FINAL REPORT

SAMPLING PLAN FOR PAVEMENT CONDITION RATINGS
OF SECONDARY ROADS

by

R. R. Long, Jr.
Research Assistant

(The opinions, findings, and conclusions expressed in this
report are those of the author and not necessarily those of
the sponsoring agencies.)

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SUMMARY

The purpose of this project was to develop a random sampling plan for use in selecting segments of the secondary highway system for evaluation under the Department's PMS. The plan developed is described here. It is a simple, workable, random sampling plan that will select a 5% cross section of secondary roads on a per county basis and also yield condition rating forms for each roadway section. The condition surveys of the 5% sample can be used to evaluate the condition of the entire secondary system.

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INTRODUCTION

Over the last few years, a great deal of effort has gone into the development and implementation of a pavement management system (PMS) for use by the Department of Highways and Transportation in planning major highway maintenance activities. Essentially, the PMS permits managers to evaluate the service conditions of roadways and establish priorities for needed pavement maintenance within existing budgetary constraints. The service conditions are determined by visual inspections and measurements of ride quality recorded on standard rating forms.

The PMS shows a great deal of promise and is being implemented for use on the state's flexible interstate and primary roads. For the interstate and primary roads, condition ratings have been made and processed. To complete the system, a scheme for evaluating the secondary roads has been devised and is being implemented. Because of the limited mileage they comprise, all interstate (1,013 mi.) and all primary (7,896 mi.) roads will be rated; however, for the extensive secondary system (comprising 31,450 mi.) only selected segments can feasibly be rated. (Note: The mileage totals listed are hard-surface roads only and are taken from the Department's December 31, 1982, Mileage Tables.) Under this approach, a method of randomly selecting the segments for evaluation has been devised.

PURPOSE AND SCOPE

The purpose of this project was to develop a random sampling plan for use in selecting segments of the secondary highway system for evaluation under the Department's PMS. Upon completion of the evaluations of these segments, management will have in hand information needed to project needed levels of funding for maintenance on the whole secondary system. Implementation of this plan will complete the pavement service condition evaluation portion of the Department's PMS for flexible pavements.

APPROACH

A computer program has been developed that will randomly sample 5% of the secondary highway system as reported in the secondary system road inventory. A 5% sample size was selected because it would yield a small enough number of sections to realistically permit annual or biennial ratings. Also this sample size would permit statistically valid interpretations to be drawn. Standard rating forms have been devised for the selected sections. Upon evaluation of these sections, the service condition of the secondary highway system can be extrapolated.

BACKGROUND

The data base for this project has been drawn from the Virginia Department of Highways and Transportation Road Inventory Mileage Records – Secondary System (T & S 5-1). The sections of roadway to be evaluated have been selected as listed in this file. Based on the selection criteria established, it has been determined that the only restriction necessary is that the sections be hard-surfaced. Further, it has been decided that dividing the sections into groups based upon daily traffic volumes will ensure the most representative sampling approach. The groups in Table 1 have been established.

Table 1

Traffic Groupings

Traffic Group	Traffic Volume (ADT)
1	0 – 100
2	101 – 300
3	301 – 750
4	751 – 1,500
5	1,501 – 4,500
6	4,500 and up

Note: These groupings are based on an "average" distribution of roadway sections so as to most evenly divide the sections.

SAMPLING PLAN

Following is a description of the execution of the sampling plan by the computer. (See Figure 1 for flowchart.)

1. Scan the file and select all hard-surfaced sections (i.e., eliminate all non-hard-surfaced sections from the list). As these sections are selected, assign a code consisting of the section's traffic group and a random number which is generated using a random number generating routine.

2. Sort the sections by traffic group and list in ascending order by random number.

3. Total the mileage for each traffic group. Compute 5% of each total to represent the minimum mileage "limit" to be sampled.

4. Select the sections to be evaluated by listing the sections in order for each traffic group and accumulate the lengths until the 5% mileage "limit" is reached. (Note: Since the section lengths are so variable, the accumulation of sections seldom yields the limit exactly—usually the total is greater than the limit; e.g., if 5% of the mileage is 10 miles and the accumulated mileage is 9.0, and the next section is 2 miles, then the section will be included in order to total the mileage to the 5% limit, but the total mileage will be 11 miles instead of 10.)

5. Resort the selected sections and list by district, county, route, and section number. Include the most pertinent information for the section listings from the Road Inventory (e.g., termini, length, pavement type, number of lanes, ADT, etc.). See Figure 2.

6. Produce rating forms from the sample listings for each section by county and compile by district. See Figure 3.

The sampling plan has been pilot tested in the Lynchburg District, where the secondary roads in Amherst County were successfully sampled and evaluated. The plan is being implemented and will be performed on a biennial basis upon completion of the first ratings.
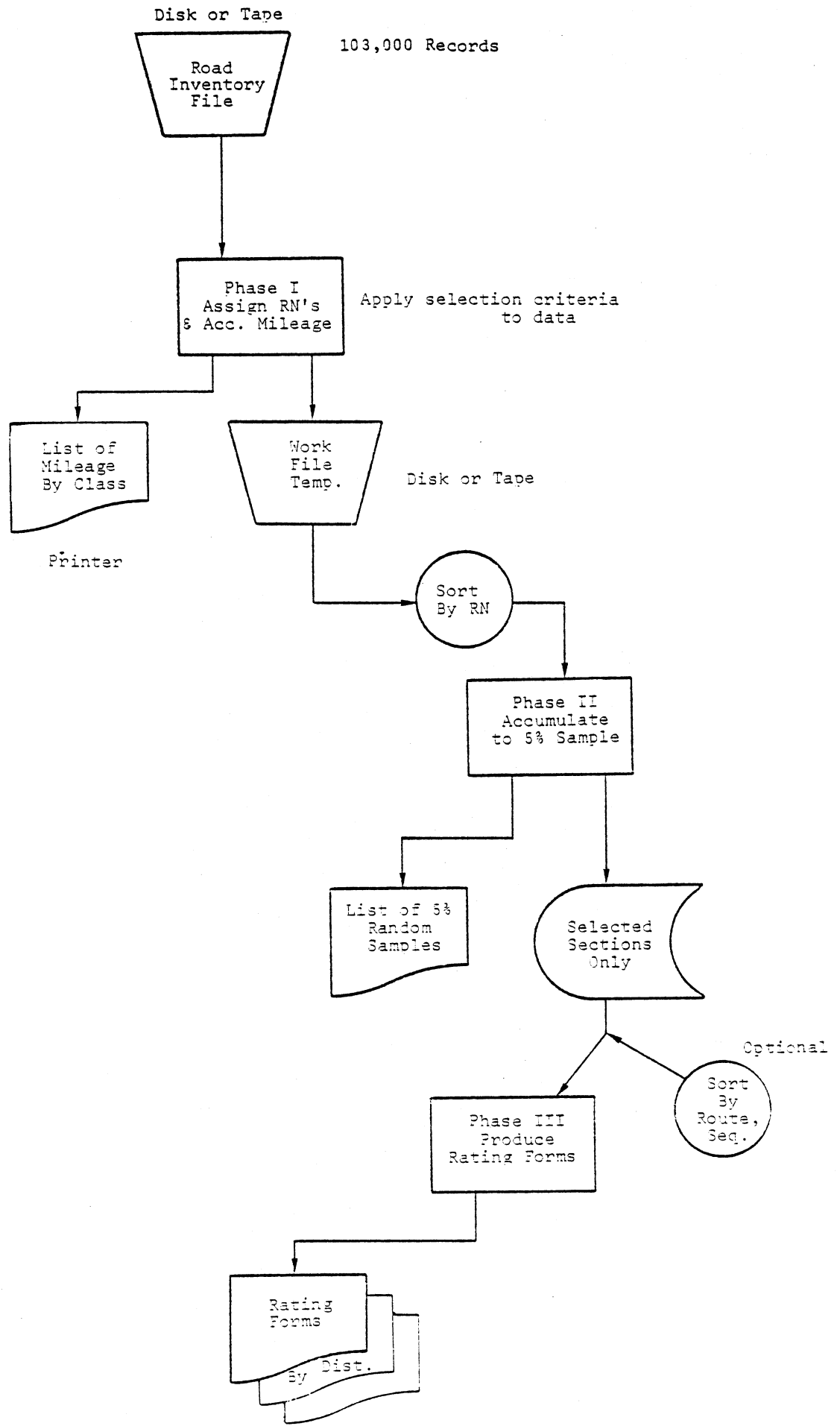
Figure 1. Input/Output flowchart for secondary system random sampling plan.

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F20-2808-02					VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION				12-01-83		
					SECONDARY SYSTEM PAVEMENT MANAGEMENT DATA						
					LIST OF RANDOM SAMPLES BY CLASS						

DCO-CTTY	RTE	SEU	TERMINI		LENGTH	PW,SW,PI,KH,LN	ADT	M.P.-TO-M.P.		RN	CLASS	LENG.	BY-CL	BY-CO
305	1066	005	RT 1030	08ME RT 1030	8	(20,04,46,20,00)	47	0.0	0.08	115	1	0.08	0.08	0.08
305	1302	005	E RT 1301	15MNW RT1301	15	(20,07,42,20,00)	94	0.0	0.15	117	1	0.15	0.23	0.23
305	652	070	S RT 787	DEAD END	100	(20,05,42,20,00)	63	4.84	5.84	117	1	1.00	1.23	1.23
305	684	005	RT. 685	162MN RT 685	162	(18,04,42,20,00)	43	0.0	1.62	118	1	1.62	2.85	2.85
305	1091	015	RT 1056	DEAD END	10	(10,01,42,20,00)	70	0.15	0.25	119	1	0.10	2.95	2.95
305	1355	005	RT 1341	CUL DE SAC	7	(20,06,42,20,00)	20	0.0	0.07	120	1	0.07	3.02	3.02
305	739	040	013 MEPT 65A	RT 50A	17	(16,05,42,20,00)	241	3.12	3.39	115	2	0.17	0.17	3.19
305	666	020	12MMN RT 69A	RT 630	5	(18,06,42,20,00)	240	2.60	2.65	115	2	0.05	0.22	3.24
305	636	040	RT 653	RT 638	270	(16,02,42,20,00)	255	3.47	6.17	115	2	2.70	2.92	5.94
305	739	030	121MF RT 822	RT 656	55	(14,04,42,20,00)	299	2.44	2.99	116	2	0.55	3.47	6.49
305	1027	005	RT 622	RT 29 RAMP	40	(12,02,47,20,00)	144	0.0	0.40	117	2	0.40	3.87	6.89
305	1021	010	RT 1006	W RT 1007	5	(12,02,42,20,00)	264	0.20	0.25	117	2	0.05	3.92	6.94
305	705	005	W RT 130	RT 730	10	(12,03,42,20,00)	148	0.0	0.10	117	2	0.10	4.02	7.04
305	1005	010	RT 1017	RT 1018	6	(12,03,42,20,00)	150	0.06	0.12	118	2	0.06	4.08	7.10
305	731	015	49ME RT 825	62MSE RT 825	13	(22,07,42,20,00)	242	0.88	1.01	118	2	0.13	4.21	7.23
305	612	005	RT 151	S RT 611	20	(14,02,42,20,00)	119	0.0	0.20	118	2	0.20	4.41	7.43
305	1202	030	RT 1207	RT 1205	10	(16,02,42,20,00)	235	0.48	0.58	119	2	0.10	4.51	7.53
305	621	020	025MW RT 713	RT 625	265	(16,02,42,20,00)	182	0.55	3.20	120	2	2.65	7.16	10.18
305	629	005	RT 666	RT 723	150	(16,04,42,20,00)	168	0.0	1.50	120	2	1.50	8.66	11.68
305	635	015	RT 702	30 MN RT 702	30	(20,05,42,20,00)	505	0.10	0.40	115	3	0.30	0.30	11.98
305	663	005	N INT RT 29	115MS RT 29	115	(14,01,42,20,00)	365	0.0	1.15	115	3	1.15	1.45	13.13
305	604	050	01MN RT 6633	N RT 643	56	(14,03,42,20,00)	478	3.13	3.69	116	3	0.56	2.01	13.69
305143	1103	005	RT 29 BUS	NCL AMHERST	45	(20,04,42,20,00)	452	0.0	0.45	117	3	0.45	2.46	14.14
305	1063	005	RT 1049	RT 1062	9	(20,04,46,20,00)	467	0.0	0.09	119	3	0.09	2.55	14.23
305	1028	005	RT 1040	11MN RT 1040	11	(14,04,42,20,00)	457	0.0	0.11	119	3	0.11	2.66	14.34
305	635	100	RT 688	E RT 60	172	(16,04,42,20,00)	312	8.99	10.71	120	3	1.72	4.38	16.06
305	645	005	RT 29 BUS	RT 643	83	(22,02,42,20,00)	1470	0.0	0.83	117	4	0.83	0.83	16.89
305	681	020	W RT 1046	E RT 1046	15	(24,07,43,20,00)	2389	0.66	0.81	116	5	0.15	0.15	17.04
305	1006	020	N RT 1022	S RT 1022	3	(24,83,37,20,00)	1766	0.17	0.20	119	5	0.03	0.18	17.07
305	766	005	RT 29	RT 643	15	(20,02,42,20,00)	2201	0.0	0.15	119	5	0.15	0.33	17.22
305	677	075	RT 809	01MS RT 909	1	(24,04,42,20,00)	1995	3.35	3.36	120	5	0.01	0.34	17.23
305	833	035	RT 1067	RT 1045	3	(18,03,52,20,00)	1602	0.74	0.79	121	5	0.03	0.37	17.26
305	766	015	RT 684	RT 1326	11	(20,02,62,20,00)	2144	1.01	1.12	131	5	0.11	0.48	17.37
305	669	005	RT 29	RT 789	25	(14,02,62,20,00)	2302	0.0	0.25	131	5	0.25	0.73	17.62
305	622	020	11ME RT 1042	W RT 833	7	(24,07,62,20,00)	4635	0.60	0.67	133	6	0.07	0.07	17.69

Figure 2. Selected sections in Amherst County - 1st run.
(For an explanation of the coding - see
Appendix A.)

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~1?04   DATE 12-01-83
                                               PAGE   1

SECTION LOCATION AND DESCRIPTION
  SYSTEM   SECONDARY | MILE POST   DESC.
  DISTRICT   LYNCHBURG | BEG.   0.00   RT 1030
  RESIDENCY   AMHERST | END   0.08   08ME RT 1030
  COUNTY   AMHERST |LENGTH 0.05

  ROUTE   1066   DIRECTION   ALL LANES
  HWY TYPE: TWO LANE

  PAVEMENT WIDTH = 20
  SHOULDER WIDTH = 04

  SURFACE TYPE -
     LIGHT BITUMINOUS TREATMENT
  BASE TYPE -
     T & MACADAM, CRUSHED AGGREGATE, GRADED AGG. BASES

            (1-22)
  322051066   0   800   SURVEY DATE ___-___-___   (23-28)
  ....1.........2..
                    FREQUENCY   SEVERITY   FRE SEV

                |---|---|---|---| |---|---|---| |---|---|
  CRACKING | N | R | O | F | | N | S | V | | | | (29-30)
                |---|---|---|---| |---|---|---| |---|---|
  RUTTING | N | R | O | F | | N | S | V | | | | (31-32)
                |---|---|---|---| |---|---|---| |---|---|
  PUSHING | N | R | O | F | | N | S | V | | | | (33-34)
                |---|---|---|---| |---|---|---| |---|---|
  RAVELLING | N | R | O | F | | N | S | V | | | | (35-36)
                |---|---|---|---| |---|---|---| |---|---|
  PATCHING | N | R | O | F | | N | S | V | | | | (37-38)
                |---|---|---|---| |---|---|---| |---|---|

  RIDING SURFACE ___ (39-40)

  REMARKS _____
                            (41-120)

Figure 3. Rating form for visual inspection of pavement.
           (Section shown is first one listed in Figure 2.)

DISCUSSION

Only one change has been made in the original sampling plan. At
first, only roads numbered 600 - 999 were to be sampled. This
eliminated school roads, subdivision roads, park entrances, etc., all of
which were not deemed important to achieving the overall goal of
sampling the condition of the secondary road system. It was pointed
out, however, that these roads are part of the secondary system and
deletion of them would, in effect, prevent the selection of a truly
representative sample. Also, by not including routes greater than 999,
the plan essentially biased the data base and thus diminished the
randomness of the sample. This problem was easily overcome by including
all roadway sections as listed in the inventory. No other real problems
were encountered.

The lengths of very short sections were discussed as possibly being
cause for concern. Some sections in the inventory are very short (a few
hundredths of a mile long). Sections of this size could present some
problems for the condition rating teams, because it is extremely diffi-
cult to accurately assess the ride quality of sections this size.
However, eliminating sections under a certain length from consideration
would also bias the data base (even more so in this case), and reduce
the randomness of the selection process. So, it was decided that very
short sections would be included and dealt with on a individual basis
with the ratings being left to the judgment of the raters.

To examine the sampling plan in operation, the pilot run in Amherst
County was made on the sections of road shown in Figure 2.

The best way to statistically evaluate the usefulness of this plan
in presenting an accurate picture of the service condition of all
secondary roads is to assess just how random the selection process
really is. Obviously, the more random the process, the more representa-
tive the sample is of the whole system.

Figure 4 and Figures 4a - 4f show the selected sections plotted on
a map of Amherst County. This map illustrates the random nature of the
selection process, and an examination of this may raise questions about
the "scatter" of the sections. It should be kept in mind, however, that
roadway sections in the higher traffic volumes will naturally cluster
around urban centers. Since Amherst County is relatively rural, the
selected sections tend to concentrate around Lynchburg. So, this
particular plot is a good one and clearly illustrates a random sample.

Further verification of the random nature of the sampling plan was
gained by making a second run on Amherst County and comparing the
results to those of the first. The second set of selected sections
(Figure 5) was composed of 45 sections, whereas the first run yielded

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35. Between the two runs, only 1 section was duplicated. This equates to a rate of about 2.5% recurrence, which, considering the total number of sections involved, is very good.

CONCLUSION

The purpose of this project has been fulfilled. A simple, feasible, valid random sampling plan has been developed for selecting 5% of the secondary road system and is being implemented. An evaluation of the ratings made on these selected sections can be extrapolated to confidently assess the service condition of the entire secondary system. Upon completion of this process, all the service condition information for all state maintained flexible roads will be complete and ready for evaluation under the Department's pavement management system.

ACKNOWLEDGEMENT

The author gratefully acknowledges the contributions of A. D. Newman, pavement management engineer, who provided background information and assisted in establishing the pavement section selection criteria, and C. S. Taylor of Information Systems who was in charge of the programming and coding. Without their assistance, completion of this project would not have been possible.
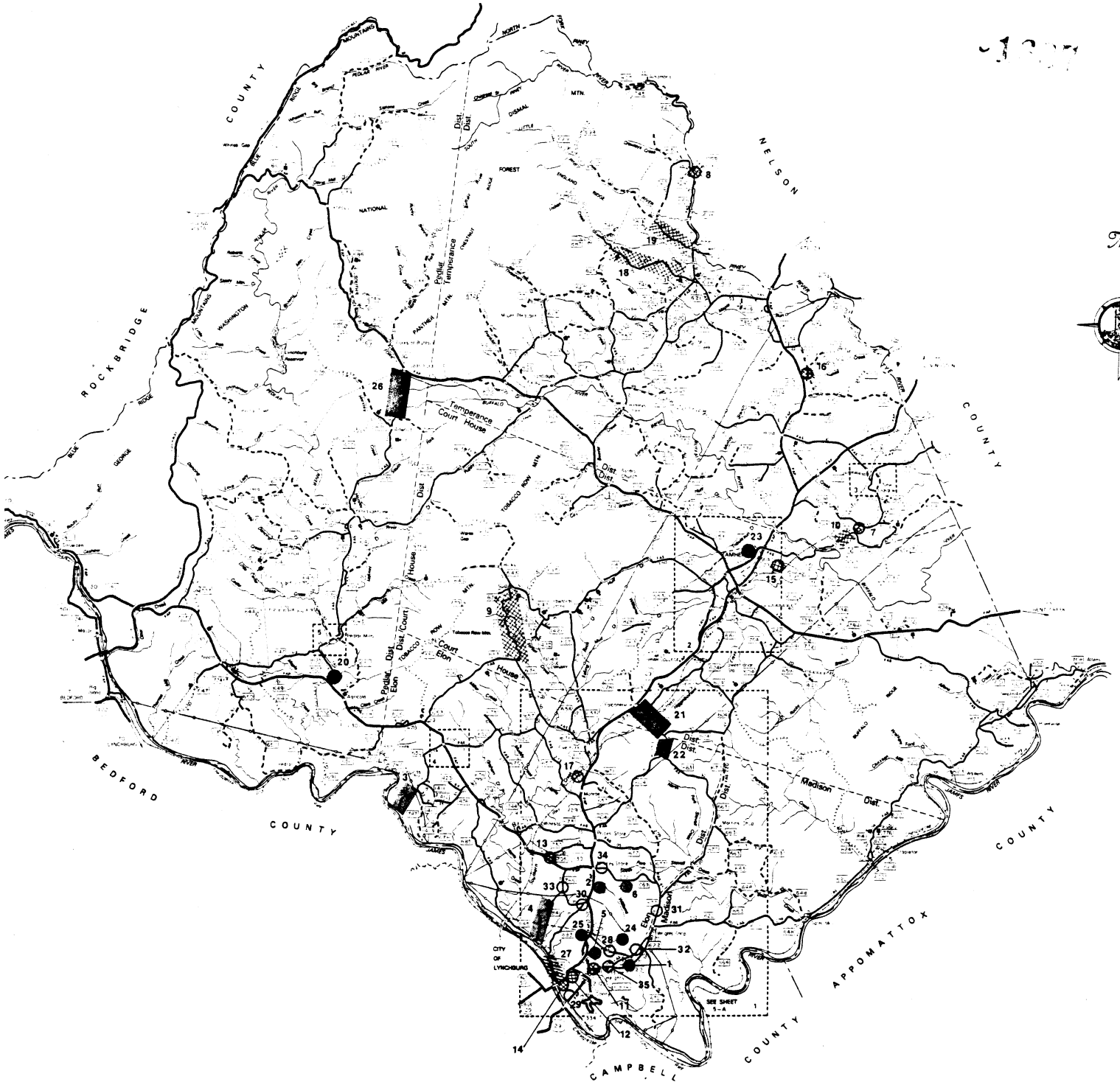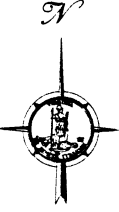
Figure 4. Locations of selected sections.

SECONDARY SYSTEM PAVEMENT M

LIST OF RANDOM SAMPLES

DCU-CITY	SELECTED SECTIONS	RTE	SEQ	TERMINI		LENGTH	PW,SW,PT,KH,LN
305	1	1066	005	RT 1030	08ME RT 1030	8	(20,04,46,20,00)
305	2	1302	005	F RT 1301	15MNW RT1301	15	(20,07,42,20,00)
305	3	652	070	S RT 787	DEAD END	100	(20,05,42,20,00)
305	4	684	005	RT 685	162MN RT 685	162	(18,04,42,20,00)
305	5	1001	015	RT 1036	DEAD END	10	(10,01,42,20,00)
305	6	1355	005	RT 1341	CUL DE SAC	7	(20,06,42,20,00)
305	7	739	040	013 MERT 658	RT 608	17	(16,05,42,20,00)
305	8	606	020	120MN RT 698	RT 630	5	(18,06,42,20,00)
305	9	636	040	RT 653	RT 638	270	(16,02,42,20,00)
305	10	739	030	121MF RT 822	RT 658	55	(14,04,42,20,00)
305	11	1027	005	RT 622	RT 29 RAMP	40	(12,02,47,20,00)
305	12	1021	010	RT 1006	N RT 1007	5	(12,02,42,20,00)
305	13	705	005	N RT 130	RT 730	10	(12,03,42,20,00)
305	14	1005	010	RT 1017	RT 1018	6	(12,03,42,20,00)
305	15	751	015	49ME RT 825	62MSE RT 825	13	(22,07,42,20,00)
305	16	612	005	RT 151	S RT 611	20	(14,02,42,20,00)
305	17	1202	030	RT 1207	RT 1205	10	(16,02,42,20,00)
305	18	621	020	025MW RT 713	RT 625	205	(16,02,42,20,00)
305	19	629	005	RT 660	RT 723	150	(16,04,42,20,00)
305	20	635	015	RT 702	30 MN RT 702	30	(20,05,42,20,00)
305	21	663	005	N INT RT 29	115MS RT 29	115	(14,01,42,20,00)
305	22	604	050	01MN RT 663S	N RT 663	56	(14,03,42,20,00)
305163	23	1103	005	RT 29 BUS	NCL AMHERST	45	(20,04,42,20,00)
305	24	1063	005	RT 1049	RT 1062	9	(20,06,46,20,00)
305	25	1028	005	RT 1040	11MN RT 1040	11	(18,04,42,20,00)
305	26	635	100	RT 688	E RT 60	172	(16,04,42,20,00)
305	27	685	005	RT 29 BUS	RT 683	83	(22,02,42,20,00)
305	28	681	020	W RT 1046	E RT 1046	15	(24,07,63,20,00)
305	29	1006	020	N RT 1022	S RT 1022	3	(24,03,47,20,00)
305	30	766	005	RT 29	RT 683	15	(20,02,62,20,00)
305	31	677	075	RT 809	01MS RT 809	1	(22,04,42,20,20)
305	32	833	035	RT 1067	RT 1045	3	(18,03,52,20,00)
305	33	766	015	RT 684	RT 1326	11	(20,02,62,20,00)
305	34	669	005	RT 29	RT 789	25	(18,02,42,20,00)
305	35	622	020	11ME RT 1042	W RT 833	7	(24,07,62,20,00)

Groups ① ② ③ ④ ⑤ ⑥ mark section bands as shown at left.

Traffic Groups

Group		Traffic Volume (ADT)
1	⬤	0 – 100
2	⬤	101 – 300
3	⬤	301 – 750
4	⬤	751 – 1500
5	○	1501 – 4500
6	⬤	4501 – →

Figure 4a. Map key for selected sections.

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Figure 4b. Location of supplements.

Figure 4c. Supplement AA.

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Figure 4d. Supplement BB.

Figure 4e. Supplement CC.

Figure 4f. Supplement DD.

F2n-2808-02   VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION   12-01-85
                                       SECONDARY SYSTEM PAVEMENT MANAGEMENT DATA
                                          LIST OF RANDOM SAMPLES BY CLASS

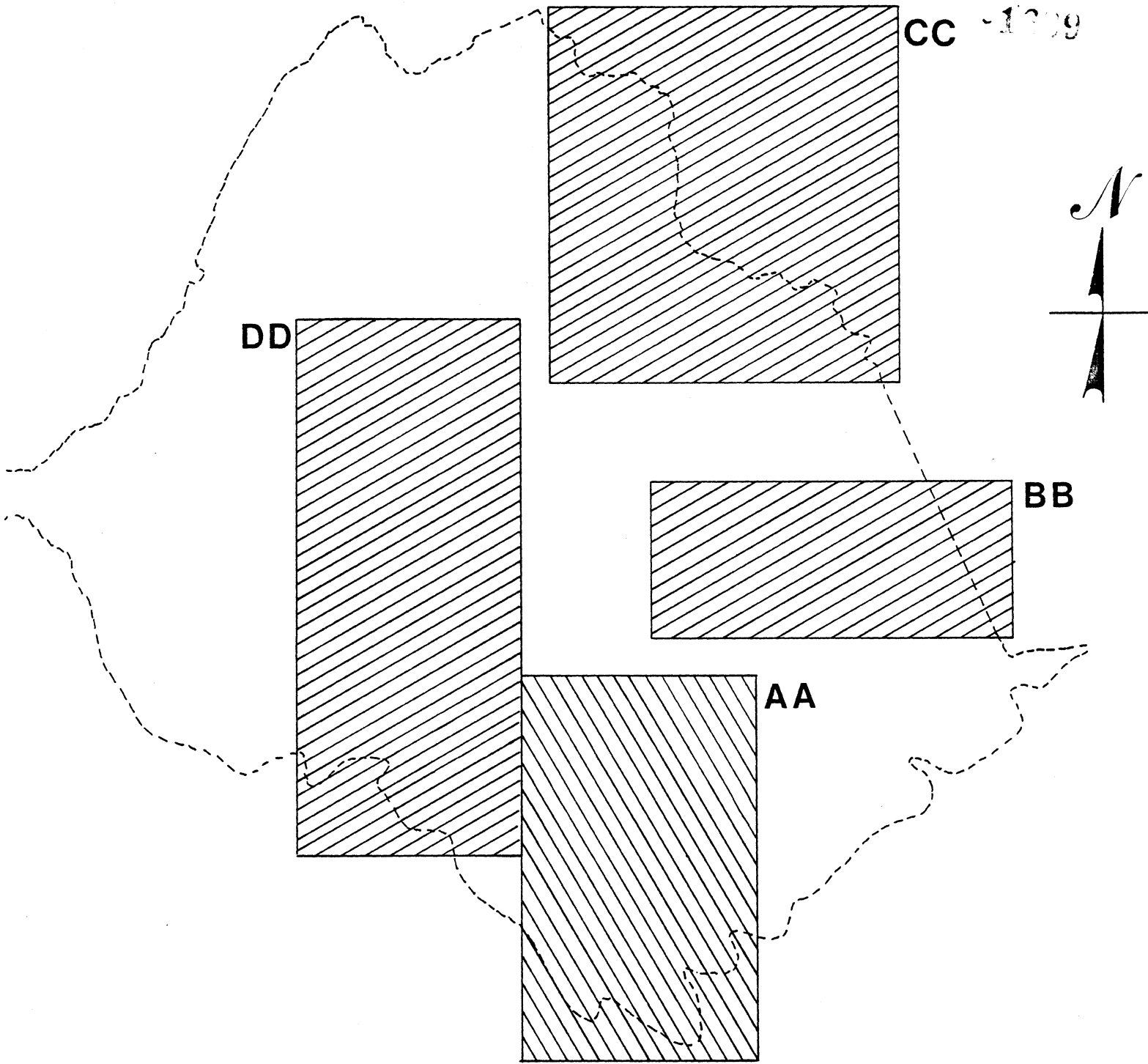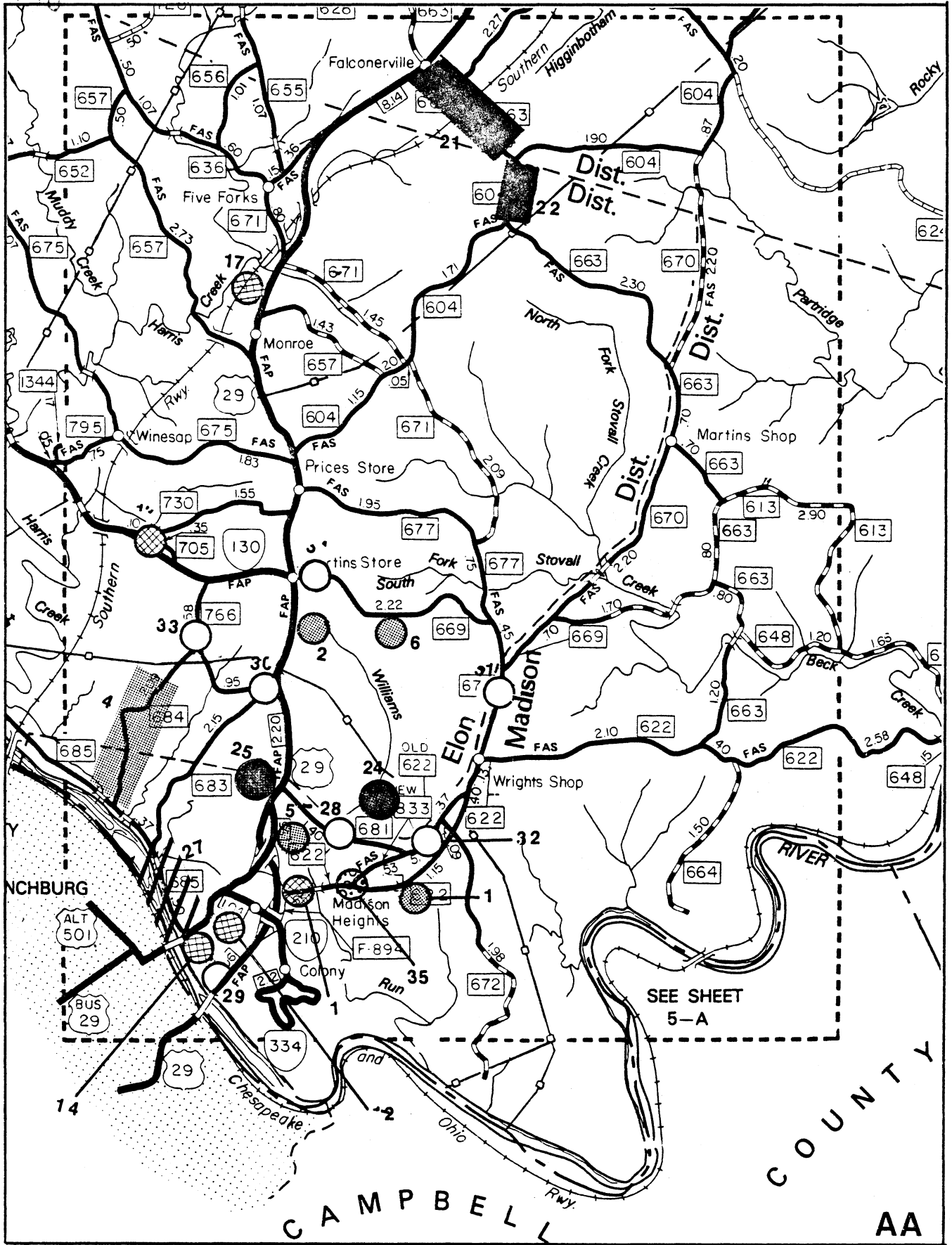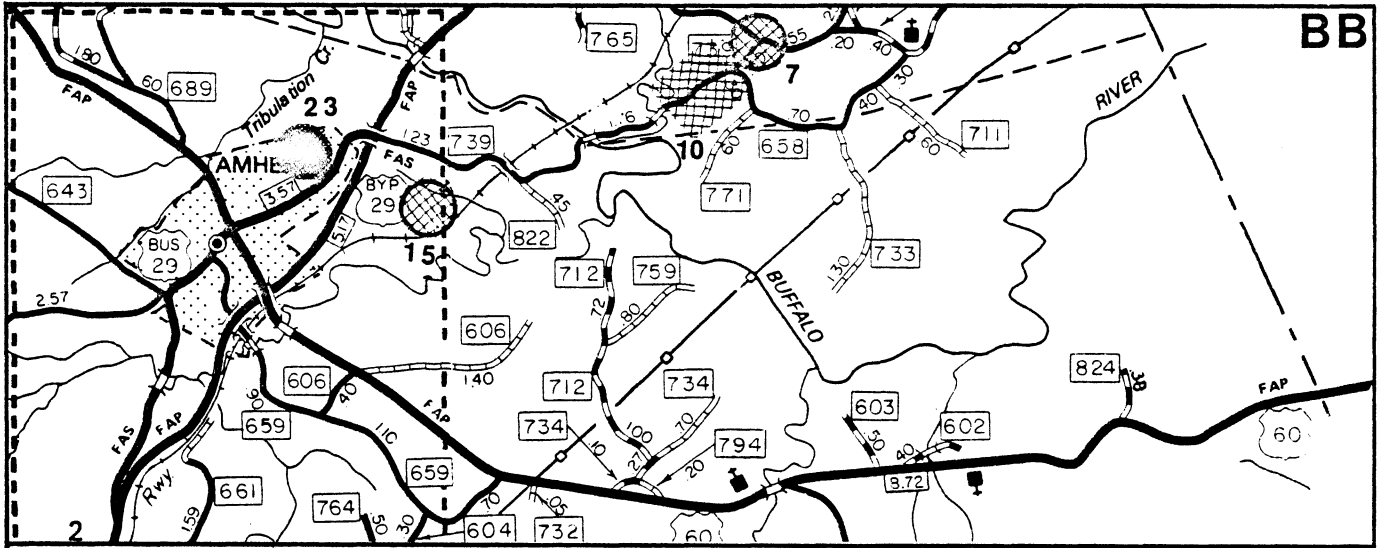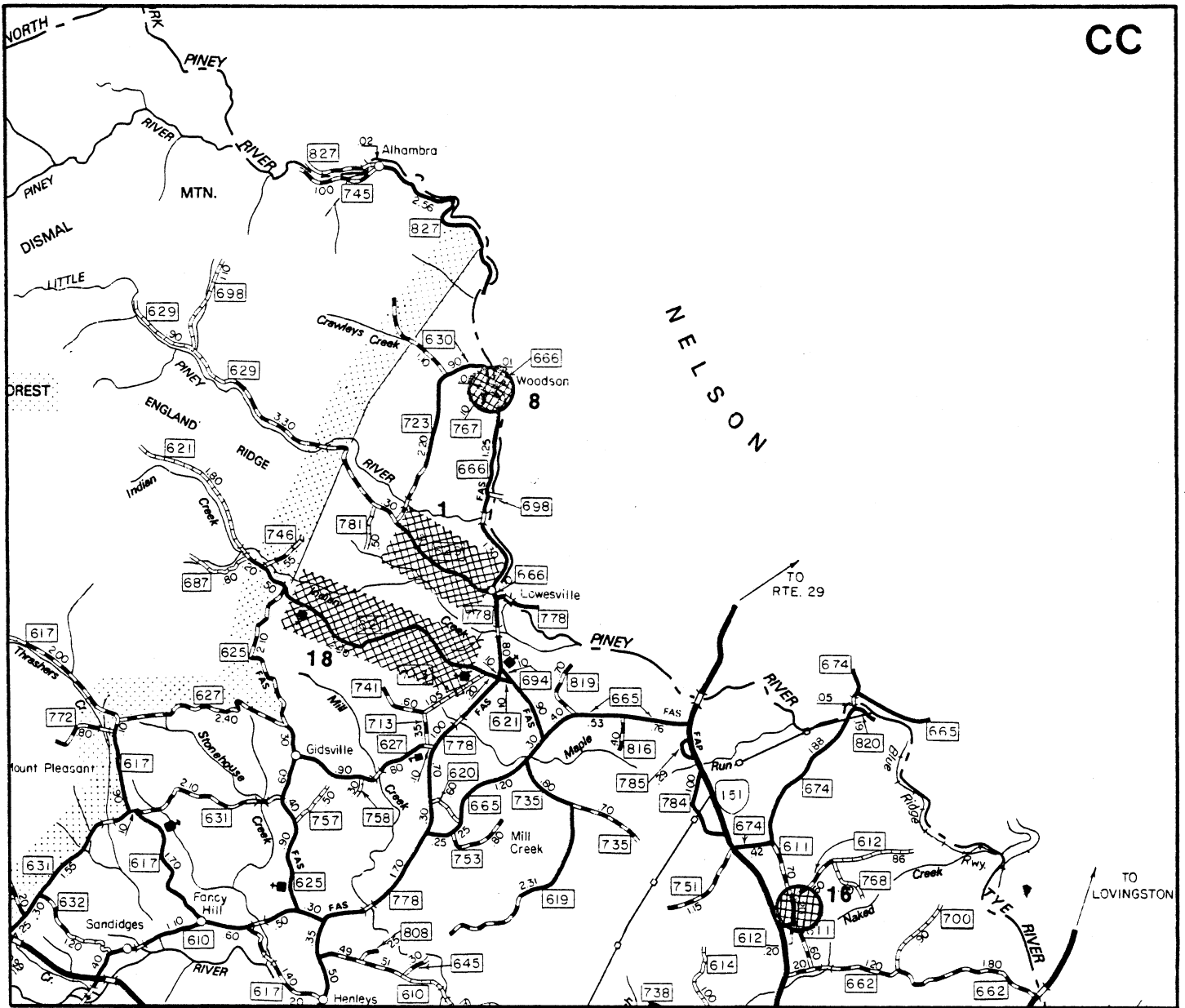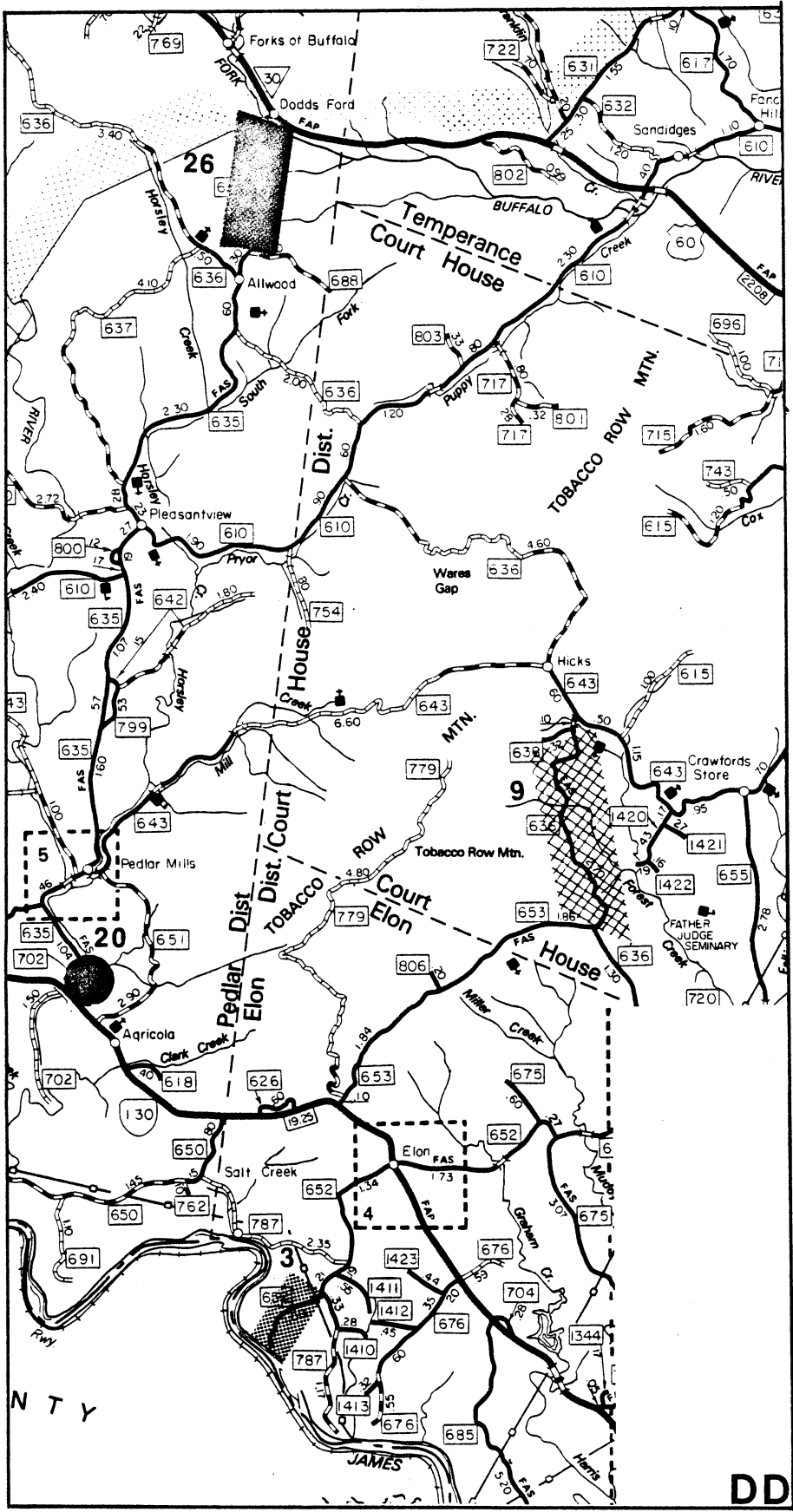| DCO-CITY	RTE	SEG	TERMINI		LENGTH	RN,SH,PT,KH,LN	ADT	M.P.-TO-M.P.		RN CLASS	LENG.	BY-CL	BY-CO.
305163	1119	005	RT 29 BUS	RT 60	28	(12,04,42,20,00)	51	0.0	0.28	115	1	0.28	0.28	0.28
305	650	010	RT 767	RT 723	48	(16,05,42,20,00)	67	0.06	0.26	117	1	0.20	1.18	1.18
305	1043	005	RT 1034	10ME RT 1034	10	(18,04,52,20,00)	66	0.0	0.10	117	1	0.10	1.28	1.28
305	1042	005	RT 622	DEAD END	10	(16,04,42,20,00)	52	0.0	0.10	117	1	0.10	1.38	1.38
305	1017	020	03ME RT1005	RT 1005	3	(12,02,82,20,00)	83	0.12	0.15	118	1	0.03	1.41	1.41
305	715	005	RT 60	RT 696	47	(14,04,42,20,00)	94	0.0	0.47	118	1	0.47	1.88	1.88
305	1060	005	RT 1030	20MS RT 1040	20	(20,04,46,20,00)	66	0.0	0.20	118	1	0.20	2.08	2.08
305	1335	005	RT 1334	S CUL DESAC	10	(20,05,42,20,00)	66	0.0	0.10	118	1	0.10	2.18	2.18
305	1312	010	RT 1313	10MW RT 1313	10	(20,06,86,20,00)	58	0.11	0.21	118	1	0.10	2.28	2.28
305	1328	005	RT 677	RT 791	13	(20,07,42,20,00)	63	0.0	0.13	119	1	0.13	2.41	2.41
305	672	005	RT 833	09MS RT 833	9	(16,02,42,20,00)	9	0.0	0.09	120	1	0.09	2.50	2.50
305	1021	020	E RT 1007	DEAD END	29	(12,02,42,20,00)	79	0.28	0.52	120	1	0.24	2.74	2.74
305	1026	005	06MW RT 1001	RT 1001	6	(14,02,42,20,00)	89	0.0	0.06	122	1	0.06	2.80	2.80
305	727	005	E RT 130	06MW RT 130	6	(14,06,47,20,00)	66	0.0	0.06	122	1	0.06	2.86	2.86
305	1301	020	RT 1303	08MW RT 1303	8	(20,07,42,20,00)	55	0.14	0.22	122	1	0.08	2.94	2.94
305	1403	005	RT 1401	RT 1402	8	(20,07,42,20,00)	43	0.0	0.08	122	1	0.08	3.02	3.02
305	770	005	RT 661	RT 663	25	(16,02,42,20,00)	269	0.0	0.25	115	2	0.25	0.25	3.27
305	735	005	RT 665	RT 619	80	(14,02,42,20,00)	179	0.0	0.80	115	2	0.80	1.05	4.07
305	739	070	RT 610	NELSON CL	160	(16,01,42,20,00)	173	5.50	7.14	116	2	1.60	2.65	5.67
305	610	185	RT 603	RT 727	166	(16,04,42,20,00)	127	27.62	29.28	116	2	1.66	4.31	7.33
305	635	095	N RT 636	RT 688	27	(14,02,47,20,00)	271	8.72	8.99	117	2	0.27	4.58	7.60
305163	1123	010	RT 1124	RT 1102	5	(20,02,42,20,00)	120	0.00	0.02	117	2	0.03	4.63	7.65
305	1017	010	RT 1007	RT 1006	6	(12,02,42,20,00)	158	0.08	0.10	117	2	0.06	4.69	7.71
305	705 *	005	W RT 130	RT 730	10	(12,02,42,20,00)	148	0.0	0.10	117	2	0.79	4.79	7.81
305	1303	005	RT 1301	DEAD END	23	(20,07,42,20,00)	113	0.0	0.23	118	2	0.23	5.02	8.04
305	622	005	RT 664	RT 608	265	(16,02,42,20,00)	225	4.90	7.55	118	2	2.65	7.67	10.69
305	622	155	E RT 600	TEMP RT 606	42	(22,06,42,20,00)	588	17.08	17.50	115	3	0.42	0.42	11.11
305	1324	005	RT 130	04MSW RT 130	44	(18,06,42,20,00)	328	0.0	0.44	115	3	0.44	0.86	11.55
305	761	020	07MW RT 639	RT 29	1	(20,60,61,20,00)	803	4.28	0.25	115	3	0.01	0.87	11.56
305	761	015	04MW RT 639	07MW RT 639	3	(24,60,61,20,00)	803	0.21	0.24	115	3	0.03	0.90	11.59
305	669	035	RT 1331	RT 1360	7	(16,02,42,20,00)	572	1.31	1.38	115	3	0.07	0.97	11.66
305	792	005	RT 29	RT 1300	30	(20,06,42,20,00)	365	0.0	0.30	116	3	0.30	1.27	11.96
305	622	145	RT 823	W RT 600	73	(22,06,42,20,00)	835	16.33	17.06	116	3	0.73	2.00	12.69
305	635	025	RT 647	W RT 603	49	(18,02,42,20,00)	547	1.11	1.60	117	3	0.49	2.49	13.18
305	1204	010	RT 1202	RT 1208	13	(16,02,47,20,00)	630	6.05	6.18	118	3	0.13	2.62	13.31
305	1336	005	RT 669	RT 1337	6	(20,04,42,20,00)	368	0.0	0.06	120	3	0.06	2.68	13.37
305	605	025	42MS RT 130	39MS RT 130	27	(20,02,42,20,00)	302	2.13	2.40	120	3	0.27	2.95	13.64
305	652	005	RT 1002	N RT 130	29	(20,03,42,20,00)	505	2.81	3.10	120	3	0.29	3.24	13.93
305	652	035	RT 1001	05MW RT 1001	5	(16,03,42,20,00)	661	2.70	2.75	120	3	0.05	3.29	13.98
305	672	010	RT 622	RT 1061	53	(18,02,47,20,00)	368	0.09	0.62	121	3	0.53	3.82	14.51
305	677	055	RT 1350	S RT 669	4	(18,03,42,20,00)	1003	3.01	3.05	116	4	0.04	0.04	14.55
305	823	010	RT 622	121ME RT 622	121	(22,05,62,20,00)	849	0.53	1.74	116	4	1.21	1.25	15.76
305	622	075	11ME RT 677	RT 818	36	(16,03,42,20,00)	1528	2.58	2.94	118	5	0.36	0.36	16.12
305	669	010	RT 789	RT 1314	50	(16,02,42,20,00)	1921	0.25	0.55	118	5	0.30	0.66	16.42
305	622	005	RAMP 29	RT 1027	31	(20,04,52,20,00)	5219	0.0	0.31	152	6	0.31	0.31	16.73

*Only duplicated section.

Figure 5. Selected sections in Amherst County - 2nd run.

APPENDIX

Secondary System 5% Random Sample Output Code

DCO-CITY

Code	District	Code	District
1	Bristol	5	Suffolk
2	Salem	6	Fredericksburg
3	Lynchburg	7	Culpeper
4	Richmond	8	Staunton

Code	County	Code	County
00	Arlington	49	King & Queen
01	Accomack	50	King William
02	Albemarle	51	Lancaster
03	Alleghany	52	Lee
04	Amelia	53	Loudoun
05	Amherst	54	Louisa
06	Appomattox	55	Lunenburg
07	Augusta	56	Madison
08	Bath	57	Mathews
09	Bedford	58	Mecklenburg
10	Bland	59	Middlesex
11	Botetourt	60	Montgomery
12	Brunswick	61	Nansemond
13	Buchanan	62	Nelson
14	Buckingham	63	New Kent
15	Campbell	65	Northampton
16	Caroline	66	Northumberland
17	Carroll	67	Nottoway
18	Charles City	68	Orange
19	Charlotte	69	Page
20	Chesterfield	70	Patrick
21	Clarke	71	Pittsylvania
22	Craig	72	Powhatan
23	Culpeper	73	Prince Edward
24	Cumberland	74	Prince George
25	Dickenson	76	Prince William
26	Dinwiddie	77	Pulaski
28	Essex	78	Rappahannock
29	Fairfax	79	Richmond
30	Fauquier	80	Roanoke
31	Floyd	81	Rockbridge
32	Fluvanna	82	Rockingham
33	Franklin	83	Russell
34	Frederick	84	Scott
35	Giles	85	Shenandoah
36	Gloucester	86	Smyth
37	Goochland	87	Southampton
38	Grayson	88	Spotsylvania
39	Greene	89	Stafford
40	Greensville	90	Surry
41	Halifax	91	Sussex
42	Hanover	92	Tazewell
43	Henrico	93	Warren
44	Henry	95	Washington
45	Highland	96	Westmoreland
46	Isle of Wight	97	Wise
47	James City	98	Wythe
48	King George	99	York

Code	*	City or Town	Code	*	City or Town
140	(95)	Abingdon	196	(25)	Clintwood
160	(01)	Accomac	197	(41)	Clover
161	(12)	Alberta	198	(97)	Coeburn
100	(00)	Alexandria	199	(96)	Colonial Beach
162	(15)	Altavista	106	(20)	Colonial Heights
163	(05)	Amherst	200	(32)	Columbia
164	(97)	Appalachia	201	(87)	Courtland
165	(06)	Appomattox	107	(03)	Covington
166	(42)	Ashland	202	(07)	Craigsville
			203	(67)	Crewe
141	(09)	Bedford	204	(23)	Culpeper
167	(01)	Belle Haven			
168	(21)	Berryville	205	(95)	Damascus
101	(97)	Big Stone Gap	108	(71)	Danville
150	(60)	Blacksburg	206	(82)	Dayton
142	(67)	Blackstone	207	(90)	Dendron
169	(01)	Bloxom	208	(14)	Dillwyn
143	(92)	Bluefield	209	(19)	Drakes Branch
170	(33)	Boones Mill	210	(77)	Dublin
171	(16)	Bowling Green	211	(84)	Duffield
172	(21)	Boyce	212	(76)	Dumfries
173	(58)	Boydton	213	(84)	Dungannon
174	(87)	Boykins			
175	(87)	Branchville	214	(65)	Eastville
176	(82)	Bridgewater	215	(85)	Edinburg
102	(95)	Bristol	216	(82)	Elkton
177	(82)	Broadway	109	(40)	Emporia
178	(12)	Brodnax	217	(65)	Exmore
	(58)	Brodnax			
179	(15)	Brookneal	151	(29)	Fairfax
180	(11)	Buchanan	110	(29)	Falls Church
103	(81)	Buena Vista	144	(73)	Farmville
181	(67)	Burkeville	218	(11)	Fincastle
			219	(31)	Floyd
182	(65)	Cape Charles	145	(87)	Franklin
183	(87)	Capron	111	(88)	Fredericksburg
184	(92)	Cedar Bluff	220	(38)	Fries
185	(19)	Charlotte C. H.	112	(93)	Front Royal
104	(02)	Charlottesville			
186	(58)	Chase City	113	(17)	Galax
187	(71)	Chatham	221	(84)	Gate City
188	(65)	Cheriton	222	(95)	Glade Spring
131	(64)	Chesapeake	223	(81)	Glasgow
189	(86)	Chilhowie	224	(35)	Glen Lyn
190	(01)	Chincotegue	225	(68)	Gordonsville
154	(60)	Christiansburg	226	(81)	Goshen
191	(90)	Claremont	227	(71)	Gretna
192	(58)	Clarksville	228	(82)	Grottoes
193	(83)	Cleveland		(07)	Grottoes
194	(29)	Clifton	229	(13)	Grundy
105	(03)	Clifton Forge			
195	(84)	Clinchport			

Code	*	City or Town	Code	*	City or Town
230	(41)	Halifax	266	(35)	Narrows
231	(01)	Hallwood	267	(65)	Nassawadox
232	(53)	Hamilton	268	(22)	New Castle
114	(27)	Hampton	269	(85)	New Market
115	(82)	Harrisonburg	121	(94)	Newport News
233	(76)	Haymarket	270	(87)	Newsoms
234	(25)	Haysi	271	(84)	Nickelsville
235	(29)	Herndon	122	(64)	Norfolk
236	(53)	Hillsboro	146	(97)	Norton
237	(17)	Hillsville			
			272	(76)	Occoquan
239	(83)	Honaker	273	(01)	Onancock
116	(74)	Hopewell	274	(01)	Onley
331	(71)	Hurt	275	(63)	Orange
240	(38)	Independence	276	(01)	Painter
241	(03)	Iron Gate	277	(06)	Pamplin City
242	(51)	Irvington		(73)	Pamplin City
243	(87)	Ivor	278	(01)	Parksley
			279	(35)	Pearisburg
244	(91)	Jarratt	280	(35)	Pembroke
	(40)	Jarratt	281	(52)	Pennington Gap
245	(52)	Jonesville	123	(26)	Petersburg
			282	(19)	Phenix
246	(01)	Keiler	283	(92)	Pocahontas
247	(55)	Kenbridge	147	(99)	Poquoson
248	(19)	Keysville	284	(16)	Port Royal
249	(51)	Kilmarnock	124	(64)	Portsmouth
	(66)	Kilmarnock	285	(97)	Pound
			125	(77)	Pulaski
250	(58)	La Crosse	286	(53)	Purcellville
251	(12)	Lawrenceville			
252	(83)	Lebanon	287	(76)	Quantico
253	(53)	Leesburg			
117	(81)	Lexington	126	(60)	Radford
254	(54)	Louisa	288	(30)	Remington
255	(53)	Lovettsville	289	(35)	Rich Creek
159	(69)	Luray	148	(92)	Richlands
118	(15)	Lynchburg	127	(20)	Richmond
			290	(44)	Ridgeway
256	(56)	Madison	128	(80)	Roanoke
155	(76)	Manassas	157	(33)	Rocky Mount
152	(76)	Manassas Park	291	(53)	Round Hill
119	(86)	Marion	292	(98)	Rural Retreat
120	(44)	Martinsville			
257	(26)	McKenney	293	(52)	Saint Charles
258	(01)	Melfa	294	(97)	Saint Paul
259	(53)	Middleburg	129	(80)	Salem
260	(34)	Middletown	295	(86)	Saltville
261	(54)	Mineral		(95)	Saltville
262	(45)	Monterey	296	(01)	Saxis
263	(96)	Montross	297	(41)	Scottsburg
264	(82)	Mt. Crawford			
265	(85)	Mt. Jackson			

Code	*	City or Town	Code	*	City or Town
298	(02)	Scottsville	316	(59)	Urbanna
	(32)	Scottsville			
299	(69)	Shenandoah	317	(55)	Victoria
300	(46)	Smithfield	153	(29)	Vienna
130	(41)	South Boston	149	(80)	Vinton
301	(58)	South Hill	318	(41)	Virgilina
302	(39)	Stanardsville	134	(75)	Virginia Beach
303	(69)	Stanley			
132	(07)	Staunton	319	(01)	Wachapreague
304	(34)	Stephens City	320	(91)	Wakefield
305	(91)	Stony Creek	156	(30)	Warrenton
306	(85)	Strasburg	321	(79)	Warsaw
307	(70)	Stuart	322	(78)	Washington
133	(61)	Suffolk	323	(91)	Waverly
308	(90)	Surry	136	(07)	Waynesboro
			324	(84)	Weber City
309	(01)	Tangier	325	(50)	West Point
310	(28)	Tappahannock			
158	(92)	Tazewell	327	(51)	White Stone
311	(30)	The Plains	137	(47)	Williamsburg
312	(82)	Timberville	138	(34)	Winchester
313	(85)	Toms Brook	328	(46)	Windsor
314	(38)	Troutdale	329	(97)	Wise
315	(11)	Troutville	330	(85)	Woodstock
			139	(98)	Wytheville

*Applicable county code shown in parentheses.

CODE	ROUTE NUMBER (RTE)	STATE
Code Direct	3 Coded	0003
	11 Alternate Coded	A011
	250 Bypass Coded	B250
	360 Business Coded	C360 (Commercial Bus.)
	600 Coded	0600
	3015 Coded	3015
	100 Frontage Road Coded	F100
	700 Frontage Road Coded	F700, etc.
	264 Extension Coded	E264

CODE	SEQUENCE NUMBER (SEQ)
Code Direct	10 Coded 010
	20 Coded 020, etc.

CODE	TERMINI - FROM
Code Direct	Limit to 12 characters and spaces
	15 MN Rt 220; 115 MN Rt 360; etc.

CODE	TERMINI - TO
Code Direct	Limit to 12 characters and spaces
	1115 MN 501; 1115 MN 4519; etc.

CODE	LENGTH	
Code Direct	0.03 Mile Coded	00003
	0.15 Mile Coded	00015
	1.76 Mile Coded	00176
	10.13 Mile Coded	01013
	109.25 Mile Coded	10925; etc.

CODE	WIDTH - SURFACE (PW)	
Code Direct	10 Coded	10
	16 Coded	16

For curb and gutter sections show width curb to curb.

CODE	WIDTH - SHOULDER (SW)	
Code Direct	4 Coded	04
	10 Coded	10; etc.

CODE	SURFACE TYPES
A	Unbuilt Mileage
B	Primitive
0	Unimproved
1	Graded and Drained
2	(Reserved for Future Use)
3	Untreated-Soils, Gravels, Stones, etc.
4	Light Bituminous Treatments (Sand and Gravel Treatments)
5	Heavy Bituminous Treatments (M.I.P. & Penetration Treatments)
6	Plant Mix (Bituminous Concrete-Sand Asphalt)
7	Rock and Sheet Asphalt
8	Portland Cement Concrete
9	Stone Block, Brick
C	Cold Mix (Bituminous Treatment)

CODE	BASE TYPES
0	Not applicable, Unknown or Unstabilized
1	Bituminous Concrete (Black Base)
2	Stabilized with Selected Materials (Soil, Gravel, Stone, etc.)
3	Stabilized with Portland Cement (Soil, Gravel, Stone, etc.)
4	Stabilized with Bituminous Material (Soil, Gravel, Stone, etc.)
5	Stabilized with Chemical (Soil, Gravel, Stone, etc.)
6	T. B. Macadam, Crushed Aggregate & Graded Aggregate Bases
7	Penetration Macadam and Water Bound Macadam
8	Portland Cement Concrete
9	Dual Type

USE OF SURFACE AND BASE CODES (PT)

An unimproved road is just what the term implies. It could be best described as a Class 4 Secondary Road that has not been graded, drained, or surfaced. The use of the "0" in the surface type column indicates that it is an unimproved road. Since unimproved roads have no surface, they have no base, and a "0" is used in the base type column for a combination code of "00".

A graded and drained road is also a Class 4 Secondary Road that has been graded and drained, but is unsurfaced. Surface type code "1" is to be used to identify graded and drained roads. As these roads do not have a surface, they have no base, and the "0" is used in the base type column for a combination code of "10".

As these Class 4 (unsurfaced) roads have no surface type they have no surface or shoulder width. Both the surface width and shoulder width should be coded "00".

Both a surface type and surface width should be shown for all other roads.

An untreated soil, gravel or stone road can be either a Class 3 or Class 2 Secondary Road depending upon its stability or performance.

(a) An untreated surface that is of insufficient quantity or quality to ensure all-weather performance would be a Class 3 (light surface) road. Surface type code "3" will identify such surfaces as untreated soils, gravels, stones, etc., and "0" in the base type column denotes that such materials are unstabilized. Until a road surface is sufficiently stable to be all-weather it is not stabilized, and the base type is to be coded unstabilized - "0".

(b) An untreated surface that is of sufficient stability to assure reasonable all-weather performance would be a Class 2 (all-weather) road. Surface type code "3" is used to identify such surfaces as untreated soils, gravels, stones, etc. A "2" would be used in the base type column if stabilized with selected materials; "3" if stabilized with portland cement; "4" if stabilized with bituminous material; and "5" if stabilized with chemicals.

A light bituminous treatment would be coded "42" when applied to a soil stabilized with select materials, and "41" when applied to a bituminous concrete surface.

A heavy bituminous treatment would be coded "54" when applied to a gravel stabilized with bituminous material, and "51" when applied to a bituminous concrete surface.

Plant mix applied to penetration or water bound macadam would be coded "67".

Rock asphalt applied to portland cement concrete would be coded "78".

Portland cement concrete would be coded "80".

Plant mix applied to bituminous concrete (black base) would be coded "61".

A "9" will be used as the second digit of the code whenever the surface or base, or both, are dual type. All dual type mileage is to be coded the predominating surface type when the types are of unequal widths. When the types are of the same width, the higher surface type is to govern.

Portland cement concrete 12 feet wide laid adjacent to bituminous treated gravel 12 feet wide would be coded "89", but portland cement concrete 12 feet wide laid adjacent to bituminous treated gravel 16 feet wide would be coded "49".

A sand asphalt surface covering the combined width of portland cement concrete 12 feet wide laid adjacent to bituminous treated gravel 8 feet wide would be coded "69", and a sand asphalt surface covering the combined width of portland cement concrete 8 feet wide laid adjacent to bituminous treated gravel 12 feet wide would also be coded "69".

In the case of a divided lane road, each lane of which is a different surface type, the foregoing principle applies. For example, a portland cement concrete lane 20 feet wide laid parallel to, but separated by a grass plot from, a bituminous treated traffic bound macadam lane 18 feet wide would be coded "89".

Code	Kind of Highway (Use a Two Digit Combination Code - KH)

Number of Lanes

Code	
0	Not Applicable
1	One-lane
2	Two-lane
3	Three-lane
4	Four-lane
5	Five-lane
6	Six-lane
7	Seven-lane
8	Eight-lane
9	Nine-lane
A	Ten-lane
B	Eleven-lane
C	Twelve-lane
F	Reserved for accident section

Type of Facility and Access Control

Code	
0	Two-way, non divided
1	Divided, no control of access
2	Divided, partial control of access
3	Divided, full control of access
4	One-way, part of a one-way system
5	Two-way, part of a one-way system
6	One-way couplet
7	Transition*
9	Not applicable
R	Reserved for accident section

*Transition - when the increase or decrease in the number of lanes is accompanied by a change in the pavement width, the transition always carries the lower number of lane.

Code	Number of Interstate Lanes Open to Traffic
	5 Years More (LN)

(Interstate Only)

Code Direct	04 Coded 04
	06 Coded 06
Code Zeros (00)	For all other records

Code   Average Daily Traffic (ADT)

Average daily traffic coded in these columns to the unit portion.
For example, ADT of 19,924 vehicles per day is coded 019924. When ADT is
unknown use a code of "000000".

Code   Milepoint

Code XXX.XX with an assumed two place decimal point.
The coded mileage represents the distance in miles from a set reference
point to the beginning of this highway segment.

Random Number (RN)

 The random numbers assigned to each section by the computer. They
are listed in ascending order.

Class

 The traffic group into which each section falls.

Group	Traffic Volume (ADT)
1	0 – 100
2	101 – 300
3	301 – 750
4	751 – 1500
5	1501 – 4500
6	4501 and higher

Length (LENG.)

 Actual decimal listing of the length of each section.

By Class (BY-CL)

 Accumulating lengths of sections by class.

By County (BY-CO.)

 Total accumulating lengths of sections by county.