Maple Island Construction Report
8/20-23/02

I Sealer/Rejuvenator Experiment

Introduction

The Maple Island sealer/rejuvenator study was conducted on the eastbound lane of TH251, just east of Maple Island, MN. The eight test sections, shown in Figure 1, were located between MP 9 and MP 10. Photo one indicates the terrain in this area. This location receives approximately XX inches of rain and is at an elevation of XX feet. The site is located in southern Minnesota and receives approximately XX inches of snowfall per year. The average summer temperature is xx degrees F. and the average winter temperature is xx degrees F.

The test sections were constructed on a X inch thick, dense-graded overlay that was placed approximately 1 ½ years earlier. Maintenance personnel reported that this new overlay typically incurred frost at a temperature of ten degrees less than surrounding roads. The reason for this is unknown. When the construction project was let to place the overlay it included a provision to route and seal any thermal cracks that existed two years after placement. In approximately six months, the contractor will be required to route and seal the existing cracks.

Eight test sections were constructed, six of which are part of the FHWA National Study on Sealer-Rejuvenators. The five products placed as part of the FHWA sealer-rejuvenator study were CSS-1h provided by Koch Materials, CRF and Reclamite provided by CAM, LLC, GSB Type B and Pass oil provided by ASI. In addition to the six FHWA study sections (including the control section) two additional test sections were placed as part of the MNDOT companion study. Specifically, a chip seal test section and a thermoplastic product named Mega Tec. The companion studies were conducted to compare the benefit of a chip seal surfacing compared to sealer-rejuvenator test sections in preserving the pavement. Mega-Tec is a locally available product that was evaluated as a similar product for sealing and preserving asphalt pavements. Mega Tec is a two component system that consists of a spray applied sealer/penetration coat followed by a second spray applied coat.

Originally, the product locations were randomly assigned. However, after incurring rainy weather the day previous to the scheduled applications, with additional impending inclement weather, it was decided to shift the products with the greatest potential for tracking to west end of the test sections. Therefore, CRF was changed to the TS 7 location, and Reclamite was changed to the TS 6 location. This way if rains did occur and any possible tracking would not adversely effect the other sections.

Test Section 8 consisted of a 3/8 minus chip seal. CRS-2P binder was applied at 0.40 gal/sq yd and 18 lbs/sq yd of cover material applied. Originally

Transition areas were used between each of the test sections to prevent or minimize tracking of one product into the subsequent product test section or control area and to allow for additional test section construction as shown in Figure 2. It should be noted that in year four, a second cycle of application is placed the test sections constructed during this phase.

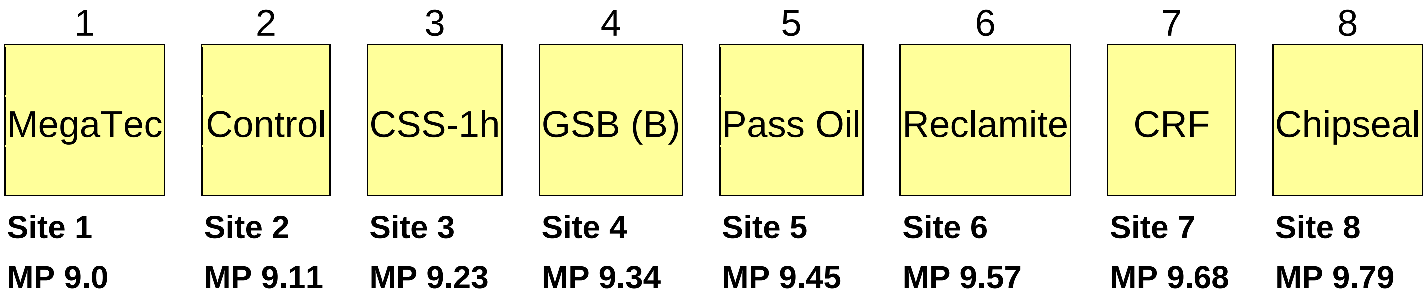

Figure 1 Initial Construction Test Section Layout

Figure 2 Six Year Test Section Layout

Each of the five products were placed at an application rate of 0.08 gal/sq yd diluted 1:1 with water.

Proper Timing of Sealer/Rejuvenator Applications and the Effect of Subsequent Applications

The Winslow sealer/rejuvenator experiment is designed to evaluate both the timing of when to apply a sealer/rejuvenator, as well as the effect of subsequent applications in 3 to 4 years on previously treated areas. To accomplish this it was necessary to divide the approximate 500 ft product test sections into subsections. The first subsection is the 200 ft long section. This section is designed to be the 1st application of the first cycle as shown in Figure 2, as well as the first application addressing the timing. As stated previously, these roadway sections are relatively new and it is somewhat early to apply these forms of sealer/rejuvenators. However, this is necessary to establish when is the proper time. Subsequent applications will be approximately 100 ft in length. The layout shown in Figure 2 indicates the zone and year in which east of the respective future applications will be applied.

Figure 2 SR 87 Sealer/Rejuvenator Cycle and Timing Test Section Layout

Purpose of the Pilot Program

Two pilot programs will be conducted in 2001 as part of a national research effort: the first in Winslow, Arizona and the second in California. The purpose of these pilots is to verify the selected tests for both practicality and usefulness at measuring relevant pavement properties. Since there is a considerable amount of field and laboratory testing being undertaken, it was desirable to evaluate the most efficient ways of conducting the testing and also to evaluate the relevance of the results. Additionally, most of these tests have not been attempted for evaluation of treatments.

II Pre-Construction and Design

Introduction

The pre-construction and design phase is intended to represent what an agency might do in advance of applying treatments. It is designed to provide material characterization of the existing material and to develop predictive capability. That is, an agency would be able to test an existing roadway and then select which products to use based upon the predicative capability of the tests. In this way, the agency knows not only which treatments to apply but also when to apply them.

The pre-construction and design phase was conducted on August 12-13, 2001 and September 6 –7, 2001. Appendix Two indicates the field and laboratory testing plan for the all four phases of the sealer/rejuvenator pilot, including the pre-construction and design.

Initially, all testing was to be conducted on August 13-14, with the test section layout occurring on the 12th. However, it rained in the afternoon and evening of the 13th and this prevented application of the treatments and subsequent friction and texture meter testing. Therefore, it was necessary to retest on September 6 & 7th for the before and after friction testing. The original before data obtained on September 13 &14 could not be used as the exact test locations could not be preserved. However, it provided useful characterization of the sections.

At the time of the August 12-14 testing, both the NB and SB directions were to be used, creating two test areas for each of the three roadway surface types. This provided replication for each test section. However, when the friction data could not be obtained to demonstrate any friction reduction resulting from application of the products, it was decided to test just the northbound. This decision, in part, was based upon some recent information concerning an accident in another state involving 14 fatalities due to reduced friction on a roadway surface. The decision was also due to the difficulty in testing both roadway directions prior to the actual application.

Test Section Layout

Each of the six test sections within a given roadway surface type and direction were marked with a PK nail at the beginning and end of the section. In conjunction with the PK nail, blue top chasers were attached. Pink was used to mark the beginning of each section and blue to mark the end. The intent was to make it very easy to see the beginning and end of each section to avoid mistakes. Photo 2 displays these markings. The length of each test section was measured using a rolling wheel measurement device. These are typically accurate to better than one foot in 100 ft.

Core Retrieval

On August 13 & 14 four six inch cores were retrieved from each of the product test sections and control sections in both the North bound and Southbound roadway directions. This resulted in 144 cores retrieved, with most of the cores being obtained on August 14. Two of the four cores were to be used to characterize the existing roadway materials and two were to be treated to evaluate the effect of the treatment.

Two portable core rigs were used to obtain the cores. Coring was conducted by Terracon, a geotechnical engineering firm. ADOT maintenance repaired the core holes and ADOT labeled, retrieved and transported the cores for future use.

Infiltration Testing

The NCAT infiltration test, the Skid Abrader outflow meter, and the Witco ring test were to be conducted. The ring test is the traditional standard of the industry for determining the field application rate of rejuvenators. Water permeability/infiltration testing using the NCAT test and the Skidabrader Outflow Meter were to be correlated to the ring test to see if a more accurate approach could be developed. The ring test was not conducted due to the rain that occurred. The skid abrader outflow meter was not functional at the time of the testing and therefore could not be used. The NCAT infiltration test was conducted on the dense graded and chip sealed surface. Although it was raining at the time of testing for the chip seal surface it appeared to work. However, since it was raining it was not possible to detect any leakage of the device. The results of the NCAT infiltration test are shown in Table 1:

TABLE 1 RESULTS OF NCAT INFILTRATION TESTING

Surface Type	Reading Interval	Reading (Seconds)	Permeability
SB Chip Seal*			
Test 1	40 - 30	31	
Test 2	40 - 30	27	
Test 3	40 - 30	26	
2^{nd} Location???			
Test 1	40 - 30	40	
Test 2	40 - 30	29	
Test 3	40 - 30	28	

*Test Conducted 3 ft north of Friction Testing

Friction and Texture Measurements:

The purpose of this testing is to determine the change in frictional properties, if any, resulting from the application of these products and the duration of this change. By measuring both friction and texture at the exact same location, it will be possible to compute the International Friction Index (IFI).

The dynamic friction tester (DFT), the CT Meter and an ADOT owned KJ Law texture measurement device were used to evaluate these properties. The DFT is a portable device that measures friction over a range of speeds by applying a braking force to pads revolving in a circular motion. The CT Meter measures the texture of the surface at the exact location that the DFT test values were obtained. This allows calculation of the International Friction Index, a universal means for characterizing friction measurements. It also allows the calculation of friction at any speed. The KJ Law device is a high speed texture measurement device, unlike the DFT and CT-Meter which are stationary measurement devices.

Non-Destructive Tests For Assessing When to Apply a Treatment

Nuclear Magnetic Resonance

Two techniques will be evaluated for determining when to apply a treatment: Nuclear Magnetic Resonance (NMR) and seismic analysis using a Portable Seismic Pavement Analyzer (PSPA). It is hoped that one or both of these devices might be capable of determining when to apply a sealer/rejuvenator.

The NMR will be used to determine when sufficient oxidation has occurred to warrant pavement treatment. Two different experiments will be conducted with this study. First, a correlation study will be conducted between a traditional laboratory NMR and a recently developed portable unit (i.e. mouse) to see if they give similar results. If this experiment is successful, the Mouse NMR will then be used to evaluate whether it can detect changes in material caused by aging. This will be done by finger printing the properties of the original asphalt and the original hot mix and then comparing the results to tests conducted on cores retrieved from an eleven year old pavement (i.e. Arizona's SPS-6 experiment). If this second series of test proves successful, the NMR will be used as one of the evaluation tests in the pilot field work, including the monitoring phase. However, essentially the testing will be done on the SPS-6 materials to verify its usefulness.

Portable Seismic Pavement Analyzer (PSPA)

The PSPA will be used to determine the change in modulus of the material with time. This technology has previously been used to evaluate the healing of micro-cracking in asphalt concrete pavements and it is hoped that it can be successfully applied in this study to identify triggers or threshold points to detect when to apply treatments. Two similar devices will be evaluated at the Arizona pilot to determine which is most effective. One device can measure to a greater depth than the other. However, since the sealer/rejuvenator depth of influence is generally considered the top ½ inch of pavement, the ability to measure greater depths may be counter productive and this is the reason for evaluating both systems. Dr. Soheil Nazarrain of the University of Texas, El Paso, conducted this testing. Testing was conducted every 100 ft through out the test section in the right wheel path. These devices measure the pavement modulus over a distance of approximately one foot.

Determination of Chemical Compatibility

The traditional method for testing asphalt compatibility is the Heithaus test. Compatibility influences important physical properties such as rheological properties (eg phase angle, viscosity, and aging propensity). WRI has refined this test and it is now referred to as the automated flocculation titrimeter. This testing will be used to assess the compatibility of the existing pavement and the sealer/rejuvenator to be applied. Samples of the extracted asphalt obtained from the field cores will be used to conduct this testing.

Formation of Surface Active Agents:

It is known that surface-active materials are generated in asphalts as a result of oxidative aging. These surface-active materials may have considerable influence on the asphalt mixture properties such as its moisture sensitivity. Non-aqueous potentiometric titration (NAPT) analysis will be performed on aged pavements to evaluate this phenomenon. If possible, a second set of experiments will be conducted using this technique on newly constructed pavements. The original materials will be aged using PAV to simulate field aging, then the test will be repeated and compared to actual field results over time.

Aging Prediction Study:

For each field test section, a sample of original extracted asphalt before treatment application and after treatment application will be obtained. Each of these samples will then be aged using the SHRP Pressure Aging Vessel (PAV). Upon completion of PAV aging, both samples will be analyzed using dynamic shear rheology (DSR) and Infrared Functional Group Analysis (IR-FGA). These results will be compared to results of similar tests performed on the treated materials over the course of the study to see how well the laboratory aging procedure predicted actual field aging properties.

Performance Assessment Study:

This study will evaluate the chemical and rheological changes that occur in both the treated and untreated sections over the course of the study. The IR-FGA and DSR (previously described) will be used to conduct this testing. The results of this study will be compared to the aging prediction results. For this testing, the top of the field-extracted cores will be sliced into three sections to assess the changes in properties with depth. The first slice will represent 0 – 3/8", the second ½"-7/8" and the third slice 1 inch to 1 3/8 inches in depth.

Compositional Analysis of Sealer/rejuvenator products:

This testing essentially consists of chemical finger printing of the actual material used for the field applications. A chemical characterization of the sulfur content, the acid content, the concentration of specific functional groups, and the aliphatic/aromatic distribution will be obtained. Tests that will be used in this analysis include the NAPT, IR-FGA and NMR.

Distress Surveys:

Field distress surveys will be conducted prior to treatment application, and at regular intervals thereafter. Crack extent and severity will be determined as well as rut measurements. It is anticipated that digital imagery will be obtained and software recently developed for the Arizona Transportation Research Center will be used to develop crack maps, determination of the lineal feet of load and non-load associated cracking, as well as development of crack width distribution histograms. One of the reported benefits of rejuvenators is the "healing" effect on cracks. That is, it is commonly believed that cracks less than 1/8 inch in width can be reduced in width by application of rejuvenators. Consideration is being given to modifying the current software to allow detection of crack width changes as small as 1/32" to be detected. Currently, non of the product test sections exhibit any cracking.

Environmental Testing:

The originals workplan included a portable weather station to be located at or near the site two weeks prior and one month after field-testing The intent was to record the actual environmental conditions prior to, during, and shortly after treatment application. Although the weather station was obtained, it was only received the day before testing commenced and it was not possible to get it operational in time. The configuration of the equipment does not lend itself to leaving unattended in the field. Therefore, additional consideration is being given to how to protect the device from vandalism.

In the late afternoon of September 13th, 4.5 inches of rain were reported at the ADOT Winslow Maintenance yard. Unfortunately, since the weather station was not installed, it is not known whether high amounts of rainfall, or any, were received at the test site locations. The Winslow maintenance yard is approximately 40 miles away.

Miscellaneous Testing

Several additional tests will be conducted as time and opportunity permit.

- Close Proximity Noise testing will be conducted over each test section.
- UV Penetration testing will be performed using a "black light" to evaluate depth of treatment penetration into the pavement.
- Field cores were obtained to provide materials for the previously described testing. Air void content and bulk density will be determined on the cores prior to slicing and binder extraction.
- The FHWA will conduct tomography imaging on selected field cores. This will allow a 3D analysis of the void structure existing in the pavement sections.
- It is also hoped that a test similar to the RSA spray test can be conducted on each of the test sections. A device has yet to be located however.

III Construction Application Testing and Evaluation

Introduction

The distributor application of the test sections was conducted on 9/12/01. Work commenced at approximately 8:00 AM and ended approximately 3:00 PM. The test sections were placed in the northbound travel lane of SR 87 between MP373 – MP374 (AR-ACFC), between MP386 – MP387 (HMAC), and between MP392 - MP393 (Chip Seal). Each of the five products was placed in a test section 200 ft in length for the width of the travel lane at each location within the three roadway sections. The pavement markings were not to be covered so the actual placement width was slightly less than 12 feet. In fact, as shown in Table 2, several of the products were not placed to the planned width due to distributor spray bar problems.

In conjunction with the test sections, the District had elected to order more material than the 100 gallons per product necessary to construct the three test sections for each product. Instead, they planned on using the remaining material on a section of roadway approximately ten miles to the south. Once a product was placed at all three test locations, the distributor truck would go to the maintenance project to the south and place the ordered quantity for the maintenance sand seal.

Traffic control consisted of using two flagman, one at each end of each test section, to keep traffic off of the products until sufficient set time had occurred. Typically, traffic was allowed on the products after approximately one hour. However, the reclamite needed more time. When traffic was allowed on it after approximately one hour, it tracked very badly. District personnel subsequently kept traffic off for at least two hours. The District maintenance personnel were responsible for making the decision of when to allow traffic on the sections.

Application Equipment

Commercial Distributor Truck

Reclamite and ERA-25 were placed using a commercial distributor provided by Hawker Evans. The commercial distributor was a Bear Cat, computer rate controlled, unit. The Reclamite was loaded onto the distributor at the Copperstate Phoenix facility. The material was already diluted 1:1 The ERA-25 was loaded onto a pup transport at this same time and the distributor truck then took both products to the job site. The ERA-25 was also diluted 1:1 prior to loading.

Once placement of the Reclamite test sections was completed, the distributor went to the maintenance project to the south and placed the remainder of the material. The distributor then went to the pup, which held the ERA-25, and loaded ERA-25 for test section placement. There was no flushing or cleaning between loads. Again the three test sections were placed and then the boot went to the maintenance project to the south.

The reason ERA-25 was loaded into the distributor truck instead of ERA-1, was because the maintenance project required more ERA-25 then ERA-1. Also, the supplier felt that any influence of the Reclamite would be better absorbed by ERA-25. Since both the ERA-1 and Reclamite are similar products, and the research is attempting to discern any difference in performance between the two, it was felt Reclamite could potentially influence the ERA-1 results.

ADOT Maintenance Distributor Trucks

Three different ADOT distributor trucks were used to place the remaining three products. All three ADOT distributor trucks were Roscoe Maximizer II units. Table 2 indicates which products were placed by the Chambers, Winslow, and Holbrook maintenance distributors, respectively. All three ADOT maintenance distributors had been loaded with MC-250 prior to loading the test products. The Chambers and Winslow distributors were flushed with diesel and then water prior to loading with product. The Holbrook vehicle was shot empty and then loaded. This probably resulted in 10-20 gallons of MC-250 being mixed with the Pass Oil.

The CSS-1h and the ERA-1 were loaded at the respective suppliers facilities as shown in Table 2. The Pass Oil was ordered in much larger quantities than needed for this work and stored in a tank that previously had Pass Oil at the Holbrook yard. The intent was to use this material for future maintenance applications as well as the experiment. The materials was then loaded from this tank into the ADOT Holbrook Distributor.

TABLE 2: Distributor Truck Placement Information

Order of Placement	Product	Distributor Truck	Product Supplier	Width Placed *	Notes
1	CSS-1h	ADOT Maint Chambers	Paramount	11’	ADOT Picked Up at Paramount Phoenix Plant already diluted 1:1
2	Reclamite	Hawker-Evans	Copperstate	10’	Loaded at Copperstate Phoenix Facility already diluted 1:1
3	Pass Oil	ADOT Maint Holbrook	Western Emulsion	8’ 4”	Delivered to tank in Holbrook yard and then loaded into truck. No clean out of truck prior to loading.
4	ERA-25	Hawker-Evans	Copperstate	10’ 2”	Loaded onto pup at Copperstate Phoenix facility already diluted 1:1, no clean out of truck prior to loading
5	ERA-1	ADOT Maint Winslow	Copperstate	10’ 4”	ADOT Picked Up at Copperstate Phoenix Plant already diluted 1:1

*Dense Graded Section

Application Rate Validation

To evaluate the actual application rate, 8 inch by 8.5 inch carpet coupons were used. The carpet was approximately ¼ inch in thickness and had a rubber backing. It was anticipated that the carpet would absorb the product, but that the backer would prevent it from penetrating through. One sample was taken from each product test section.

The sample was taken at the same location for all test sections. The sample was taken at approximately 5 feet off the shoulder stripe approximately 100 ft from the start of the application. The carpet coupons were weighed to the nearest 0.005 lbs prior to arriving at the project and assigned a number between 1 and 15.

At the project, the sample was retrieved immediately after the distributor truck would pass over and weighed to the nearest 0.005 lbs. The objective was to weigh each sample within one minute of application. The longest time was about two minutes. One sample was left on the scale for approximately two minutes after weighing to see if a detectable change from water evaporation could be noted. No change in weigh was detectable during this time frame.

The results shown in Table 3 indicate that the actual applications were not always very close to those specified, especially for the state supplied distributor trucks. In a subsequent conversation with Francis McCauley, the maintenance foreman doing the maintenance project to the south, reported that they also determined the Reclamite to be at 0.1 and the CSS-1 to be 0.05 gal/sq yd, respectively. Their measurements were taken on large areas using the tank volume indicators. This tended to validate this measurement approach.

TABLE 3: PRODUCT APPLICATION DATA

Surface Type	**Product Name**	**Application Rate* (Gal/ Sq Yd)**	**Deviation From Specified (%)**	**Product Temperature (F)**	**Placement Time**
AR-ACFC					
	Pass Oil	0.091	14.3		
	Reclamite	0.091	14.3	135	9:45 AM
	ERA-25	0.080	0.0	175	12:40 PM
	CSS-1H	0.057	-28.5	125	8:20 AM
	ERA-1	0.069	-14.3	140	12:50 PM
Dense Graded					
	Pass Oil	0.080	0.0		11:30 PM
	Reclamite	0.103	28.6	135	10:20 AM
	ERA-25	0.069	-14.3	175	
	CSS-1H	0.057	-28.5	125	9:00 AM
	ERA-1	0.069	-14.3	140	1:40 PM
Chip Seal					
	Pass Oil	0.069	-14.3		11:40 AM
	Reclamite	0.103	28.6	135	10:35 AM
	ERA-25	0.069	-14.3	175	1:45 PM
	CSS-1H	0.034	-57.1	125	9:15 AM
	ERA-1	0.069	-14.3	140	2:00 PM
	Product	Average Application Rate			
	Pass Oil	0.080			
	Reclamite	0.099			
	ERA-25	0.072			
	CSS-1H	0.050			
	ERA-1	0.069			

*Application Rate is not corrected for temperature

Placement Sequence

The order of product placement was the same for each test section. The products were placed in the following order: CSS-1h, Reclamite, Pass Oil, ERA-25, and then ERA-1. It should be noted that this placement order is the order in which the distributor trucks arrived and their respective test sections shot. It is not the same order as the sections are physically located. Each product was placed first in the AR-ACFC section, then in the dense graded section, and then in the chip seal section. Upon completion of a product application, the process would begin again in the AR-ACFC starting with the next product. This sequence was used throughout the product placement except at the end when both the ERA-25 and ERA-1 distributor trucks were both on the test sections at the same time. The order of placement remained the same, however.

Figure One indicates the Test Section Layout

Personnel Involved in Placement

The project personnel are listed in Table 4 along with their affiliations.

TABLE 4 PROJECT PERSONNEL

Name	Affliation	Phone Number
Dave Sikes	ADOT District Maintenance Engineer	928-524-6801
Antone Secakuku	ADOT Maintenance Foreman	928-738-2285
Francis McCauley	ADOT Maintenance Foreman	928-289-2478
Larry Scofield	ADOT Research	602-712-3131
Pete Pradere	Consultant	
Doug Hanson	NCAT	
Dennis Ryan	Copperstate	
Peggy Simpson	Western Emulsions	

IV Baseline Construction Testing

This testing will begin on October 8th, 2001.

V Monitoring and Evaluation

This activity will begin in September 2002. Since this experiment has been placed upon the existing surface treatment test, PASCO type LTPP filming has already occurred and will continual annually.

Areas for improvement for next pilot

1) Surface temperatures and air temperatures should have been obtained throughout the day.
2) Both longitudinal and transverse distributor application variation should have been measured. A minimum of four test pads should be used.
3) The residual asphalt on the pads should also be weighed, once the water has evaporated.
4) Require verification of application rate prior to shooting actual section. Consideration should be given to having the state do this even before the application day to prevent problems the day of the application.
5) Instead of ring test, use 2 x 2 area to time absorption. This can then give you an idea of how long to keep traffic off of it also.
6) We should require the sections to not have traffic on them for a minimum of two hours.
7) Install a calibration guage on the side of the DFT tank so we can monitor the amount of water used for each test to make sure it is operating the same(using same amount of water).
8) Make sure weather station is operational
9) Need to have a minimum of three people for the testing and probably four.
10) Construct an enclosure for the scale to block wind and to allow some grade adjustments
11) Construct a way to hold the carpet samples after weighing so the residual asphalt can be determined.
12) Treat cores samples with actual application rates measured in the field
13) Mix samples at 1:1 for preparing hand applications in large quantities and then make small quantities of 1:1 mix volumetrically without the need for weighing.

14) Obtain emulsion samples after the pre-shot verification has occurred.
15) Do additional testing to see if water with surfactant better predicts penetration of sealants. However, need to develop some criteria for determining the end point.
16) Get Shot Rates from Frances for all materials to compare to measured quantities on experiment
17) Include Residual asphalt contents and all carpet weights as an appendix table so all source data is there.
18) Put balance scale specifications, brand, etc in report
19) Get emulsion temperatures using IR gun from sample taken from boot truck to verify truck gauge reading.
20) Use zip lock bags to put carpet sample in immediately after removal from roadway to prevent moisture loss. Samples could then be stored in zip lock bags. This would also allow the samples to be weighed later on level ground and out of the wind.
21) Control head of water on DFT. Make a mark at top to fill water level to each time. Each test needs to start with the same head of water. After each test recharged water level to the correct level. Maybe use battery operated submersible pump to refill with holes at the proper level. This allows continuous testing and constant head of water.
22) Control volume of water. Put scale in tank to record amount of water used for each test to ensure that the proper amount of water has been consumed.