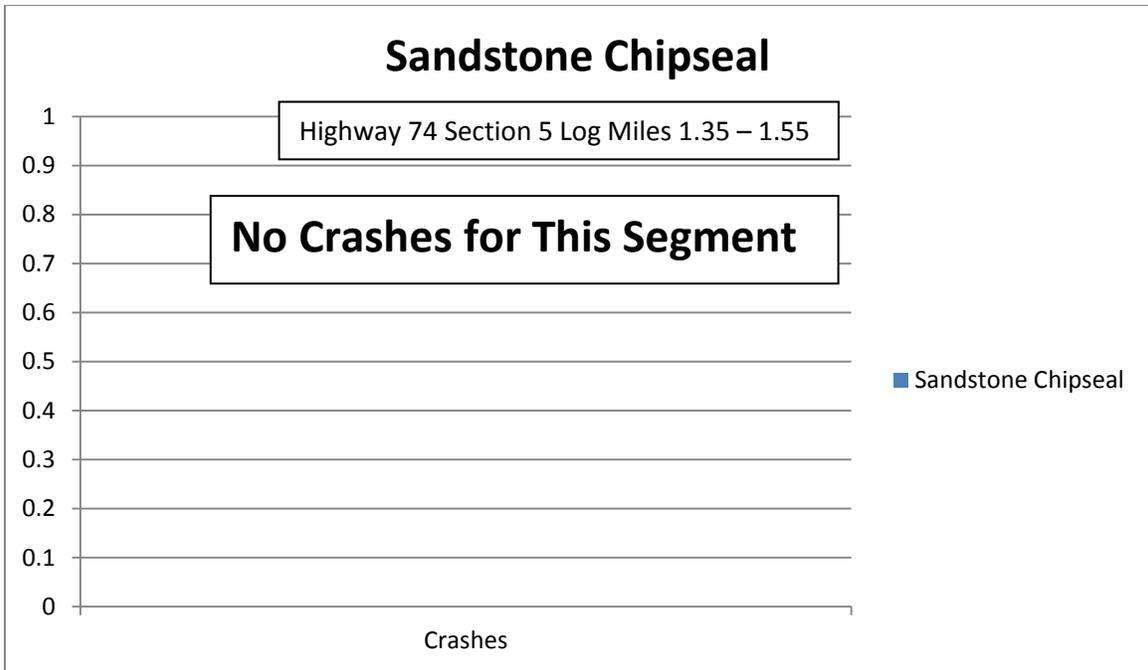
**Figure 48**



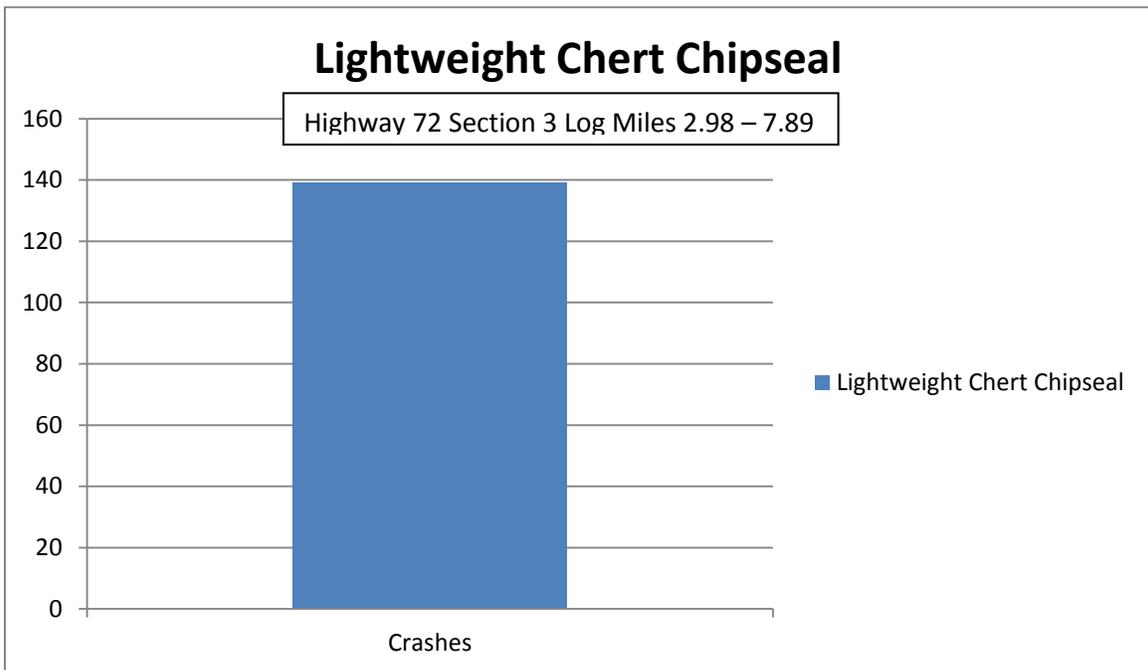
**Figure 49**



**Figure 50**

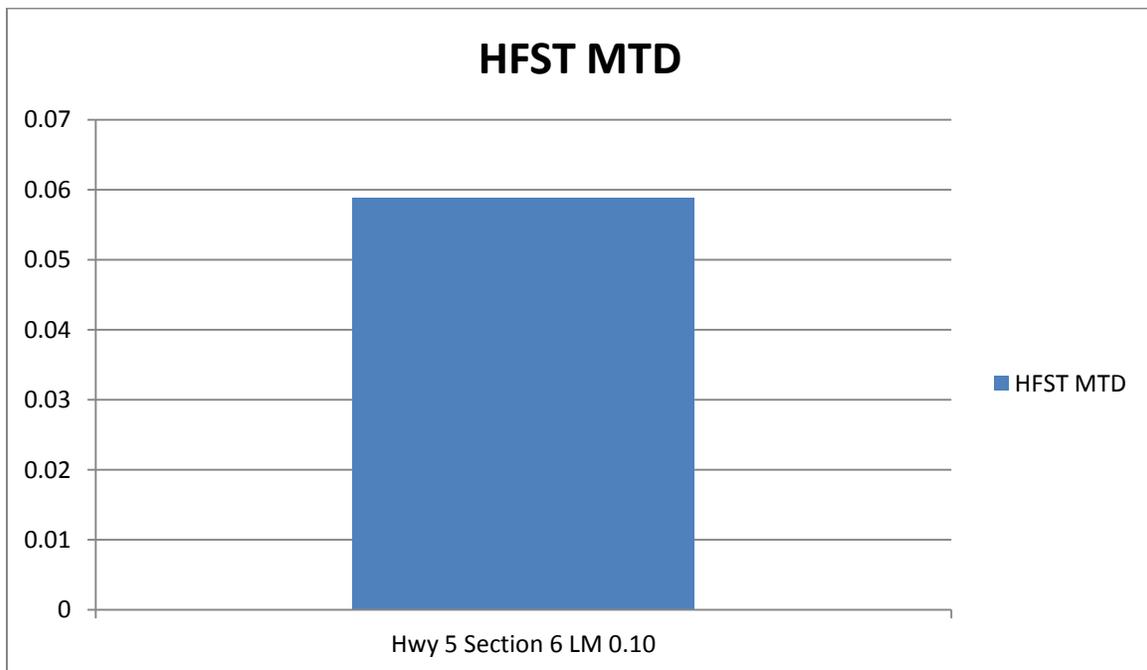


**Figure 51**

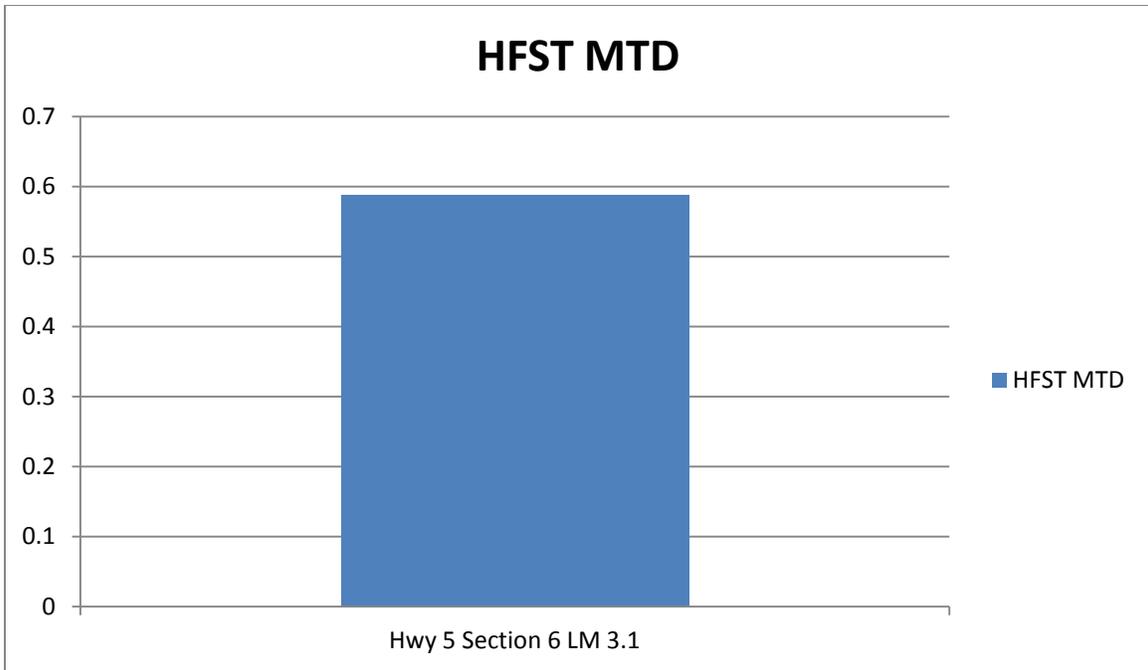


**Figure 52**

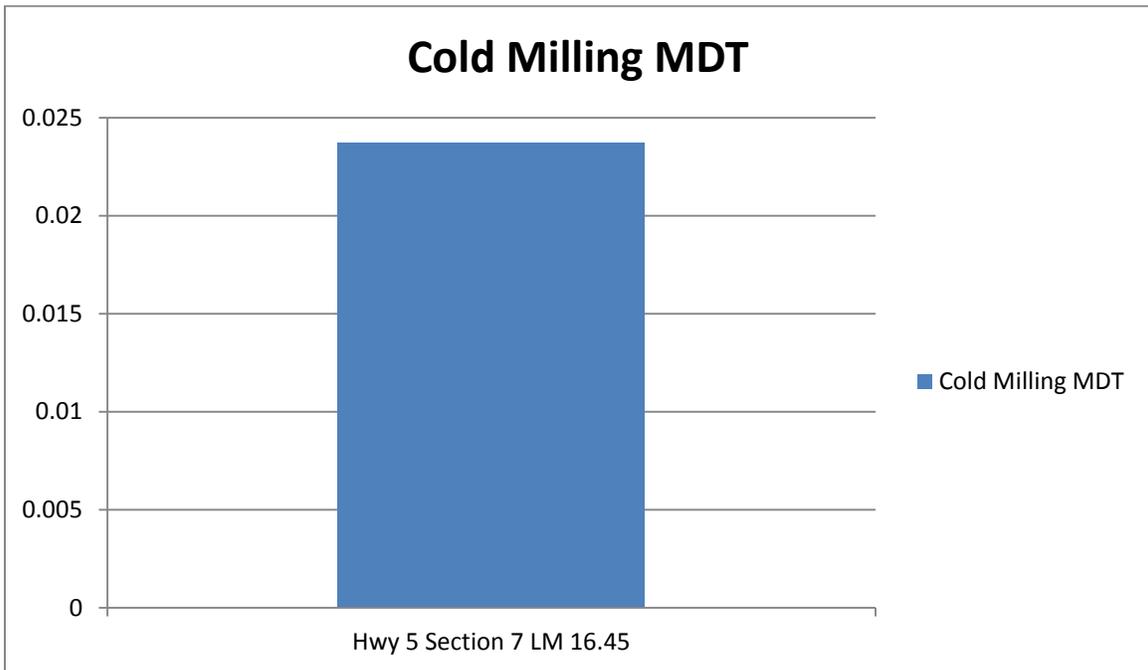
Micro texture is the pavement's texture with a wavelength (distances from bumps to dips) of less than 0.5 mm and the macro texture is the pavement's texture where the wavelength is between 0.5 mm to 50 mm. The sand patch test and the CTM are ways to measure the micro and macro textures. The sand patch test uses a volumetric approach of measuring the pavement micro/macro texture. In the sandpatch test a known amount of material is spread evenly over the pavement surface to form a circle. This fills the surface voids with material. Then, the diameter of the circle is measured on four axes and the value averaged. The Mean Texture Depth (MTD) is then calculated with the known value. The MTD is shown for each location in the following graphs (Figures 53 – 70).



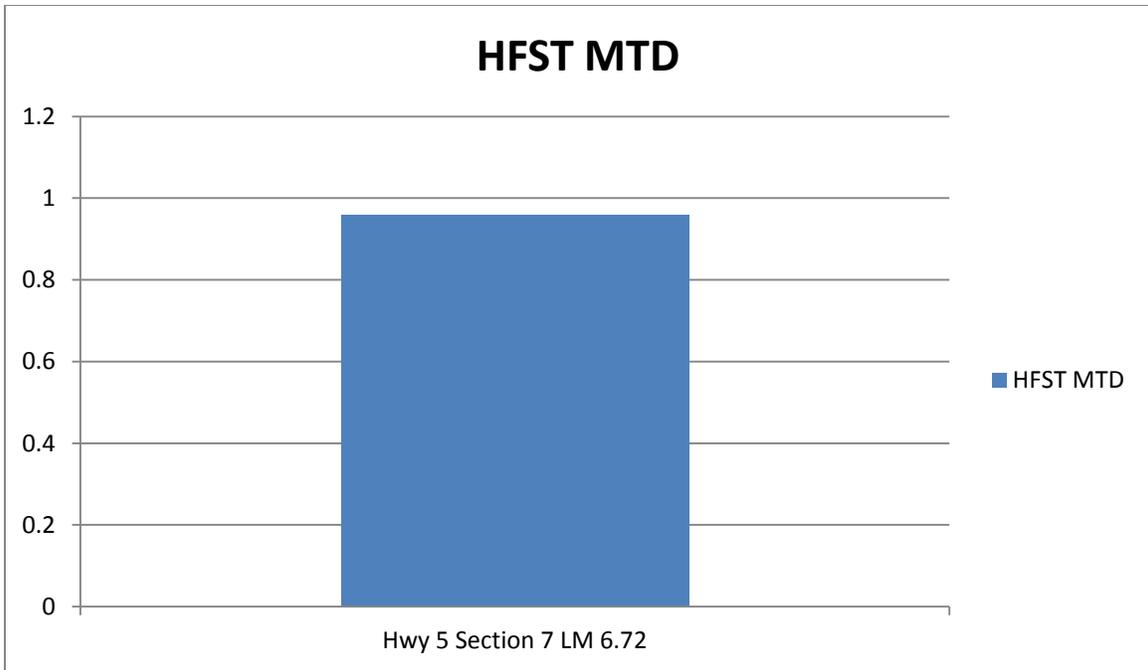
**Figure 53**



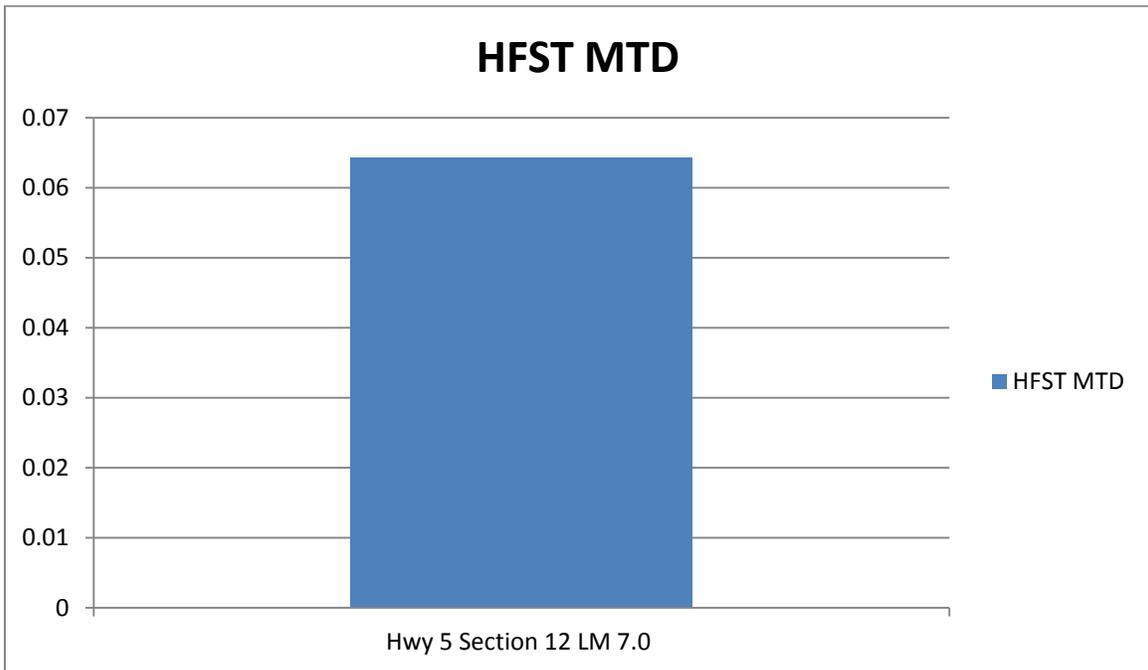
**Figure 54**



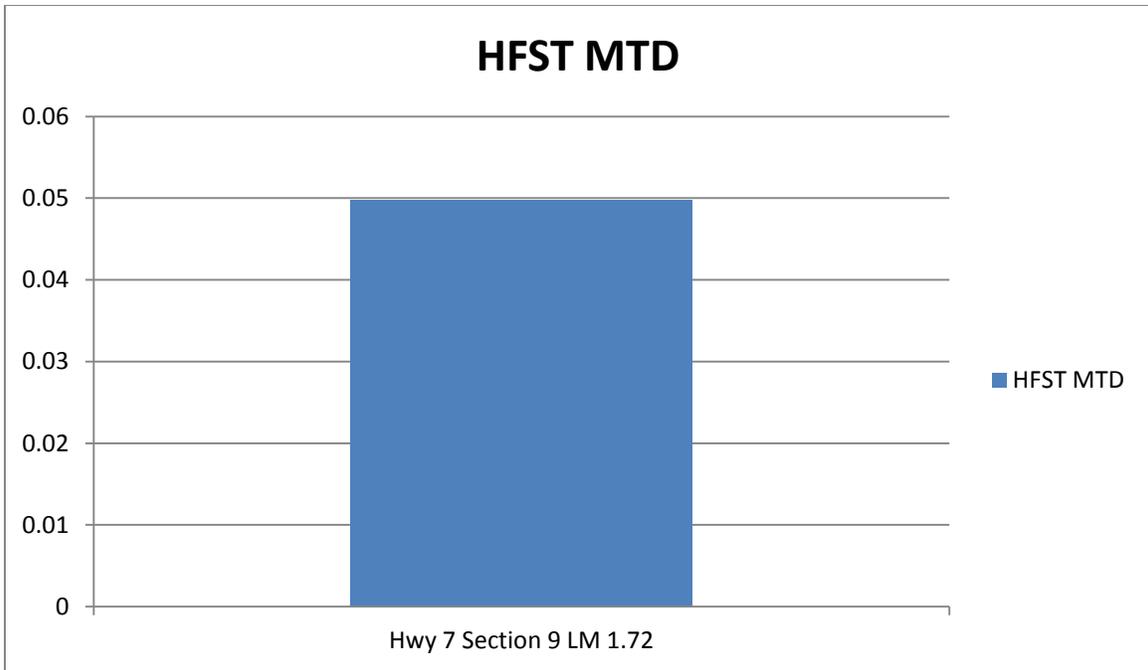
**Figure 55**



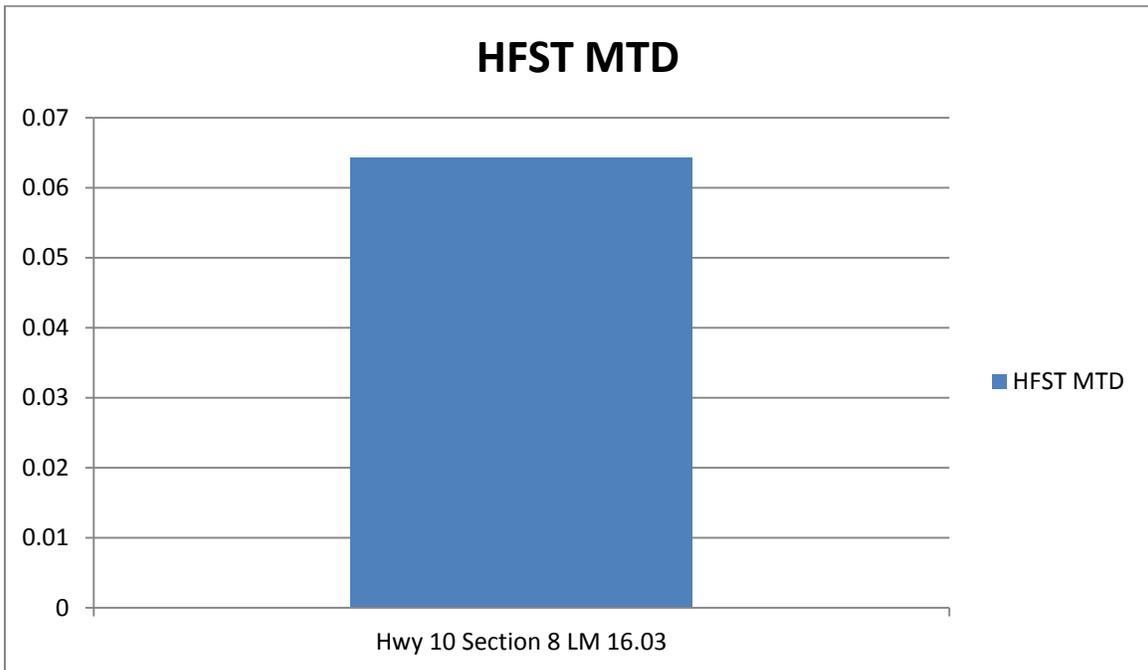
**Figure 56**



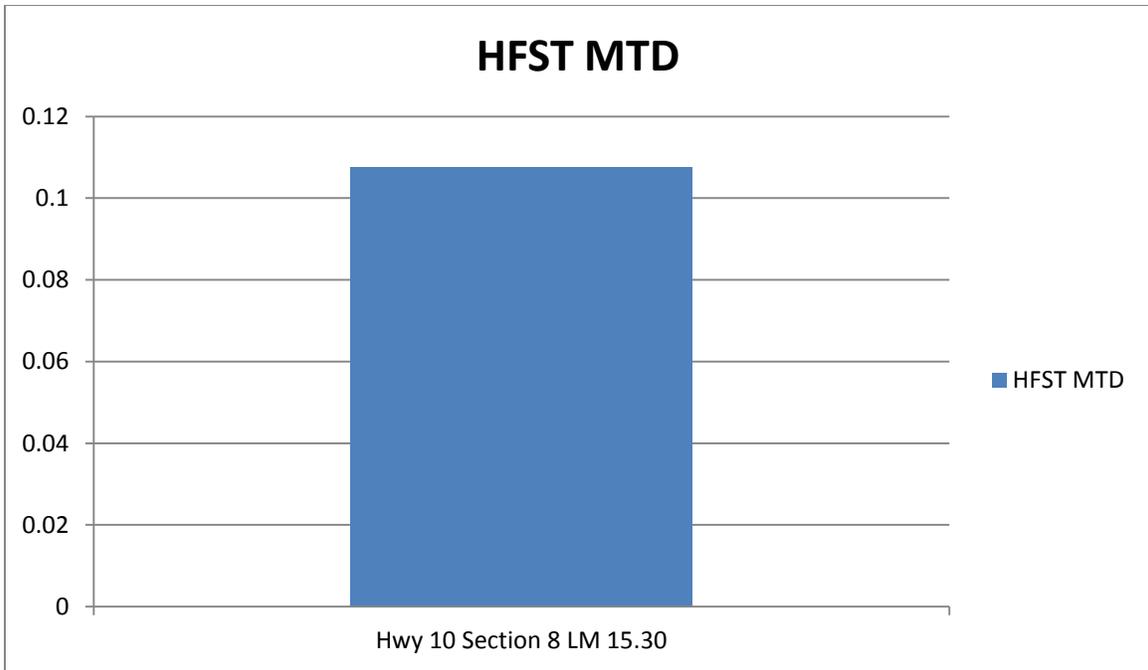
**Figure 57**



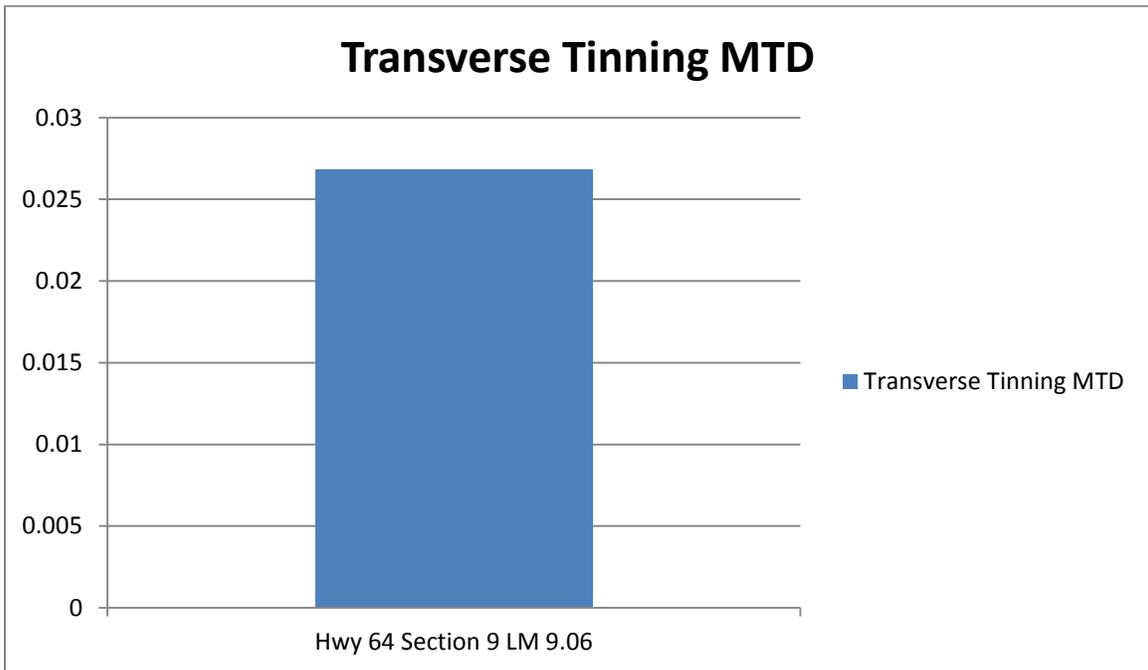
**Figure 58**



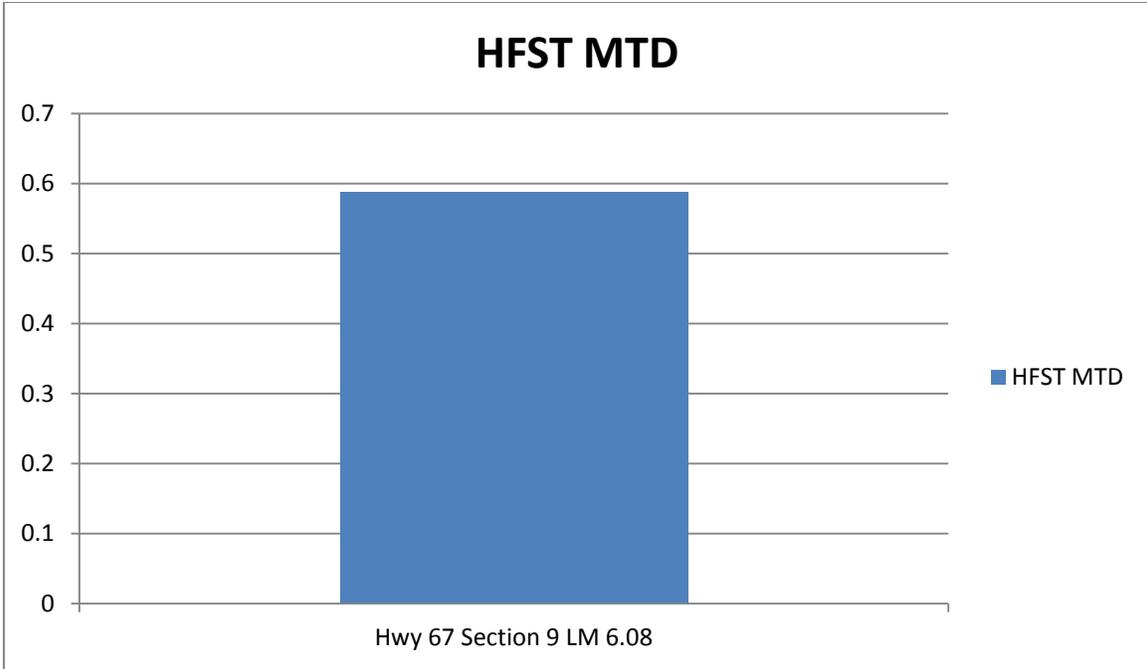
**Figure 59**



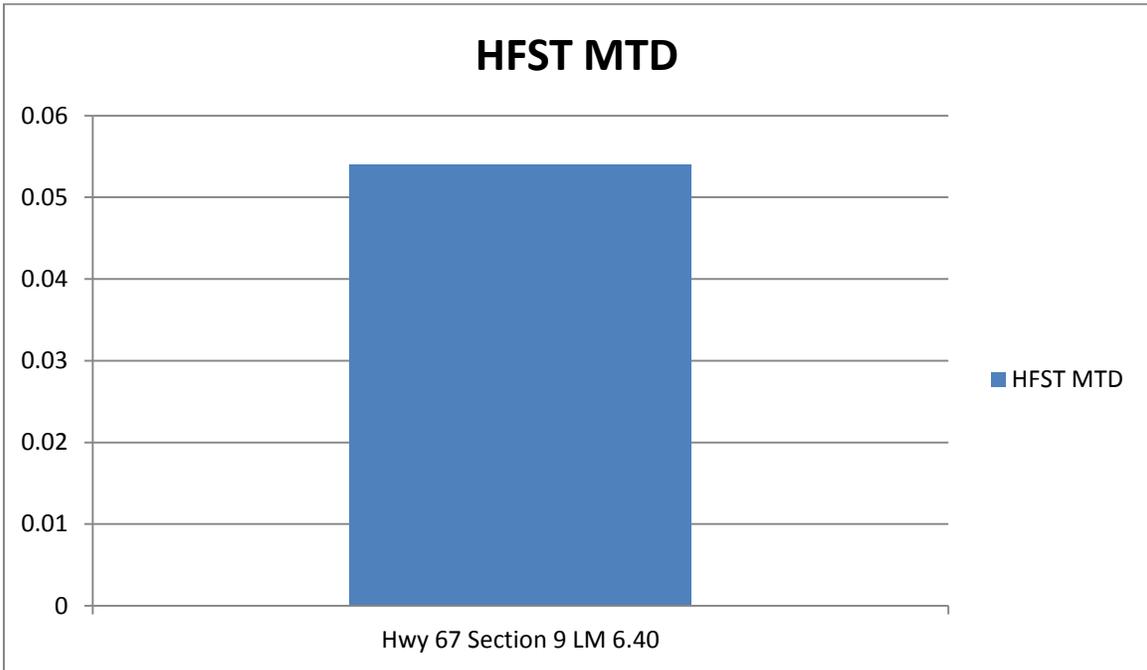
**Figure 60**



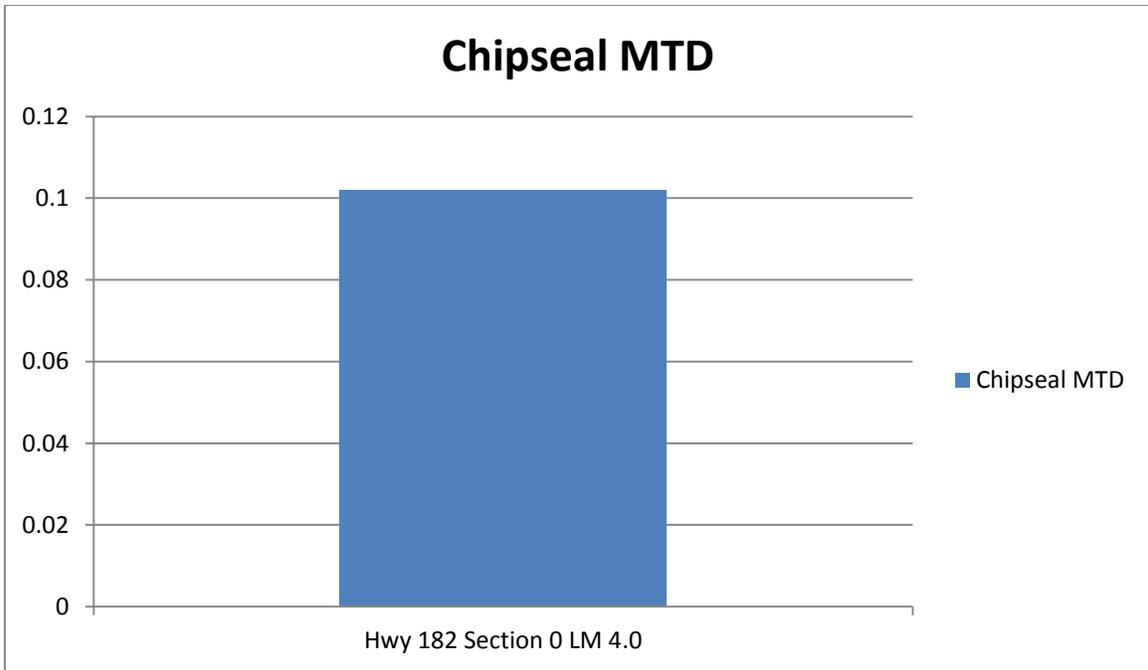
**Figure 61**



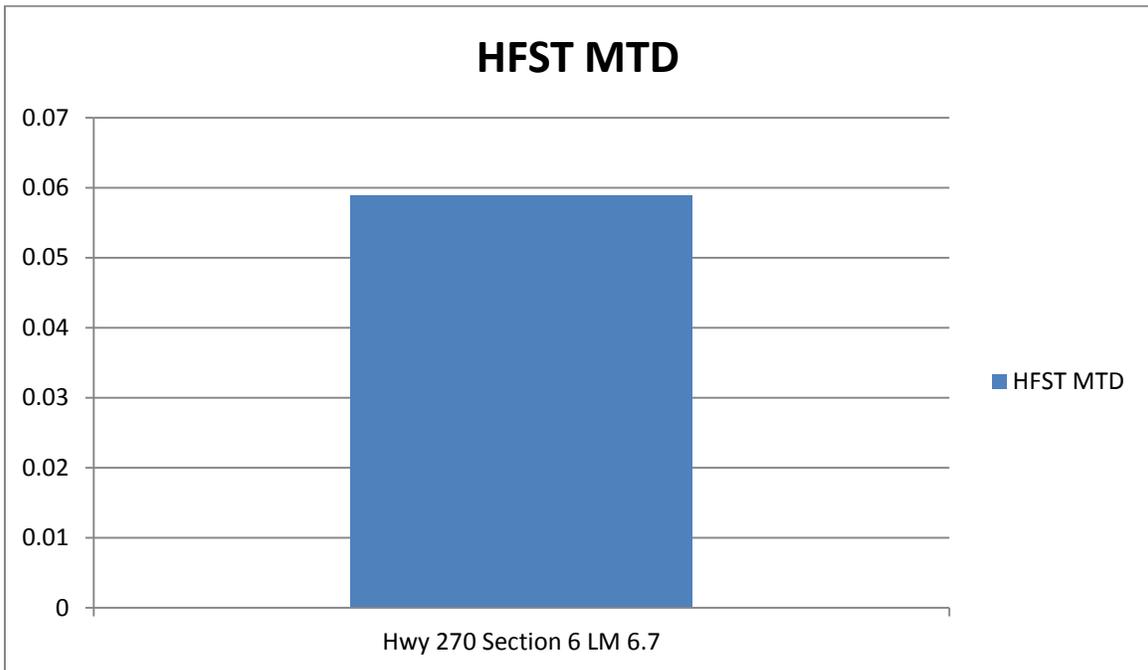
**Figure 62**



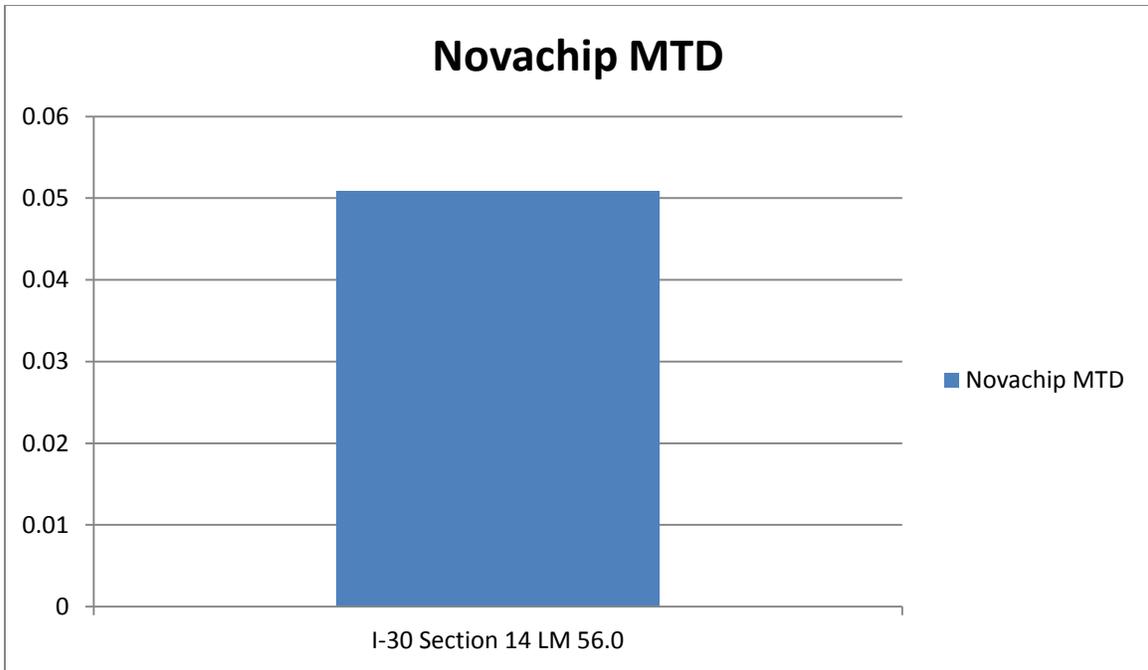
**Figure 63**



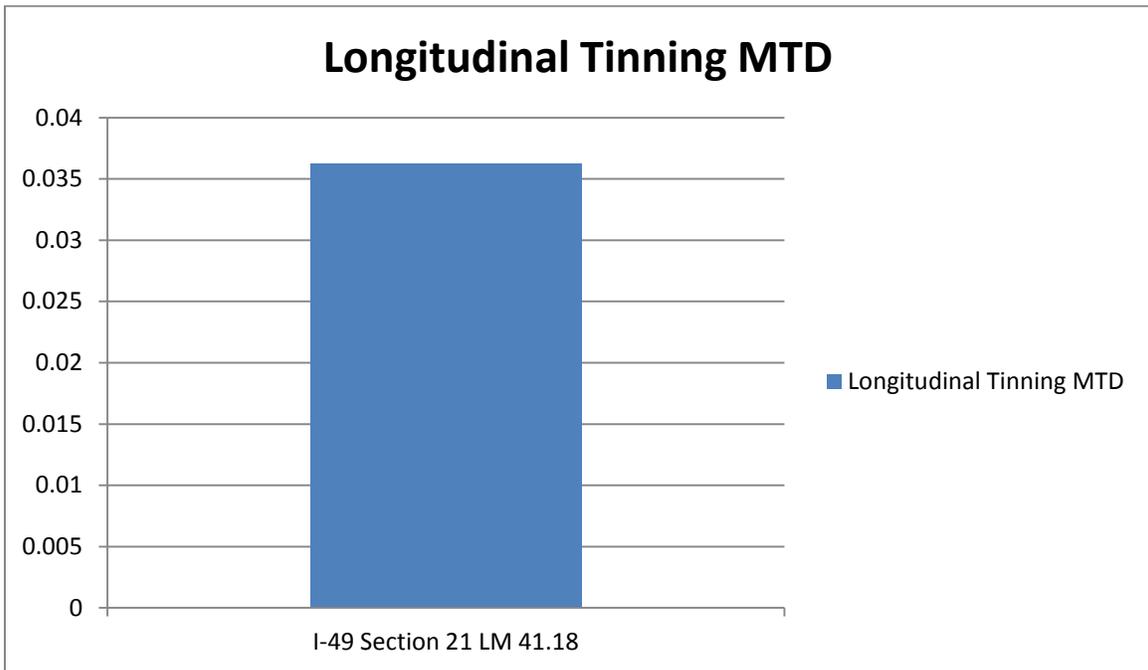
**Figure 64**



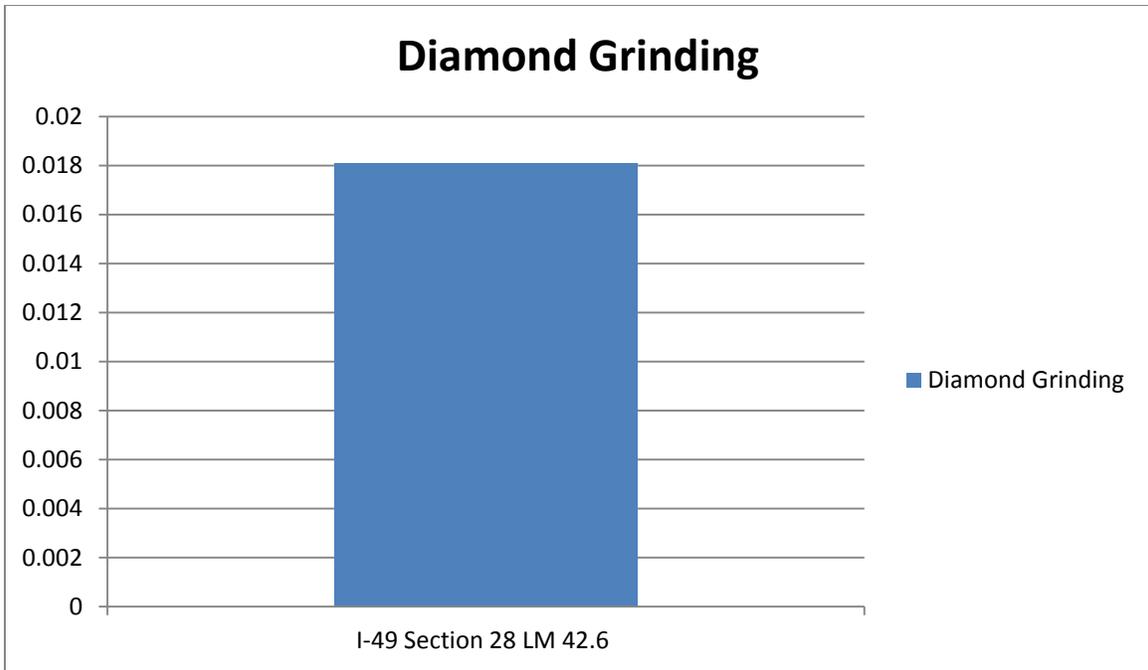
**Figure 65**



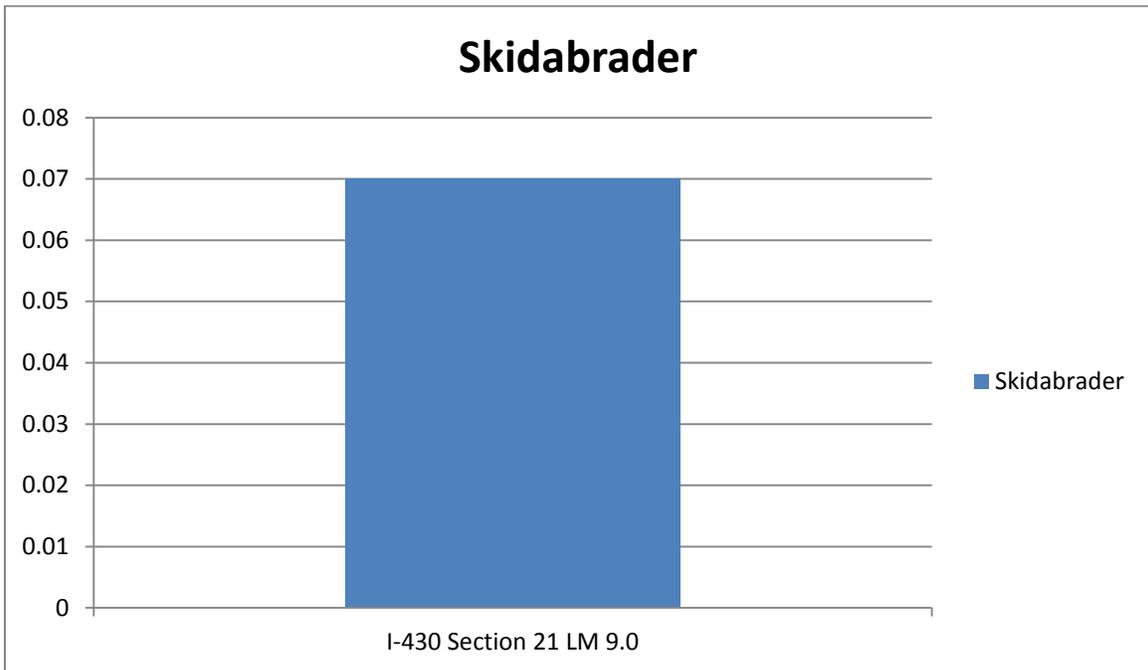
**Figure 66**



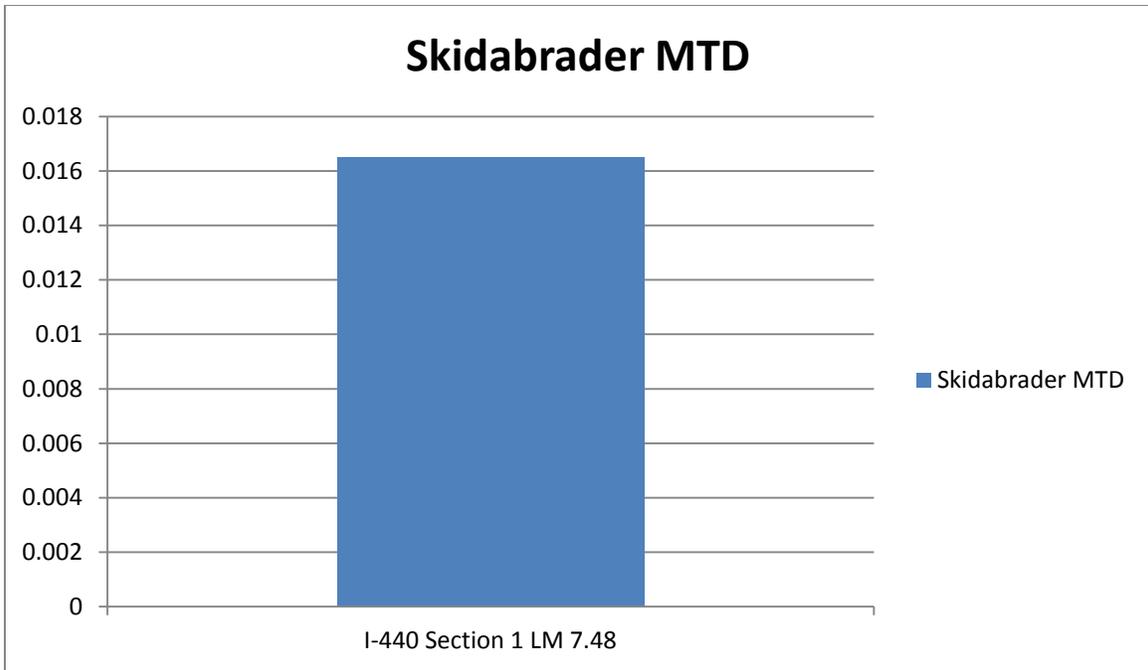
**Figure 67**



**Figure 68**



**Figure 69**



**Figure 70**

The cost effectiveness of each treatment widely varies. The first table (Figure 71) shows the costs of the HFST. The second table (Figure 72) shows the cost of all the other existing treatments. There are no direct costs for the longitudinal and transverse tinning. The tinning is done by the contractor when the roadway is being constructed.

District	Route	Section	BegLM	EndLM	Treatment	Cost
2	65	21	0	0.04	HFST	\$52,000
2	278	15	5.51	5.93	HFST	\$250,000
6	10	8	15.16	15.5	HFST	\$155,000
6	10	8	16	16.07	HFST	\$59,000
6	5	7	6.65	6.87	HFST	\$155,000
6	5	6	0	0.2	HFST	\$110,000
6	5	6	3	3.2	HFST	\$160,000
6	270	6	6.64	6.8	HFST	\$145,000
6	7	9	1.62	1.83	HFST	\$155,000
6	67	9	6.03	6.11	HFST	\$110,000
6	67	9	6.37	6.47	HFST	\$115,000
6	5	12	6.7	7.3	HFST	\$155,000
6	107	1	0.19	0.435	HFST	\$130,000

**Figure 71**

Treatment	Cost
Diamond Grinding	\$2.90/Sq yd
Skidabrader	\$2.15/Sq yd
Longitudinal Tinning	NA
Transverse Tinning	NA
Novachip	\$65,000/Lane mile
Sandstone Chipseal	\$15,000/Lane mile
Lightweight Chert Chipseal	\$15,000/Lane mile
Chipseal	\$13,000/Lane mile
Cold Milling	\$3.25/Sq yd

**Figure 72**

## **Conclusions and Recommendations**

At the time of this report the crash data after the HFST was applied was not available. Once the crash data becomes available around May of 2017 the report will be revised. Since there is no crash data after the HFST was applied it is not possible to come up with a recommendation at this time.

The HFST is not the most cost effective because of the price of the aggregate. The calcined bauxite can only be gotten from overseas. There is one bauxite mine in Arkansas and it is in Bauxite, Arkansas. This mine has been closed for a long time and there are no plans to start mining again.

The HFST also had the highest skid numbers and best MTD numbers out of all of the treatments.

It is recommended that AHTD apply more HFST in certain areas. The areas the HFST is applied should have a high wet weather crash rate. It will be good to put the treatment in places where vehicles tend to lose friction and run off of the road.

It is not recommended to place the HFST on straightaways or interstate on and off ramps. If there is a sharp curve on an off ramp it will be good to apply the HFST on that ramp. It is determined that the crashes that occur on onramps are not from a skidding problem. The onramp crashes occur because of drivers not

paying attention to the vehicle in front of them. The onramps to the service road on Interstate 30 have yield signs installed at them. Most of the crashes that occur there are because of one driver stopping at the yield sign and the driver behind that one running into the back of the vehicle that is stopped at the yield sign. The driver in the back is more-than-likely looking at the traffic coming down the service road. The rear driver will see a gap where they think they can shoot out into traffic. The driver in the front does not think they can make it so they stop at the yield sign causing the vehicle in the rear to rear end the front vehicle. There is no reason a vehicle should be skidding getting onto an interstate or roadway while on an onramp, so it is not recommended to apply a HFST to onramps.

There are certain off-ramps that can use a HFST. If the off-ramp is a straight away there is no need for the HFST. Drivers do not seem to lose control of their vehicle on straightaways. One place that can use the HFST on an off-ramp is on Interstate 40 at exit 154 North Hills Boulevard. Once the driver gets off of the interstate at exit 154 they quickly approach a very sharp curve. There have been numerous occasions that a vehicle has skidded and ran off of the road in this location. It is recommended that a HFST be applied to off-ramps that have a curve and a history of vehicles losing control and running off the roadway.

It is recommended to use a HFST at known locations that have a rate of crashes such as in curves. HFST has the capability to reduce the number of crashes and to keep vehicles from skidding and running off the roadway in curves. There are reports showing that there was a high number of crashes before a HFST was applied to a known high-hazardous location. After the treatment was applied and monitored for at least one year the crashes were greatly reduced, sometimes not having any crashes at all at that location. The crash data for one year after the HFST was applied in Arkansas is not available at this time. We are not able to come to our own conclusion of the HFST reducing crashes in Arkansas based on our own data.