Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/VA-87-16		
4. Title and Subtitle Final Report - The Use of Hydrated Lime as an Antistripping Additive		5. Report Date January 1987
		6. Performing Organization Code
7. Author(s) G. W. Maupin, Jr.		8. Performing Organization Report No. VTRC 87-R16
9. Performing Organization Name and Address Virginia Transportation Research Council Box 3817, University Station Charlottesville, Virginia 22903-0817		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. HPR 2254
12. Sponsoring Agency Name and Address Virginia Department of Transportation 1221 E. Broad Street Richmond, Virginia 23219		13. Type of Report and Period Covered Final
		14. Sponsoring Agency Code

15. Supplementary Notes

In cooperation with the U. S. Department of Transportation, Federal Highway Administration

16. Abstract

The purpose of this investigation was to evaluate the performance of six test sections of asphalt concrete that contained no additive, hydrated lime, and a chemical additive. Tests were also conducted on pavement samples taken periodically to determine whether hydrated lime slows the hardening rate of asphalt cement as has been reported by others.

Visual examination of pavement samples generally revealed less stripping in pavements containing hydrated lime than in pavements with no additive or with the chemical additives that are routinely used. The tensile strength ratio correlated reasonably well with the amount of stripping observed; but there were some exceptions that were possibly caused by differences in the permeabilities of the pavements. The stripping has not caused any significant pavement distress.

The correlation between the hardening of the asphalt cement and age of the pavements was poor for five of the projects. The only project which produced acceptable correlations showed no significant difference in the hardening rates of the various mixes.

17. Key Words	18. Distribution Statement
Hydrated lime, stripping, test sections, performance, asphalt hardening	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Va. 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	30	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

- 983

FINAL REPORT

THE USE OF HYDRATED LIME AS AN ANTISTRIPPING ADDITIVE

by

G. W. Maupin, Jr.
Research Scientist

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the
Virginia Department of Transportation and
the University of Virginia)

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

Charlottesville, Virginia

January 1987

VTRC 87-R16

BITUMINOUS RESEARCH ADVISORY COMMITTEE

ABSTRACT

The purpose of this investigation was to evaluate the performance of six test sections of asphalt concrete that contained no additive, hydrated lime, and a chemical additive. Tests were also conducted on pavement samples taken periodically to determine whether hydrated lime slows the hardening rate of asphalt cement as has been reported by others.

Visual examination of pavement samples generally revealed less stripping in pavements containing hydrated lime than in pavements with no additive or with the chemical additives that are routinely used. The tensile strength ratio correlated reasonably well with the amount of stripping observed; but there were some exceptions that were possibly caused by differences in the permeabilities of the pavements. The stripping has not caused any significant pavement distress.

The correlation between the hardening of the asphalt cement and age of the pavements was poor for five of the projects. The only project which produced acceptable correlations showed no significant difference in the hardening rates of the various mixes.

FINAL REPORT

THE USE OF HYDRATED LIME AS AN ANTISTRIPPING ADDITIVE

by

G. W. Maupin, Jr.
Research Scientist

INTRODUCTION

Stripping of asphalt concrete is a weakening process resulting from moisture; this may lead to the detachment of the asphalt film from the aggregate surface or a softening (emulsification) of the asphalt cement. It is a nationwide problem; approximately 60% of the states use anti-stripping additives.(1) There were numerous national and regional meetings during the past decade which discussed the causes and possible cures of stripping. The following were found helpful in preventing or lessening stripping:(2) (1) the provision of adequate compaction which prevents moisture from entering the asphalt mix; (2) the elimination of the use of moisture-susceptible aggregates and asphalts; (3) the provision of adequate drainage; (4) the sealing of the asphalt-aggregate mixture surface; and (5) the treating of the moisture-susceptible aggregate and asphalt as a system.

Chemical additives and filler additives such as hydrated lime and cement have been used in an attempt to prevent stripping. There have been differences of opinion concerning the effectiveness of chemical additives.(3,4,5) A national survey in 1981 revealed that eleven of thirty-two agencies that used chemical additives viewed them as being partly or generally ineffective.(1) The district materials engineers of the Virginia Department of Highways and Transportation for the most part think additives provide short-term benefits, but that their long-term benefits are questionable.(6) Several agencies have used hydrated lime with apparent long-term success or have measured the benefits of hydrated lime through laboratory testing (7,8,9,10,11). This investigation of the effectiveness of hydrated lime was initiated owing to the uncertainty of the effectiveness of the chemical additives that were being used in Virginia.

PURPOSE AND SCOPE

The purpose of this investigation was to install and evaluate the performance of six test sections of asphalt concrete, which contained either no additive, hydrated lime, or a chemical additive. Periodic observations of pavement distress and of samples cut from the pavement were used to assess the effectiveness of the chemical additives and hydrated lime. A secondary objective was to determine whether hydrated lime slows the hardening rate of the asphalt cement as has been reported by others.

INSTALLATION OF TEST SECTIONS

An attempt was made to locate the test sections throughout a reasonably large geographical area of the state so that different weather conditions and aggregates would be involved. Negotiations with contractors and scheduling prevented all of the test sections from being constructed during one construction season; therefore, two of the test sections were paved in 1982(7), and four were paved in 1983. Traffic loading, which has a significant effect on pavement performance, varied considerably from project to project (Table 1); however, these differences should not have affected the comparison of mixes at individual sites. It is possible that stripping might not have developed in mixes that were susceptible to stripping if traffic loading had been very low.

Table 1. Traffic, TSR, and Performance for Hydrated Lime Projects

Route	Traffic Per Test Lane Total vpd	ESAL	Type of Additive	TSR	Stripping in Cores (3-4 years)
58	3,600	160	No Additive	0.41	Slight
			Chemical additive	0.68	Slight
			Lime	0.87	None
600	-	-	No additive	0.62	Moderate
			Chemical additive	0.65	Slight
			Lime	0.98	None
10	6,500	73	No additive	0.41	None
			Chemical additive	0.48	None
			Lime	0.80	None
250	1,805	82	No additive	0.54	Slight
			Chemical additive	0.51	Slight
			Lime	0.93	None
360 (M)	7,600	110	No additive	0.66	Moderate--Severe
			Chemical additive	0.89	Moderate
			Lime	0.95	Very slight
360 (B)	1,480	318	No additive	0.45	Severe
			Chemical additive #1	0.85	Moderate
			Chemical additive #2	0.97	Slight
			Lime	0.81	Slight--Moderate

The types and sources of materials contained in the various mixes are listed in Table 2. Extraction tests were performed on samples that were obtained during construction at each project site except the first on Route 58 to determine the gradation and asphalt content. The hydrated lime was applied in a dry form to dry aggregate at all of the sites.

Table 2. Amounts and Sources of Materials

Route 58, Martinsville

50%	#8 crushed granite	Martinsville Stone, Fieldale
20%	Stone sand	Martinsville Stone, Fieldale
30%	#10 crushed granite	Martinsville Stone, Fieldale
1%	Hydrated lime	Virginia Lime Co., Kimballton
5.9%	AC-20 asphalt cement	Amoco, Chesapeake
0.5%	Pave Bond Special additive	

Route 600, Petersburg

75%	S-5 blend crushed granite	Jack Quarry, Petersburg
25%	Sand	Lone Star (Puddledock Farm) Petersburg
1%	Hydrated lime	Virginia Lime Co., Kimballton
6.1%	AC-20 asphalt cement	Exxon & Chevron, Richmond
0.5%	Kling Beta XP-251 additive	

Route 10, Chesterfield

85%	Crushed S-5 stone	Dale Quarry, Chesterfield
15%	Pit sand	Old Dominion Sand & Gravel, Chesterfield
1%	Hydrated lime	Virginia Lime Co., Kimballton
	Asphalt cement	Chevron, Richmond
1%	Kling Beta XP-251 additive	

Route 250, Afton

55%	#68 crushed granite	Martin Marietta, Red Hill
20%	#10 crushed granite	Martin Marietta, Red Hill
25%	Rivanna River sand	S. L. Williamson Co., Charlottesville
1%	Hydrated lime	Source unknown
	Asphalt cement	Chevron, Richmond

Route 360, Mechanicsville

85%	Crushed stone	APAC of Virginia, Chesterfield
15%	Concrete sand	Lone Star, Richmond
1%	Hydrated lime	Source unknown
5.6%	Asphalt cement	Exxon, Richmond

Route 360, Burkeville

60%	#68 crushed granite	Luck Quarries, Burkeville
40%	#10 crushed granite	Luck Quarries, Burkeville
1%	Hydrated lime	Source unknown
	Asphalt cement	Chevron, Richmond
0.5%	Pave Bond AP Special additive (Chemical additive #1)	
0.5%	BA-2000 additive (Chemical additive #2)	

Route 58 -- Martinsville

S-5 surface mixes were placed by APAC-Virginia, Inc. in a 1.4 in (36 mm) thick lift on the eastbound traffic lane of Route 58 east of Martinsville. The existing slurry-seal surface was moderately cracked. As noted in Figure 1, the installation comprised a section of S-5 mix containing a chemical additive, a section with hydrated lime, and a section with no additive. The target mix gradation and asphalt content are tabulated in Table 3a.

The mix containing a chemical additive was placed on June 9, 1982, and the mixes containing no additive and the one with hydrated lime were placed on June 11.

Table 3. Extraction Results of Field Samples

% Passing

Table 3a. Route 58, Martinsville

Sieve	No Additive	Chemical Additive	Hydrated Lime
1"			
3/4"			
1/2"	100	100	100
3/8"			
#4	53	53	53
#8			
#30	20	20	20
#50			
#100			
#200	6	6	6
AC, %	5.9	5.9	5.9

NOTE: No extractions were performed on samples from Route 58; therefore the values given are for the job mix design.

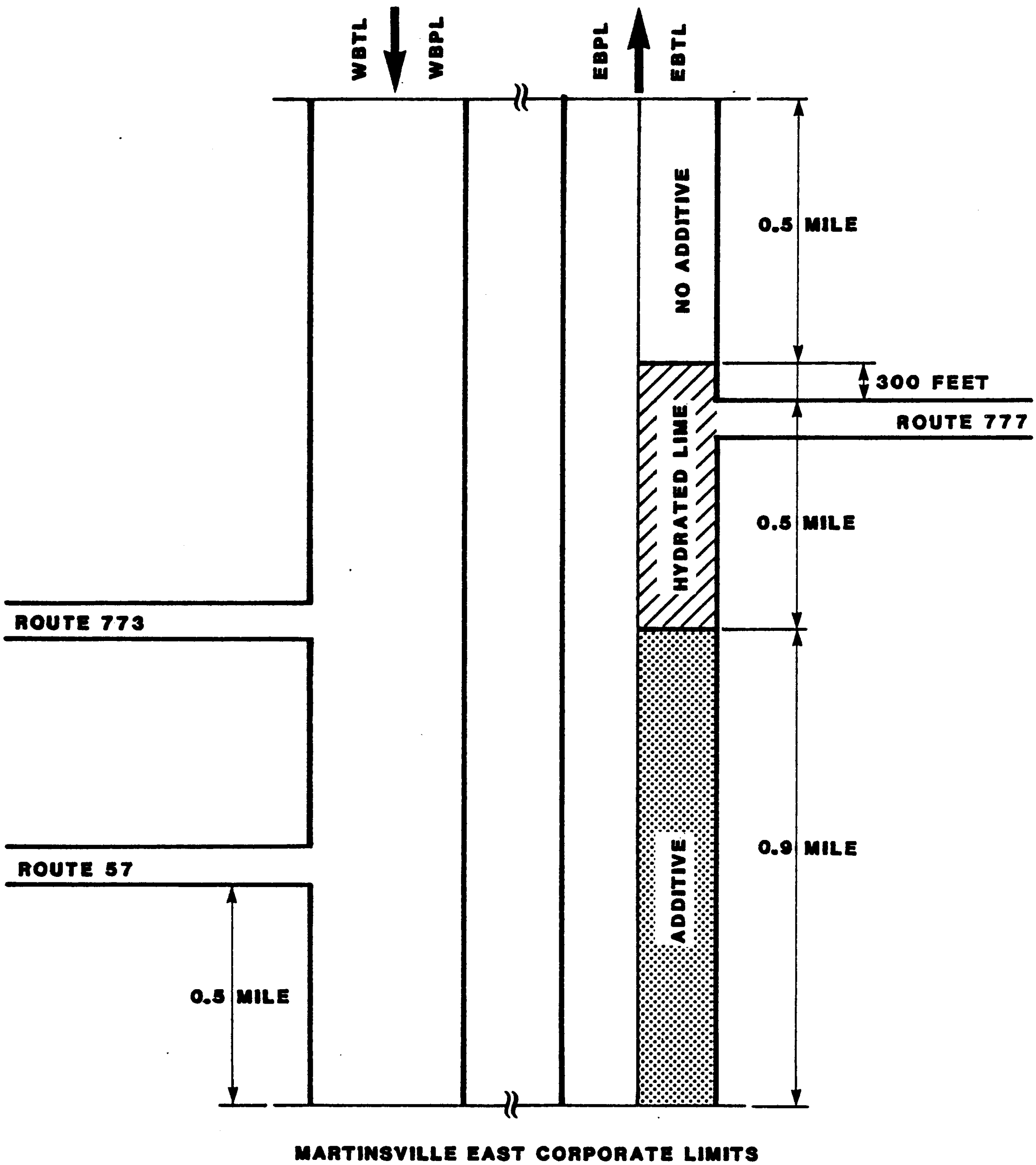

Figure 1. Installation in eastbound lane of Route 58.

Route 600 -- Petersburg

The S-5 mixes with chemical additive, hydrated lime, and no additive were placed in a 1.1 in (28 mm) thick layer on July 28 and 29, 1982, by the Short Paving Company, Inc. The installation is on Route 600 from 0.1 mi (0.2 km) west of Route 226 to the Appomattox River (Figure 2). The old surface contained numerous skin patches.

Although it would have been desirable to use the same brand of asphalt for all mixes, it was necessary for the contractor to purchase asphalt with no additive from Exxon and asphalt with 0.5% chemical additive from Chevron. Two tankers of the Exxon asphalt cement were used for the lime mix and the mix with no additive.

Table 3B

Results of the Extraction Tests for Route 600, Petersburg

Sieve	No Additive	Chemical Additive	Hydrated Lime
1"			
3/4"	100	100	100
1/2"	99	99	99
3/8"	87	87	87
#4	69	62	69
#8	58	47	56
#30	30	23	29
#50	16	13	16
#100	9	8	10
#200	4.8	4.2	5.7
AC, %	6.0	5.6	6.0

994

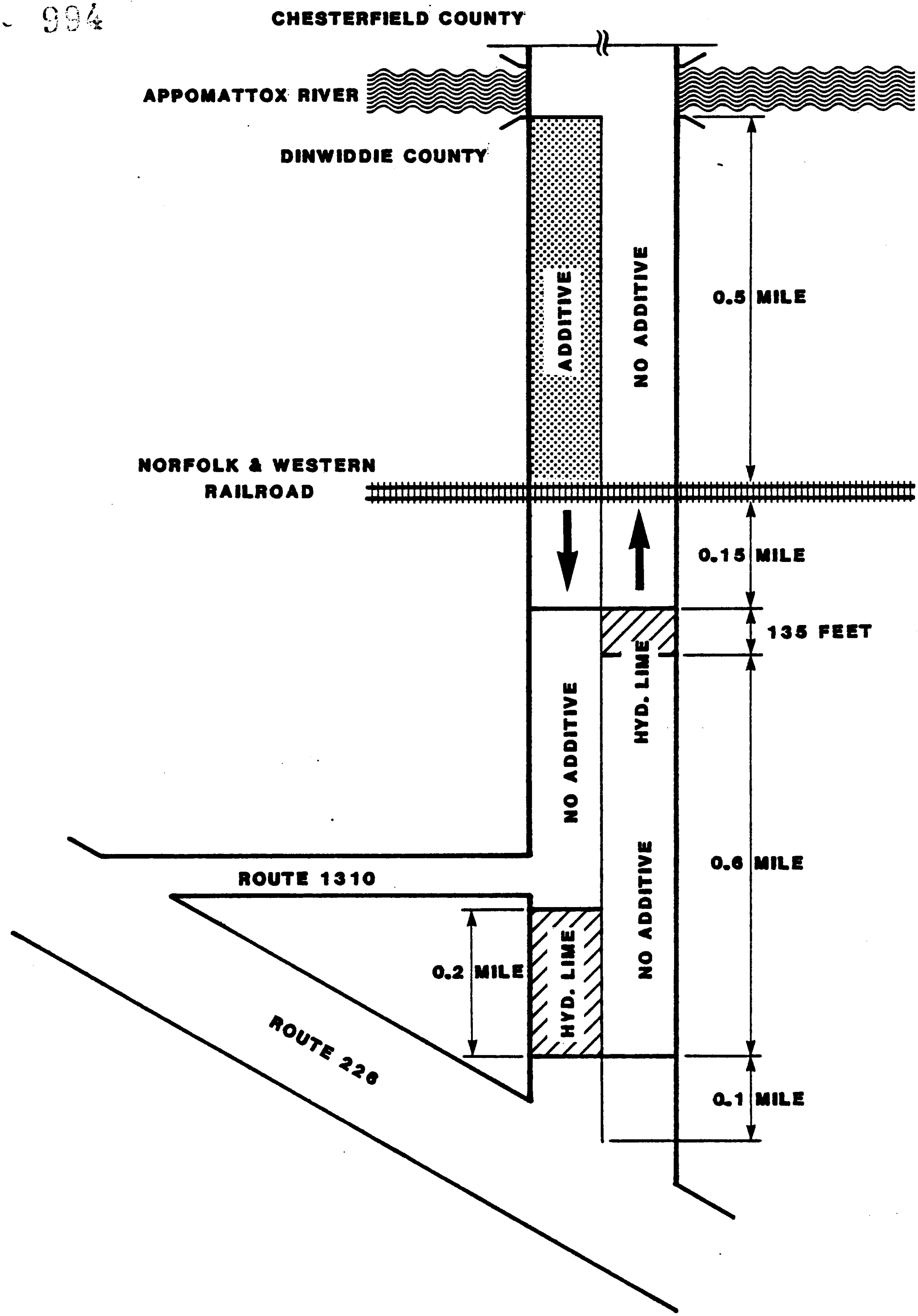

Figure 2. Installation on Route 600.

Route 10 -- Chesterfield

The S-5 mixes were placed in a 1.4 in (36 mm) thick lift on Route 10 north of Chesterfield on June 8, 1983 (Figure 3). The existing plant-mix surface was patched and the cracks had been filled with liquid asphalt. Mixes containing no additive, chemical additive, and hydrated lime were placed by Shoosmith Brothers with the ambient temperature at approximately 75° to 80°F.

Table 3C

Results of the Extraction Tests for Route 10, Chesterfield

Sieve	No Additive	Chemical Additive	Hydrated Lime
1"			
3/4"			
1/2"	100	100	100
3/8"	96	96	95
#4	68	71	67
#8	52	57	41
#30	29	34	23
#50	20	22	17
#100	11	11	12
#200	5.3	5.0	7.6
AC, %	6.2	6.4	5.7

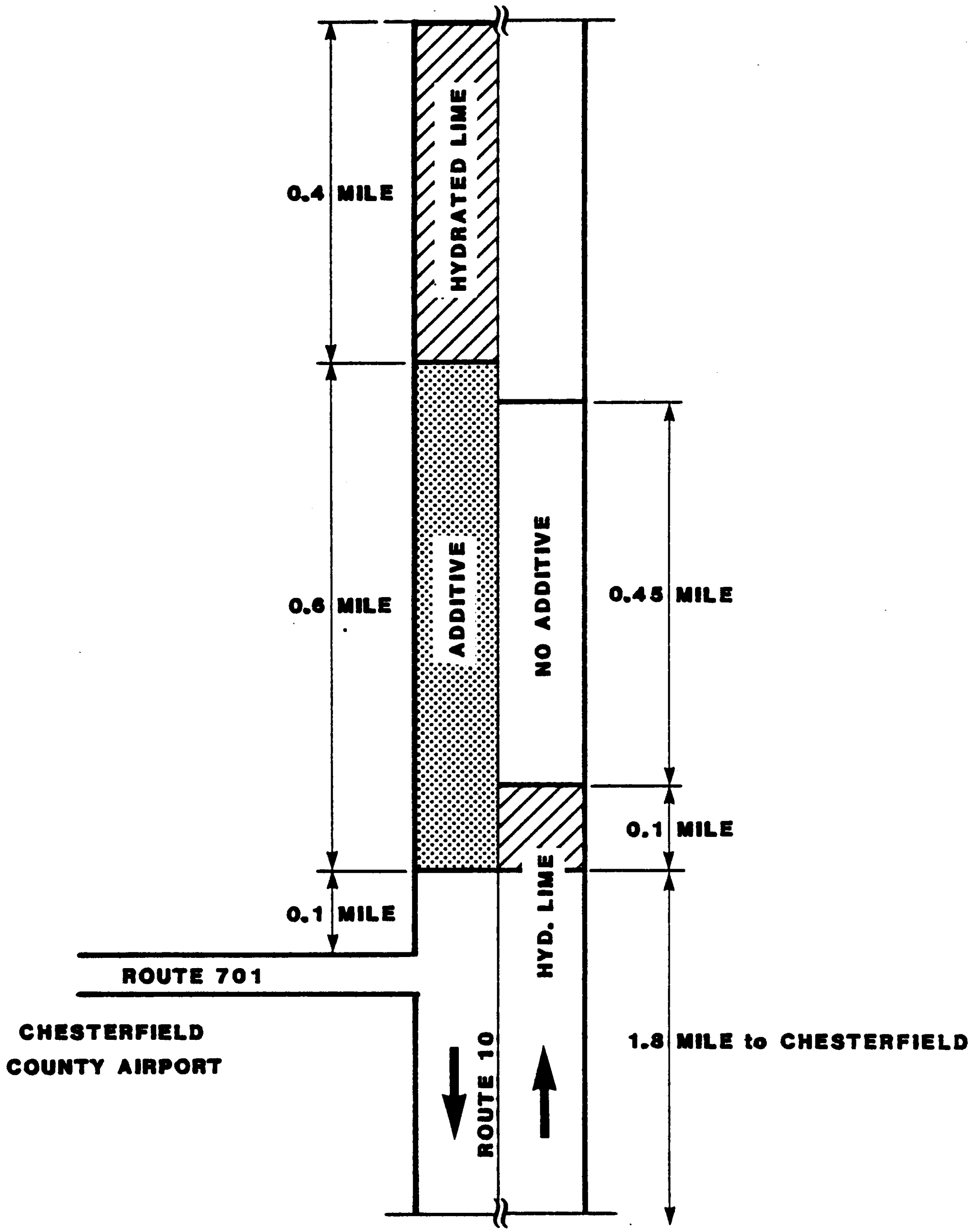

Figure 3. Installation on Route 10 near Chesterfield.

Route 250 -- Afton

The I-2 mixes were placed in a 1.4 in (36 mm) thick lift on a cracked plant mix surface of Route 250 near Afton (Figure 4). S. L. Williamson Company placed mixes containing no additive and hydrated lime on August 8, 1983, and the mix containing chemical additive on August 9. The existing hot-plant-mix surface had a considerable amount of cracking. The ambient temperature was 92°F on August 8 and 95°F on August 9 (a thunderstorm occurred at 5:00 p.m. on the 9th).

Table 3D

Results of the Extraction Tests for Route 250, Afton

Sieve	No Additive	Chemical Additive	Hydrated Lime
1"	100	100	100
3/4"	98	97	98
1/2"	80	83	80
3/8"	66	73	70
#4	40	45	48
#8	30	32	36
#30	16	15	18
#50	11	10	12
#100	8	7	9
#200	5.0	4.5	5.5
AC, %	5.4	5.5	5.1

998

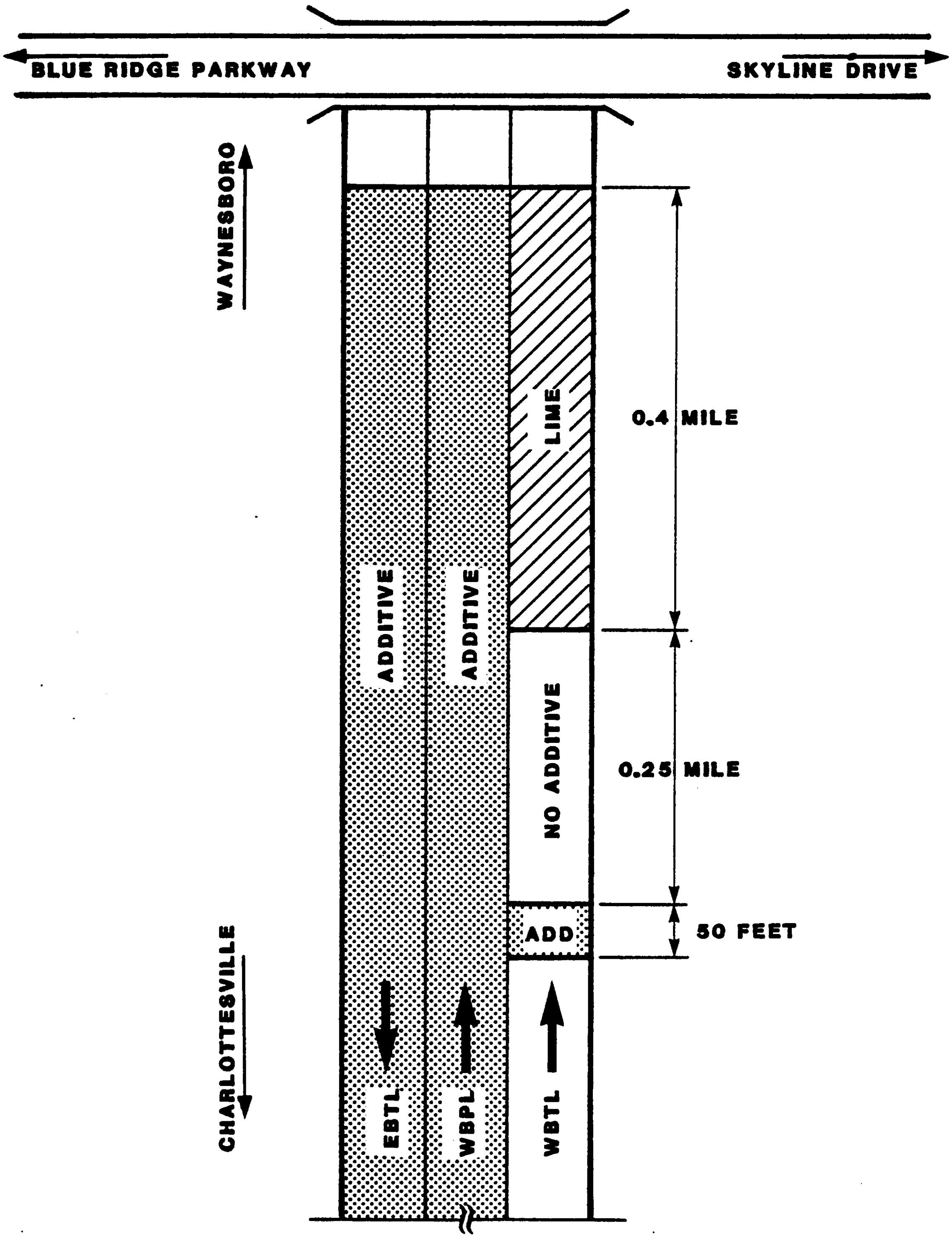

Figure 4. Installation on Route 250 near Afton.

Route 360 -- Mechanicsville

The S-5 mixes were placed in a 1.1 in (28 mm) thick lift on a slurry-seal surface in the westbound traffic lane of Route 360 near Mechanicsville (Figure 5). Mixes containing no additive, chemical additive, or hydrated lime were placed by APAC-Virginia, Inc. on August 9, 1983 with ambient temperatures in the 90's (^{o}F).

Table 3E

Results of the Extraction Tests for Route 360, Mechanicsville

Sieve	No Additive	Chemical Additive	Hydrated Lime
1"			
3/4"			
1/2"	100	100	100
3/8"	95	92	92
#4	66	66	62
#8	48	51	47
#30	24	27	26
#50	16	18	17
#100	10	11	10
#200	5.2	5.9	5.8
AC, %	5.8	5.7	5.5

Route 360 -- Burkeville

The I-2 mixes were placed in a 1.3 in (33 mm) thick layer approximately two miles west of Burkeville on the westbound traffic lane of Route 360 by Adams Construction Company (Figure 6). The existing slurry-seal surface was badly distressed with cracks, potholes, and ruts; it also contained numerous patches. The test sections containing no additive, hydrated lime, or the chemical additive (#1) routinely used by the contractor were constructed August 25, 1983. A fourth test section containing a different chemical additive (#2), which is claimed to be more effective, was constructed on August 30, 1983.

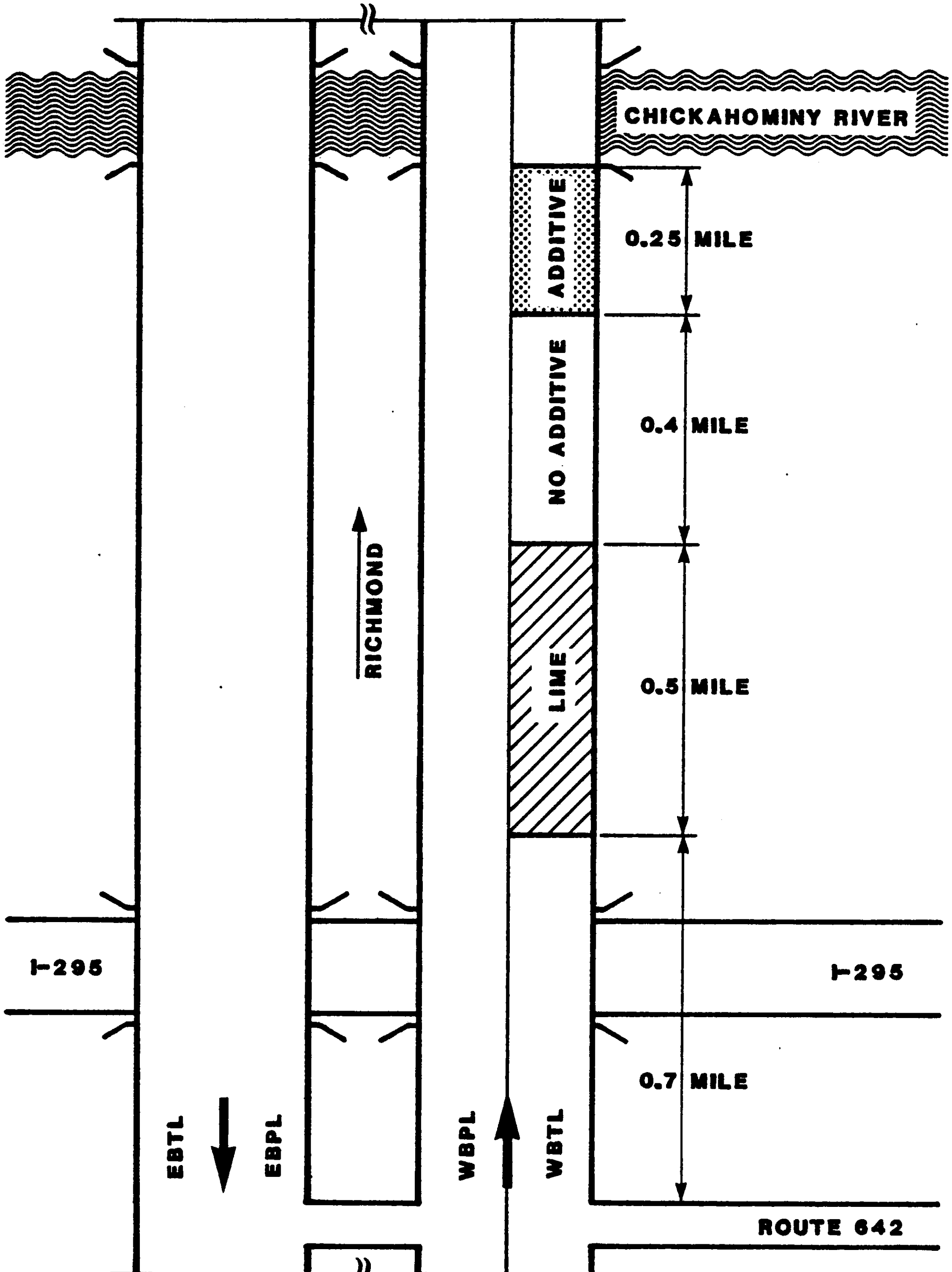

Figure 5. Installation on Route 360 near Mechanicsville.

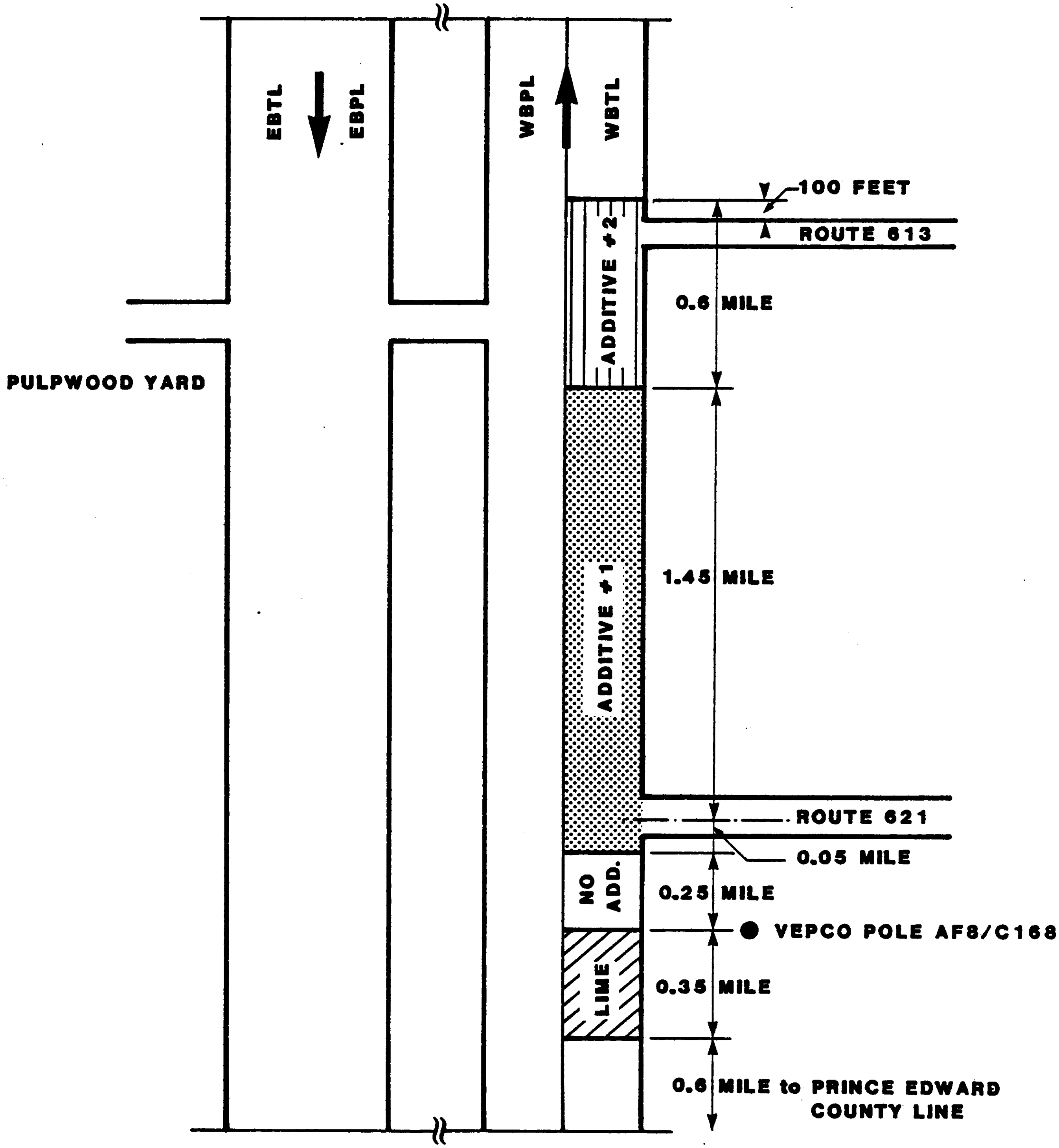

Figure 6. Installation on Route 360 near Burkeville.

Table 3F

Results of the Extraction Tests for Route 360, Burkeville

Sieve	No Additive	Chemical Additive #1	Chemical Additive #2	Hydrated Lime
1"			100	
3/4"	100	100	98	100
1/2"	76	77	80	79
3/8"	58	61	64	60
#4	36	39	42	36
#8	26	28	32	26
#30	19	18	21	18
#50	15	15	16	15
#100	9	9	10	10
#200	5.1	4.5	5.2	5.2
AC, %	4.9	5.0	5.0	5.0

TEST RESULTS

Voids

Slabs were cut from the pavements and the voids were determined at the job site or in the laboratory. The results, which are averages of several slab samples for each pavement, are listed in Table 4. The mix containing no additive on Route 600 and the mix containing lime on Route 10 had unusually high voids. There was no indication that the gradation or asphalt content had an effect on the voids for the mix with no additive on Route 600; but the mix with lime was significantly coarser than the other mixes on Route 10.

Table 4. Pavement Voids, VTM

Route	Additive	Voids Total Mix, VTM
58	No additive	7.2
	Chemical additive	8.8
	Lime	6.6
600	No additive	12.5
	Chemical additive	6.9
	Lime	5.0
10	No additive	8.8
	Chemical additive	9.5
	Lime	13.6
250	No additive	8.4
	Chemical additive	-
	Lime	9.0
360 (Mechanicsville)	No additive	7.9
	Chemical additive	9.2
	Lime	7.1
360 (Burkeville)	No additive	6.6
	Chemical additive #1	8.9
	Chemical additive #2	7.4
	Lime	6.6

Stripping Tests

A modified Lottman stripping test (Appendix A) was used to test samples of the mixes, which were taken during construction, of the test sections to predict the mixes' performance. The test procedure uses a ratio of conditioned tensile strength to unconditioned tensile strength to predict the stripping susceptibility, which is commonly referred to as the tensile strength ratio (TSR). The TSR values can range from 0 for a mix that will disintegrate completely to 1 for a mix with no damage, and it is usually accepted that the minimum TSR should not be lower than 0.75.

The test results listed in Table 1 reveal TSR's lower than 0.75 for all of the mixes with no additive and for four of the mixes containing the routine chemical additive; therefore some stripping damage was expected in these test sections. All of the mixes containing hydrated lime had satisfactory TSR's.

Asphalt Recovery

Slab samples were sawed from the same general area in each test section immediately after construction and annually thereafter, sealed in plastic bags, and returned to the laboratory for Abson recovery testing (ASTM Designation D 1856-79). The recovered asphalt cement was tested for viscosity at 140°F (ASTM Designation D 2171-85) and 275°F (ASTM Designation D 2170-85) and penetration at 77°F (ASTM Designation D 5-83).

We anticipated that trends would be observed in the rate of hardening of the mixes containing different additives. Other investigations reported that hydrated lime reduced the hardening rate of asphalts, particularly soft asphalts such as AC-10.(10,11,12,13)

The individual test results for penetration and viscosity are listed in Tables 5, 6, and 7. We developed linear regressions for each mix by assigning age as the independent variable and penetration or viscosity as the dependent variable; however, the regressions were very poor. The lack of correlation was probably caused by the large variability inherent in the Abson recovery process and the small number of samples that were taken per mix. Also, because of the large number of samples that had to be taken at about the same time, the samples had to be stored for various intervals before the Abson recovery could be performed. The project on Route 360 at Burkeville was an exception and good correlations were obtained for all of the mixes; however, there was not a significant difference in the rate of hardening among the four mixes.

Table 5. Penetration at 77°F (0.1 mm) of Original and Recovered Asphalts

Location	Type of Mix	Original	After Construction	1 yr.	2 yr.	3 yr.	4 yr.
Route 58	No additive	-	59	29	44	31	36
	Chem. additive	-	51	43	38	37	33
	Lime	-	61	33	36	34	39
Route 600	No additive	76	51	27	25	26	36
	Chem. additive	83	51	32	27	31	32
	Lime	76	50	42	40	51	44
Route 10	No additive	84	49	33	40	54	
	Chem. additive	86	43	28	36	39	
	Lime	84	45	36	33	37	
Route 250	No additive	98	37	43	42	41	
	Chem. additive	76	44	45	32	43	
	Lime	98	39	40	36	48	
Route 360 Mechanicsville	No additive	84	37	36	35	33	
	Chem. additive	87	37	34	31	36	
	Lime	84	36	31	33	34	
Route 360 Burkeville	No additive	95	53	40	35	31	
	Chem. additive #1	100	51	39	35	37	
	Lime	95	53	47	37	38	
	Chem. additive #2	93	47	39	33	36	

-1008

Table 6. Viscosity at 140°F (poises) of Original and Recovered Asphalts

Location	Type of Mix	Original	After Construction	1 yr.	2 yr.	3 yr.	4 yr.
Route 58	No additive	-	4,883	27,419	11,527	21,804	9,705
	Chem. additive	-	6,021	10,499	15,611	15,856	17,430
	Lime	-	4,457	15,085	13,032	12,437	9,017
Route 600	No additive	1,822	4,772	15,297	19,342	21,063	12,319
	Chem. additive	1,746	4,006	9,867	13,445	10,911	9,488
	Lime		4,504	5,150	5,455	3,653	5,187
Route 10	No additive	1,890	5,100	10,657	10,926	8,180	
	Chem. additive	1,774	7,629	10,841	11,468	13,291	
	Lime		5,912	9,815	10,479	7,268	
Route 250	No additive	1,267*	6,866	5,326	6,333	5,134	
	Chem. additive	1,629	5,916	9,510	17,093	11,021	
	Lime		5,083	5,999	6,122	4,466	
Route 360 Mechanicsville	No additive	1,751	8,549	7,138	9,364	10,373	
	Chem. additive	1,966	-	6,901	10,827	6,970	
	Lime		10,278	11,679	8,379	8,218	
Route 360 Burkeville	No additive	1,751	6,293	12,279	10,723	11,807	
	Chem. additive #1	1,592	6,278	10,279	13,124	8,183	
	Lime		5,677	9,006	12,702	16,360	
	Chem. additive #2	1,759	8,756	12,969	21,076	15,426	

*Smelled fuel oil

Table 7. Viscosity at 275°F (Cs) of Original and Recovered Asphalts

Location	Type of Mix	Original	After Construction	1 yr.	2 yr.	3 yr.	4 yr.
Route 58	No additive	-	670	1,402	1,011	1,262	941
	Chem. additive	-	733	1,002	988	1,150	1,177
	Lime	-	636	1,113	1,044	907	898
Route 600	No additive	408	622	976	1,072	1,097	1,031
	Chem. additive	391	666	815	903	842	785
	Lime	-	601	641	658	558	706
Route 10	No additive	413	636	849	800	739	
	Chem. additive	392	733	817	845	979	
	Lime	-	667	794	805	671	
Route 250	No additive	329	645	598	611	601	
	Chem. additive	355	672	818	1,023	897	
	Lime	-	574	601	604	574	
Route 360	No additive	373	734	630	724	747	
Mechanicsville	Chem. additive	429	-	630	772	652	
	Lime	-	812	746	667	674	
Route 360	No additive	411	747	916	905	932	
Burkeville	Chem. additive #1	394	730	860	966	831	
	Lime	-	694	801	888	1,086	
	Chem. additive #2	402	850	953	1,216	1,035	

PAVEMENT PERFORMANCE

The stripping observed in the last group of samples that were cut after three to four years is described in Table 1. In general the mixes containing hydrated lime showed very good stripping resistance; four of the six mixes showed no stripping. The mixes containing routine chemical additives exhibited slight-to-moderate stripping in five of six cases. The mixes with low TSR values developed stripping with the exception of the mixes on Route 10, which have no stripping damage. The samples from Route 10 appeared to have low permeability and a rough check of the moisture content of samples removed in 1985 revealed much less moisture in the samples from this route than in the samples from the other projects. Also, it was noticed during the sampling that when the samples were put into plastic bags more condensation formed in some than in others. The differences in permeability and moisture content could help explain why the TSR values did not correlate with stripping in every case.

Even though stripping is manifested in various degrees in many of the mixes the pavements do not show surface distress that is necessarily attributable to stripping. Reflection cracks are visible in sections on Route 58 and Route 10, and there is some shoving in one spot on Route 360 at Mechanicsville probably owing to too much asphalt in the no-additive mix. The same area on Route 360 received a heavy tack coat prior to paving; therefore, the tack coat could have bled to the surface and caused shoving. Surface distress caused by stripping may manifest itself as the stripping damage progresses.

CONCLUSIONS

1. Generally there was less visible stripping in pavements containing hydrated lime than in pavements with no additive or with the chemical additives that are used routinely.

2. The TSR relates reasonably well with the amount of stripping that was observed. The exceptions are possibly caused by differences in the permeabilities of the pavements.

3. The correlations between the hardening of the asphalts and the age of the pavements was poor for five of the projects. There was no significant difference in the hardening rates of the various mixes on the sixth project which produced acceptable correlations.

4. The stripping that is present has not caused any significant pavement distress to date.

REFERENCES

1. Tunnicliff, David G. 1982. Antistripping additives in asphalt concrete--state-of-the-art 1981. Proceedings of the Association of Asphalt Paving Technologists 51.

2. Kennedy, Thomas W. and James N. Anagnos. 1984. Techniques for reducing moisture damage in asphalt mixtures. Research Report 253-9F, Center for Transportation Research, The University of Texas at Austin.

3. Field, F. 1977. Evaluation of anti-stripping additives for asphaltic concrete mixes-effectiveness and recommended usage. Presented at the Annual Conference of the Canadian Technical Asphalt Association.

4. Brown, Ronald A. and Thomas E. Wohlscheid. 1981. Performance of asphalt concrete pavements containing anti-stripping additives. Technical Report 81-3, New York Department of Transportation.

5. Peevy, Calvin. 1982. Stripping of asphalt from aggregates in Arkansas. Presented at the Federal Highway Administration Stripping Workshop in Atlanta, Georgia.

6. Maupin, G. W., Jr. 1982. The use of antistripping additives in Virginia. Presented at the annual meeting of the Association of Asphalt Paving Technologists.

7. _______ 1983. Use of hydrated lime as an antistripping additive. Report 83-R26, Virginia Highway and Transportation Research Council.

8. Welch, Bob H. 1982. Asphalt stripping--District of Columbia Department of Transportation. Presented at the Federal Highway Administration Stripping Workshop in Atlanta, Georgia.

9. Georgia Department of Transportation, Office of Materials and Research. 1982. Moisture damage of asphaltic concrete pavements. Presented at the Federal Highway Administration Stripping Workshop in Atlanta, Georgia.

10. Kennedy, Thomas W., Freddy L. Roberts, and Kang W. Lee. 1982. Evaluating moisture susceptibility of asphalt mixtures and the effectiveness of antistripping agents using the Texas Freeze-Thaw Pedestal Test. Presented at the annual meeting of the Association of Asphalt Paving Technologists.

11. Welch, Bob H. and Max L. Wiley. 1976. Investigation of hydrated lime--asphalt and aggregate interactions. Utah Department of Transportation.

12. Liddle, Wallace J., Dale E. Peterson, and Max L. Wiley. 1971. Use of hydrated lime in bituminous mixtures to decrease hardening of the asphalt cement. Utah State Highway Department.

13. Edler, A. C., M. M. Hattingh, V. P. Servas, and C. P. Marais. 1985. Use of aging tests to determine the efficacy of hydrated lime additions to asphalt in retarding its oxidative hardening. A paper prepared for presentation at the annual meeting of the Association of Asphalt Paving Technologists.

Virginia Test Method

For

Stripping Test for Bituminous Concrete

Designation: VTM-62

1. Scope

This test method measures the strength loss resulting from damage caused by "stripping" under laboratory controlled accelerated water conditioning. The results may be used to predict long term stripping susceptibility of a bituminous concrete.

2. Apparatus

a. Automatic Marshall Compactor

b. Freezer (0°F ± 5°F)

c. 140°F ± 2°F Water Bath

d. 77°F ± 1°F Water Bath

e. Vacuum capable of 26 inches of mercury

f. Polycarbonate plastic or equal vacuum container

g. Marshall Stability Test Machine

h. Aluminum pans having a surface area of 75-100 square inches in the bottom and a depth of approximately 1 inch.

i. 10 ml graduated cylinder

j. Stripping Test Breaking Head

k. Miscellaneous supplies; such as plastic film, masking tape, plastic bags, aluminum foil, and paraffin wax.

3. Test Specimens

a. Aggregate is to be graded to the required gradation and heated in a 275°F oven until the temperature of the aggregate is 275°F. The asphalt cement is heated on a hot plate with continuous stirring or in an oven to 275°F. The aggregate and asphalt are combined and mixed until the aggregate is thoroughly coated. The aggregate and asphalt may be mixed as a single specimen or it may be mixed as multiple specimens and then separated.

b. After mixing, the mixture for each specimen is spread uniformly in an aluminum pan and placed in a 275°F oven for not less than 1 hour and not more than 2 hours prior to compaction at a temperature of 275°F ± 5°. (Mix samples from the hot mix plant should be reheated to 275°F ± 5° and thoroughly remixed. Mix should not remain in the oven for an extended time and it should only be reheated once).

Note: Remove the plus 3/4 inch material when testing Bituminous Concrete mixtures containing plus 1 inch aggregate.

c. The mixture is then compacted into Marshall specimens (4" dia. x 2.5" thick) with a Marshall hammer. A compactive effort to yield 7.5% ± 1% VTM should be used. Once this compactive effort has been established, it should be used in all subsequent tests on the mix provided the gradation, aggregate, etc. do not change. After extraction from the molds, the specimens should be stored for 3 hours at room temperature before determining the bulk specific gravity.

4. Preconditioning

a. Prior to preconditioning, the bulk specific gravity of each specimen is to be determined in accordance with AASHTO T 166 Method A. The average of the eight specimens selected for the test should have an average void content of 7.5% ± 1°% (6.5% to 8.5%) however, no individual specimen shall be included with a void content above 7.5% ± 2.0% (5.5% to 9.5%). The specimens will be divided into a dry group and a preconditioned group consisting of 4 specimens each. The average bulk gravity of the dry group and the preconditioned group should be equal or very close. However, as many specimens as possible with bulk specific gravities furtherest from the average bulk specific gravity of the eight specimens should be assigned to the dry group.

b. The dry group will be stored at room temperature until testing. Approximately 19.5 hours after compaction, the specimens to be preconditioned are to be placed in a vacuum container and supported above the container bottom by a spacer. The container is to be filled with water (distilled or treated to eliminate electrolytes) and subjected to a vacuum of 26 inches of mercury for 30 minutes, gently agitate two or three times. After 30 minutes of vacuum saturation, the cores are left submerged and under atomospheric pressure for an additional 30 minutes.

c. The vacuum saturated specimens, in surface damp condition, are then covered tightly with plastic film which should be taped securely. Each sample is then placed in a plastic bag with 10 ml of water and the bag sealed. Approximately 21 hours after compaction, place the samples in a freezer at 0°F ± 5°F for 6 hours. After 6 hours, place the specimens into a 140°F ± 2° water bath for 22 hours. As soon as possible after placement in the water bath, remove the plastic bag and film from the specimens.

5. Testing

a. After 22 hours in the 140°F water bath, remove the specimens and place them in a water bath already at 77°F ± 1°F for 2 hours. It may be necessary to add ice to the water bath to prevent the water temperature from rising above 77°F. Not more than 15 minutes should be required for the water bath to reach 77°F.

The dry specimens shall be covered with aluminum foil, coated with paraffin wax and placed directly into the 77°F water bath for 2 hours prior to testing. Not more than 15 minutes should be required for the water bath to reach 77°F.

b. Remove the specimen from the water bath and place in the stripping test breaking head. Place the completed assembly in position on the testing machine. Care must be taken in placing the specimen in the breaking head so that the load will be applied along the diameter of the specimen. Apply the load to the specimen by means of the constant rate of movement of the testing-machine head of 2 inches per minute. Stop loading as soon as the maximum compressive load is reached. Record the maximum compressive load noted on the testing machine or converted from the maximum micrometer dial reading. Remove the specimen, measure and record the side (edge) flattening to the nearest 0.1 inch. The flattening may be easier to measure if the flattened edge is rubbed with the lengthwise edge of a piece of chalk or keel. After recording the flattening, replace the specimen in the compression machine and compress until a vertical crack appears. Remove the specimen from the machine and pull apart at the crack. The interior surface shall be inspected for stripping a visual description recorded.

6. Results

Calculate each specimen's indirect tensile strength as follows:

$S_t = \frac{S_{10} \; P}{10,000 \; t}$, where

S_t = indirect tensile strength, psi

S_{10} = flattening correction obtained by graph

P = maximum compressive load, lb.

t = thickness of specimen, in. (average of 4 measurements taken 90° apart)

Calculate the average indirect tensile strength of the dry specimens and preconditioned specimens. The standard deviation for each set should not be greater than 10 psi. Calculate the tensile strength ratio as follows:

TSR = $\frac{\text{ITS (preconditioned)}}{\text{ITS (dry)}}$, where

TRS = tensile strength ratio

ITS (preconditioned) = average indirect tensile strength, psi, of preconditioned specimens

ITS (dry) = average indirect tensile strength, psi, of dry specimens

The tensile strength ratio may be used to predict the stripping damage that will occur in a bituminous concrete.