

INSTALLATION REPORT

2129

BLENDED AGGREGATE BITUMINOUS MIXES

by

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Virginia Highway & Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia
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SUMMARY

Virginia has provided skid resistant pavements in the limestone area of the state by placing thin overlays of sand mixes incorporating local materials, by sprinkling highly skid resistant aggregates on limestone bituminous mixes prior to rolling, and by blending polish resistant aggregate with limestone. All of these methods have met with success, but the blended mixes have proven to be the most reliable and durable. To date the blended mixes have employed at least 45% of imported, polish resistant aggregate, which, of course, is the expensive portion of the mix. It is the feeling of the investigators that the quantity of polish resistant aggregate can be reduced, which would reduce the cost of the blended mixes.

This report describes the installation of five experimental sections of bituminous mixes incorporating relatively small amounts of nonpolishing aggregates with limestone screenings. These sections are located in the Staunton and Bristol Districts as described in the report.

It is hoped that these mix types will retain an adequate skid value so as to provide an economical alternative to 100% nonpolishing and sprinkle mixes.

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INTRODUCTION

The Research Council is continuously trying to develop economical skid resistant bituminous surface courses. This endeavor is particularly important in the state's western construction districts where nonpolishing aggregates are scarce and costly to import.

In the past, the Council has worked with field personnel in developing such skid resistant mixes as the S-1, which is a fine sand mix similar to natural Kentucky rock-asphalt; sprinkle mixes, which consist of a plant mix fabricated from 100% polish susceptible aggregate and sprinkled with a light application of precoated polish resistant aggregate prior to rolling; mixes fabricated from local materials; and blend mixes, which are blends of coarse polish resistant aggregate and fine polish susceptible materials. All of these mixes have performed satisfactorily; however, the ones that have proven to be the most reliable from the combined consideration of lasting skid resistance and physical durability have been the blended mixes.

The majority of the blended mixes have incorporated about 40% or more of imported polish resistant aggregate. For reasons of economy, it is highly desirable to reduce the quantity of the imported materials. For this reason, the Bituminous and Maintenance Sections of the Council have joined with the Materials personnel of the Staunton and Bristol Districts to ascertain if the quantity of polish resistant aggregates in the blended mixes can be reduced without a sacrifice in skid resistance.

This report deals with an attempt to blend small amounts of coarse, nonpolishing aggregates with limestone fines to produce a durable skid resistant mix. The experimental mixes, which were designed by Staunton and Bristol materials personnel, are described in the report and the test sections are located. Initial skid values are also reported.

The performance of the mixes will be evaluated primarily by use of skid values although surface distress will also be monitored.

EXPERIMENTAL SITES

Two of the experimental sites are in the Staunton District and three are in the Bristol District. In the Staunton District, one is on Route 55 east of Front Royal (Warren County) and the other on Route 50 west of Winchester (Frederick County). The three sites in the Bristol District are on Route A-58 of Dryden (Lee County), Route 19 east of Lebanon in Russell County, and Route A-58 east of St. Paul, also in Russell County. Details of each site follow and schematic drawings are shown in Figures 1 through 5 appended.

Route 55 — Warren County

Figure 1 shows the layout of the experimental sections on Route 55 in Warren County. The paving was done by the Virginia Asphalt Company. As indicated, the site is on a two-lane portion of Route 55 approximately 4 miles (6436 metres) east of the east corporate limits of Front Royal, beginning at about milepoint 1.3 (2091.7 metres) and extending eastward. The 1973 average daily traffic count was 5,355. Since this is a two-lane roadway, the AVD is 2,678 per lane. The surface will be exposed to approximately one million vehicle passes per year.

The design called for two nonpolishing aggregates — #8 Paris greenstone and #8 Leakesville gravel — each in amounts of 10, 20, and 30% blended with 90, 80, and 70% Riverton limestone screenings (#10 stone), respectively, for a total of six mixes. Marshall mix data are given in Table 1. The values shown are close to but not exactly what the Marshall design predicted. The discrepancies resulted from the fact that the design percentages of nonpolishing aggregates deviated from the actual blends appreciably. Table 2 shows the comparison between the design and actual blends. Tests on the actual blends (plant samples) were performed by both the Research Council and the Staunton District. The values in the rounded average column are the rounded averages from the data from the two laboratories and are assumed to be the actual quantities of polish resistant material in the mixes.

Table 1

Marshall Data, Route 55 — Warren County

Design Section	A.C., %	Stability, lb.	Newtons	Density		VFA	VMA
				Marshall	Field		
10% Greenstone	7.0	2,040	9 074	93.7	88.4	71.9	22.3
20% Greenstone	6.8	1,950	8 674	93.1	86.8	69.3	22.5
30% Greenstone	6.8	1,700	7 562	91.1	87.3	62.9	24.1
10% Gravel	7.4	1,400	6 227	93.9	88.0	72.3	22.0
20% Gravel	6.8	1,930	8 585	95.6	92.0	78.1	20.1
30% Gravel	6.6	1,940	8 629	95.5	89.8	77.3	19.0

Table 2

Design vs. Actual Percentages of Nonpolishing Aggregates,
Route 55 — Warren County

Aggregate	Design %	Actual %		Rounded Average
		VH&TRC	Staunton District	
Greenstone	10	10.2	11.8	11
Greenstone	20	6.0	7.2	7
Greenstone	30	5.3	5.8	6
Gravel	10	9.4	10.2	10
Gravel	20	12.3	13.9	13
Gravel	30	10.1	15.0	13

The Virginia Highway & Transportation Research Council values were obtained by gradation separation; those from Staunton by the insoluble residue method. The use of different methods plus the expected testing error account for the small differences shown. The discrepancies between the design and actual values are probably due to the limestone screenings spilling over from the Number 1

into the Number 2 bin and thus being weighed as nonpolishing aggregate. However, these sections will be of great value in providing a measure of the effect of small amounts of nonpolishing aggregate on pavement skid resistance.

The control section consists of the 1,500 feet (457.2 m) of roadway immediately east of the blended sections and is paved with 135 psy (5932 kg/m²) of MI-2 consisting of the following proportions: 35% #68 greenstone, 10% #8 greenstone, 20% #10 granite, and 35% #10 limestone.

The initial skid values shown in Table 3 do not give an indication of future skid values; however, they are included for completeness.

Table 3
Average Initial Skid Values for
Route 55 - Warren County Test Sections

Field Test Section	SN ₄₀ *	PSDN ₄₀ *
11% Greenstone	47	54
7% Greenstone	45	53
6% Greenstone	44	52
10% Gravel	41	50
13% Gravel	43	51
13% Gravel	44	52

*The SN₄₀ values are skid numbers obtained with the Research Council trailer, used according to ASTM E 247-70. Each value is the mean of five repeat tests. The PSDN₄₀ is the predicted stopping distance number for 40 mph (17.88 m/s) tests as derived from a correlation curve developed by Runkle.⁽¹⁾ It is this value that the engineers in Virginia should consider since the Department has for years judged skid resistance on stopping distance numbers.

Route 50 — Frederick County

Figure 2 shows the layout of the experimental sections placed by the Perry Paving Company in the eastbound traffic lane of Route 50 approximately 6 miles (9,654 m) west of the west corporate limits of Winchester beginning at about milepoint 14.3 (23,009 m) and extending eastward. The 1973 AVD count was 5,120. To ascertain the volume of traffic in the eastbound traffic lane, 5,120 is first halved and then multiplied by 80% as prescribed by traffic manuals. The result is 1,024 AVD, in or about 375,000 vehicles per year.

This site includes a section of 100% Perry limestone screenings. (The relatively high insoluble residue, 14.5%, of this material indicates that it is not as polish susceptible as most of Virginia's limestones.) The remaining sections include blends that employ #8 or #78 Paris greenstone as the non-polishing aggregate, in percentages of 10, 20, and 30%. The remaining aggregate of each of the mixes is Perry limestone screenings.

The Marshall mix design data are given in Table 4.

Table 4

Marshall Mix Data, Route 50 — Frederick County

Design Section	A.C., %	Stability, lb.	Newtons	Marshall Density	VFA	VMA
100% Limestone	6.8	1,890	8 407	93.7	71.0	21.6
10% #8 Greenstone	6.2	2,200	9 786	95.3	75.6	19.0
20% #8 Greenstone	6.1	2,320	10 319	95.0	73.9	19.4
30% #8 Greenstone	6.1	2,250	10 008	96.3	79.8	18.2
10% #78 Greenstone	6.5	2,340	10 408	97.0	83.6	18.3
20% #78 Greenstone	6.1	2,210	9 830	95.6	81.1	17.8
30% #78 Greenstone	6.0	1,910	8 496	95.5	79.5	18.1

Hot bin analyses were performed frequently in order to more accurately control the design blend percentages. The results are shown in Table 5.

Table 5

Design vs. Actual Percentages of Nonpolishing Aggregate
Route 50 — Frederick County

Aggregate	Design Percentage	Actual VH&TRC	Percentage Staunton	Rounded Average
# 8 Greenstone	10	12.9	10.5	12
# 8 Greenstone	20	20.8	17.5	19
# 8 Greenstone	30	31.2	26.8	29
#78 Greenstone	10	6.1	5.2	6
#78 Greenstone	20	19.3	16.8	18
#78 Greenstone	30	29.8	27.3	29

The discrepancies between the actual percentages by the Virginia Highway & Transportation Research Council and Staunton are probably due, as on Route 55, to the methods of aggregate separation and expected testing error. Again the Virginia Highway and Transportation Research Council results are based on gradation, whereas the Staunton results are based on insolubility, and the Perry limestone, having a higher insolubility than many limestones, is the primary source of the variability in the results. At any rate, the actual percentages more closely approximate the design percentages than was the case with Route 55 results.

The control section consists of 70 psy (3076 kg/m^2) of MS-11 mix from Riverton, made from 100% #8 greenstone.

The initial skid values are shown in Table 6.

Table 6

Average Initial Skid Values for Route 50 —
Frederick County Test Sections

Field Test Section	SN ₄₀	PSDN ₄₀
100% Limestone	41	50
12% #8 Greenstone	39	48
19% #8 Greenstone	41	50
29% #8 Greenstone	42	51
6% #78 Greenstone	41	50
18% #78 Greenstone	44	52
29% #78 Greenstone	43	51

Route A-58 — Lee County

Figure 3 shows the layout of the experimental section in Lee County, which was paved by the Adams Construction Company. The site is on a two-lane section of Route A-58 approximately 1.5 miles (2413 m) east of Dryden, starting at about milepoint 7 (11.263 m) and extending eastward. The AVD count in 1973 was 3,540. This being a two-lane roadway, the traffic count in one direction is 1,770 AVD, or about 650,000 vehicles per year.

Twenty percent of #8 Tri-City gravel, the nonpolishing aggregate, was blended with Marty Quarry limestone screenings. The Marshall mix data come from the design procedure, and at the recommended asphalt content of 6.4% provides a stability of 2,785 lb. (12,388 Newtons), a density of 98.2%, a VMA of 16.9%, and a VFA of 89.7%.

The actual percentage of the #8 nonpolishing aggregate used as determined from sample separation by the Research Council was 14.5% rounded to 15%. Samples taken from the cold feed belt cross section were used to control the percentage at the plant.

The initial skid values on this section are shown in Table 7. The control section, consisting of 135 psy (5932 kg/m²) of MI-2, had the following proportions: 35% #68 granite, 15% #8 sand, and 50% #10 limestone.

Table 7

Initial Skid Values for Route A-58 — Lee County

Section	SN ₄₀	PSDN ₄₀
15% #8 Tri-City Gravel		
EBL	45	53
WBL	44	52
Control		
EBL	52	58
WBL	54	60

Route 19 — Russell County

Figure 4 shows the layout of the experimental section in Russell County paved by the Adams Construction Company. As shown, the site is on a two-lane section of Route 19 about 2.5 miles (4022.5 m) north of Lebanon, beginning at about mile-point 13.0 (20 917 m) and extending eastward. The 1973 AVD count was 7,170. Again, since this is a two-lane road, the traffic in each lane is 3,585 AVD, or about 1.3 million vehicles per year.

The design called for 30% #78 nonpolishing aggregate from Jack Quarry blended with 70% Pounding Mill limestone screenings. The Marshall design at a recommended asphalt content of 5.0% provided a stability of 2,820 lb. (12 543 N), a density of 96.3%, a VMA of 15.4%, and a VFA of 76.0%.

The actual percentage of the #78 nonpolishing aggregate used, obtained by separation by the Research Council, was 22.0%.

The control sections consist of 135 psy (5932 kg/m²) of MI-2 made from 100% #8 gravel (sprinkle treatment).

Table 8

Initial Skid Values for Route 19 — Russell County

Section	SN ₄₀	PSDN ₄₀
22% #78 Jack Quarry		
NBL	50	57
SBL	55	60
Control		
NBL	50	57
SBL	52	58

Route A-58 — Russell County

Figure 5 shows the layout of each experimental section paved by the Pope Paving Company as part of construction project 6058-083-104 C501 in Russell County. As indicated, the site is in the eastbound lanes just west of Dickensonville, beginning

at milepoint 8.51 (13 693 m) and extending westward. The control section is located in the westbound lanes. The AVD count before several relocations was 4,320. The breakdown is about 630,000 and 160,000 vehicles per year for the traffic and passing lanes, respectively. The design called for two nonpolishing aggregates — #8 and #78 gravel from the Tri-City Sand Company — each in amounts of 20, 30, and 40% blended with Vulcan Materials limestone screenings. The 30% #8 section was repeated to make a total of seven experimental sections. The Marshall mix data taken at the plant are given in Table 7.

Table 7

Marshall Field Data, Route A-58 — Russell County

Design Section	A.C., %	Stability, lb.	Newtons	Marshall Density	VFA	VMA
20% # 8 Gravel	6.0	2,120	9 430	96.1	18.1	76.8
30% # 8 Gravel	6.2	2,250	10 008	95.6	18.8	74.6
40% # 8 Gravel	6.2	2,150	9 563	97.8	16.8	85.6
20% #78 Gravel	6.2	2,260	10 052	96.5	17.0	84.7
30% #78 Gravel	6.2	2,430	10 809	97.0	17.5	81.6
40% #78 Gravel	5.9	2,120	9 430	94.0	18.7	71.0

The design vs. actual percentages of nonpolishing aggregates are shown in Table 8. The actual percentages were obtained by separation from cores provided by the district.

Table 8

Design vs. Actual Percentages of Nonpolishing Aggregate, Route A-58 — Russell County

Aggregate	Design %	Actual %	Rounded Average
# 8 Gravel	20	22.5	22
# 8 Gravel	30	18.0	18
# 8 Gravel	40	35.5	36
#78 Gravel	20	26.5	26
#78 Gravel	30	36.3	36
#78 Gravel	40	37.0	37

REFERENCE

1. Runkle, Stephen N., "Evaluation of the New Virginia Department of Highways & Transportation Skid Trailer," Virginia Highway & Transportation Research Council, February 1975.

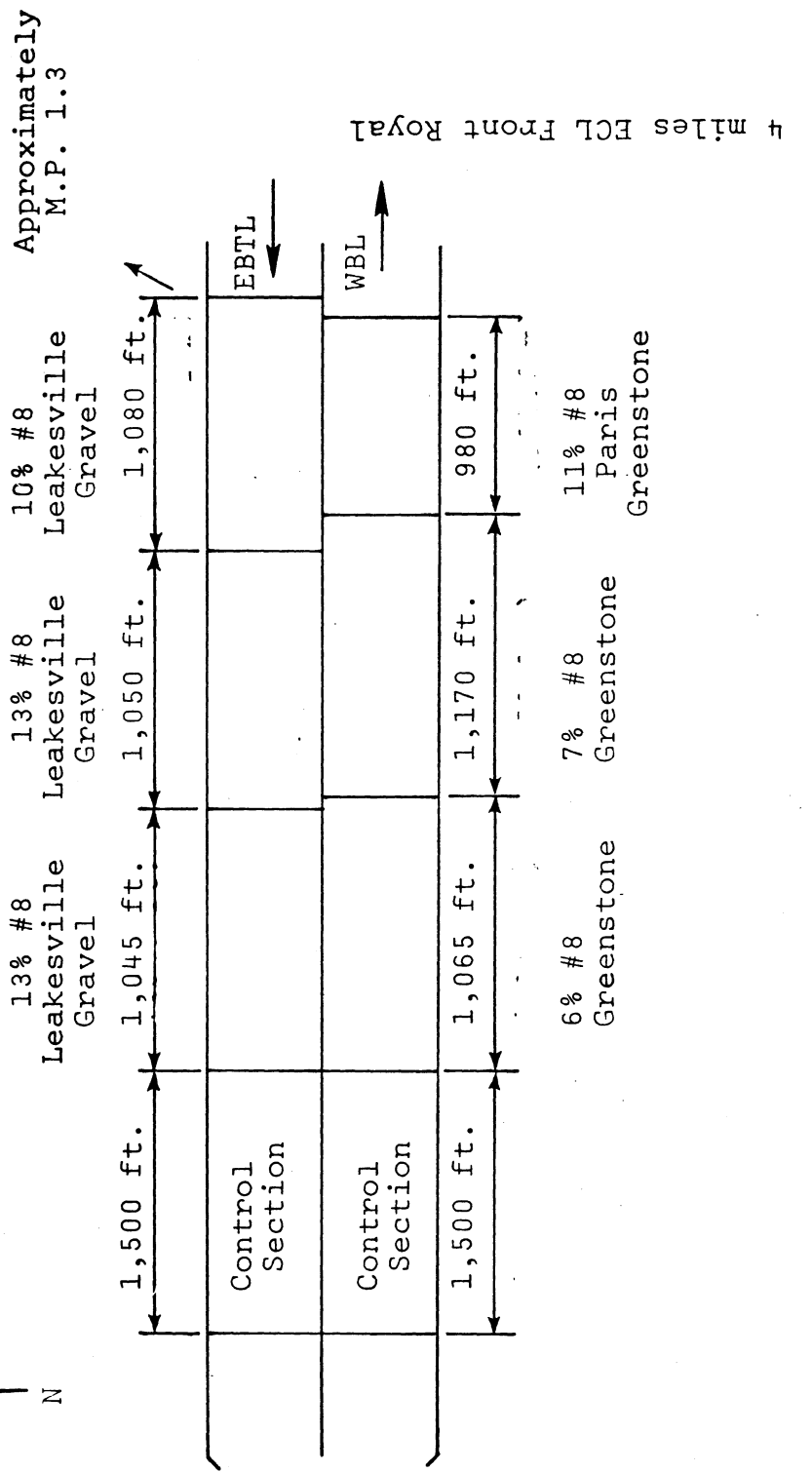
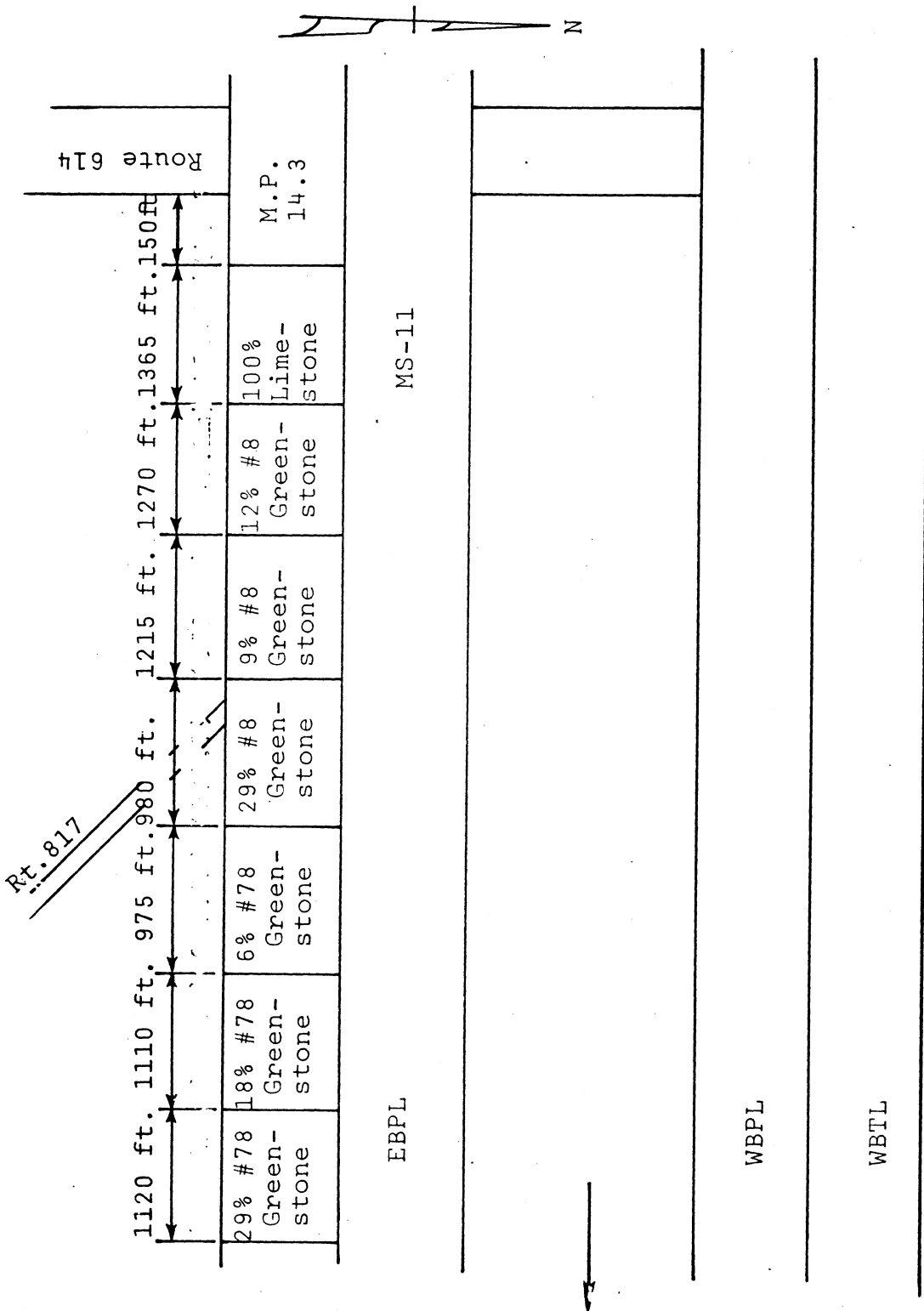


Figure 1. Route 55 -- Warren County.

(1 foot = .304 m)

(1 mile = 1.6 km)

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Approximately 6 miles to Winchester

Figure 2. Route 50 — Frederick County.
 (1 foot = .304 m).
 (1 mile = 1.6 km)

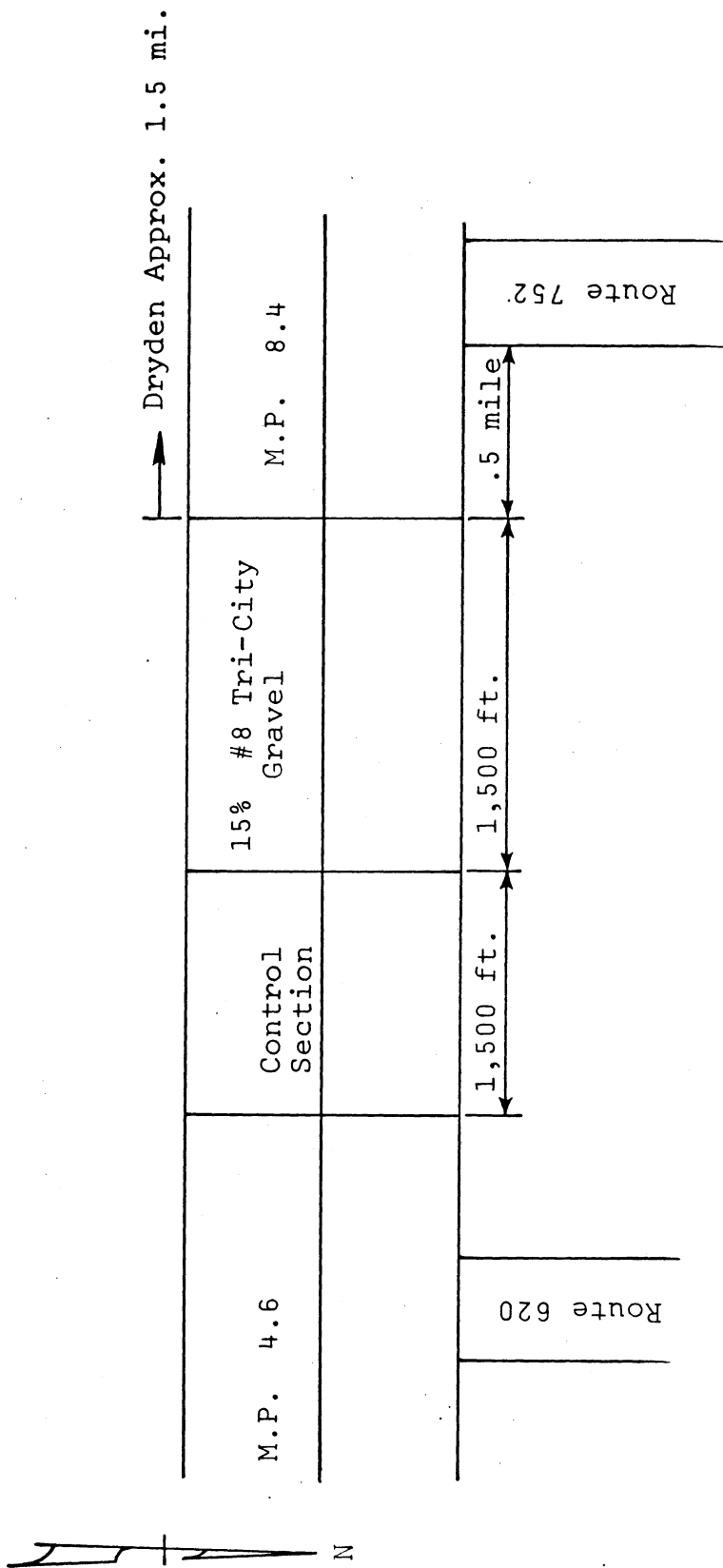


Figure 3. Route A-58 - Lee County.
 (1 foot = .304 m).
 (1 mile = 1.6 km)

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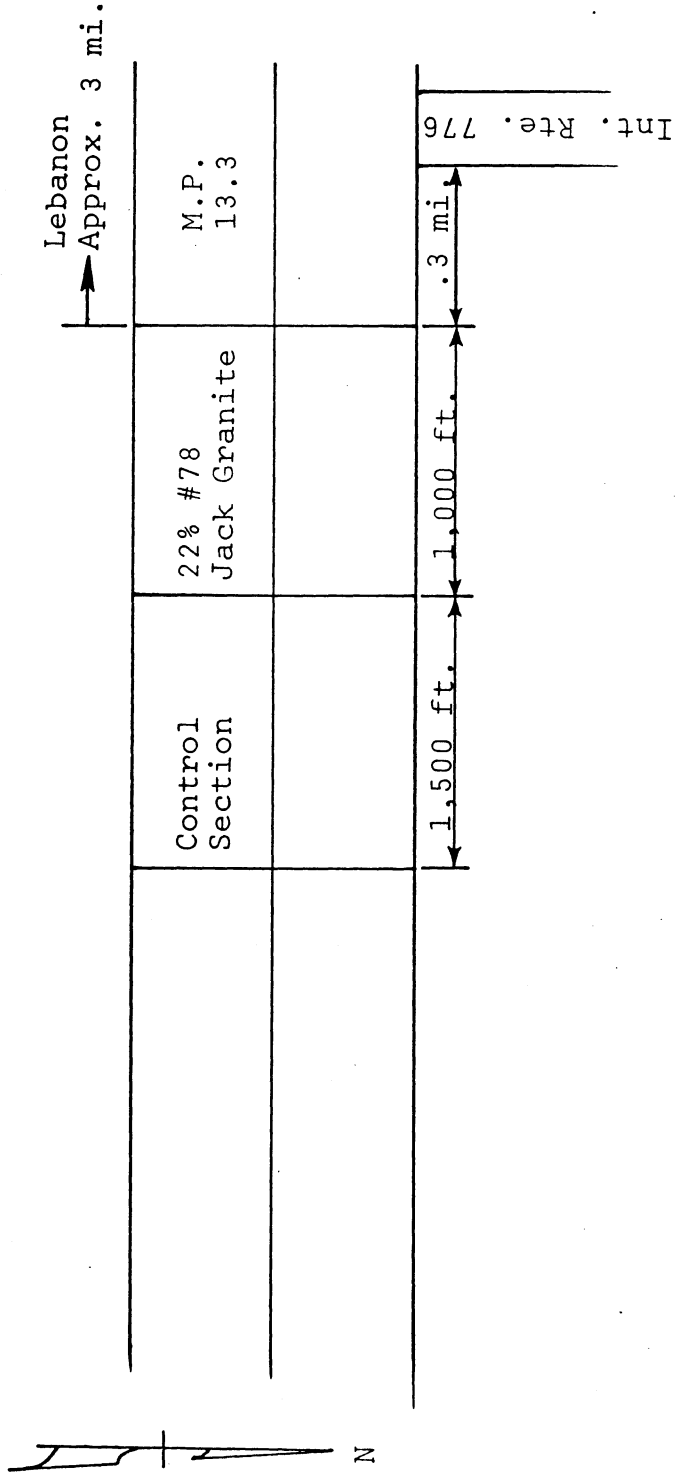


Figure 4. Route 19 - Russell County.
 (1 foot = .304 m)
 (1 mile = 1.6 km)

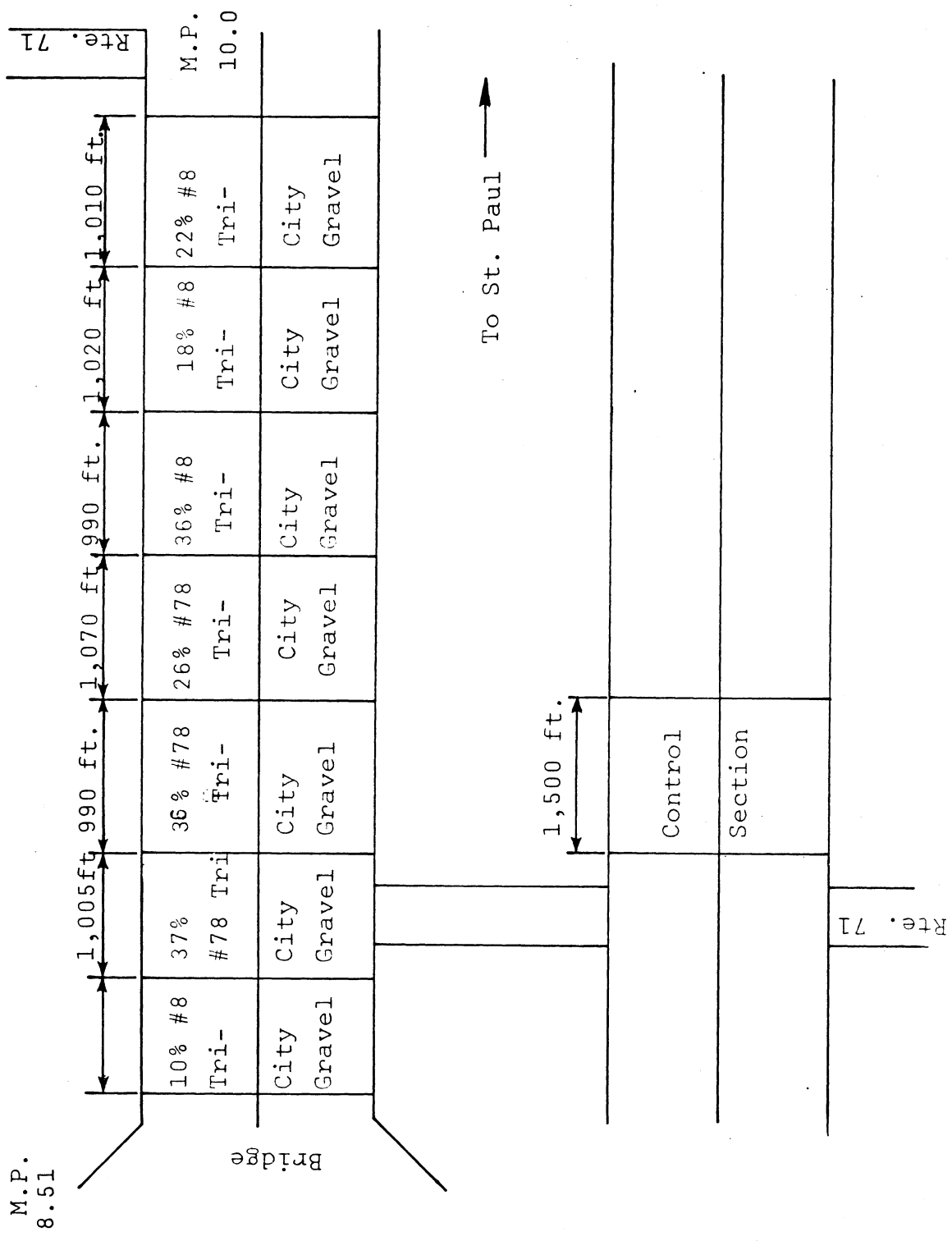


Figure 5. Route A-58 - Russell County.
 (1 foot = .304 m)
 (1 mile = 1.6 km)

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