Analysis of Sampling County Road Needs In Minnesota

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● A COMPREHENSIVE needs study was completed, in 1954, for a highway study committee of the Minnesota legislature. The needs were developed by section appraisal. Standard reporting forms served as a basis for the field appraisal and made possible a high degree of uniform reporting of existing conditions and determining needed improvements.

The 87 county engineers of the state made the appraisal of the county and township road systems by completing work sheets for each road section of these systems. All work sheets were reviewed by the study staff to insure that procedures had been followed and that improvements proposed were justified and costs were accurately estimated.

These established needs for the county and township systems were separately tabulated for each county and totaled to establish state totals. After this tabulation was completed, it was decided to explore methods of sampling and compare the results obtained with the table of the comprehensive study. If a sample would give reasonable results, it could be used in future years to arrive at state needs to date or it could be used in other states to determine a state needs total.

For administrative purposes, Minnesota is divided into eight construction districts by the Department of Highways. These eight districts are geographically located to provide reasonably comparable areas for administration of the state trunk highway system and also for the administration of inter-related road affairs between the state and local authorities. Because of the geography the counties within each district should be somewhat similar with respect to factors, such as terrain, economic conditions, population density, relative wealth, and general road policy. As these factors affect road needs, each district could be used as a basis for sampling.

A tabulation was prepared in which the counties were grouped by districts showing the existing miles, deficient miles and percent deficient for the state aid, county and township systems, and corresponding total data for all systems within the county. These data were accumulated in district totals and also in statewide totals.

As the tabulated data were taken from a preceding needs appraisal, a test of sampling methods could be made by comparison of the sample expansions to the actual state totals. It was decided to use two methods of sampling and to test the expanded percentage of miles deficient for the two samples against the corresponding known data. Both samples were chosen by selecting one county from each district. Sample A was chosen by an engineer familiar with state conditions and his sample was to reflect his judgment of counties which would have average needs for the districts. Sample B chose a random county from each district.

The expansion of sample A showed 3.0 percent more deficient mileage than actual; whereas, expansion of sample B showed 5.3 percent more than actual. These differences are relatively small and indicate that sampling procedure, if carefully done, would produce a reliable estimate of the total state needs.

To test the sampling further, tests were also made of the two samples within the three system categories of state aid roads, county aid and county roads, and township roads. Sample A produced expanded estimates differing from actual values by -0.49 percent for state aid roads, +1.83 percent for county aid and county roads, and +7.81 percent for township roads. The second sample produced corresponding values of +1.90 percent, -5.04 percent, and +18.77 percent.

Both samples show a high degree of accuracy in the higher system category, a lesser degree of accuracy in the intermediate system category and the poorest degree of accuracy in the low system category.

It is not logical to assume that this difference in degree of accuracy can be attributed to sampling technic. There is probably less accuracy in the actual estimates in the lower system category than in the higher system category.

TABLE 1

DEFICIENT MILES BY COUNTY AND DISTRICT

County	State Aid Miles Exist	State Aid Miles Def	State Aid % Def	Co Aid & Co Miles Exist	Co Aid & Co Miles Def	Co Aid & Co % Def	Township Miles Exist	Township Miles Def	Township % Def	Total Miles Exist	Total Miles Def	Total % Def
District I												
Carlton	145	73 10	50 41	264	76 40	28 94	462	102 20	22 12	871	251 70	28 90
Cook	65	35 00	53 85	92	60 10	65 33	290	130 85	45 12	447	225 95	50 55
Itasca	148	81 51	55 07	686	388 00	56 56	1,099	348 05	31 67	1,933	817 56	42 29
Koochiching	76	30 00	39 47	315	119 20	37 84	361	46 60	12 91	752	195 80	26 04
Lake	46	8 86	19 26	130	124 70	95 92	412	104 20	25 29	588	237 76	40 44
Pine	175	114 80	65 60	443	237 20	53 54	775	226 95	29 28	1,393	578 95	41 56
St Louis	430	141 70	32 95	2,391	563 71	23 58	1,132	127 70	11 28	3,953	833 11	21 08
Total	1,085	484 97	44 70	4,321	1,569 31	36 32	4,531	1,086 55	23 98	9,937	3,140 83	31 61
District II												
Beltrami	195	111 69	57 28	406	196 20	48 33	927	173 87	18 76	1,528	481 76	31 53
Clearwater	143	67 66	47 31	355	181 86	51 23	555	75 25	13 56	1,053	324 77	30 84
Hubbard	79	29 02	36 73	428	233 49	54 55	689	132 30	19 20	1,196	394 81	33 01
Kittson	179	84 90	47 43	251	87 00	34 66	1,373	354 60	25 83	1,803	526 50	29 21
Lake of the Woods	59	13 50	22 88	346	125 30	36 21	258	25 80	10 00	663	164 60	24 83
Marshall	193	51 50	26 68	549	155 30	28 29	1,790	930 00	51 96	2,532	1,136 80	44 90
Norman	114	44 90	39 39	570	296 70	52 05	746	85 25	11 43	1,430	426 85	29 84
Pennington	121	109 79	90 74	508	103 75	20 42	434	100 30	23 11	1,063	313 84	29 52
Polk	272	124 79	45 88	617	217 90	35 32	2,078	645 50	31 06	2,967	988 19	33 31
Red Lake	105	75 20	71 62	301	67 40	22 39	270	24 00	8 88	676	166 60	24 64
Roseau	137	24 80	18 10	617	78 45	12 71	1,040	180 30	17 34	1,794	283 55	15 81
Total	1,597	737 75	46 20	4,948	1,743 35	35 23	10,160	2,727 17	26 84	16,705	5,208 27	31 18
District III												
Aitkin	132	123 60	93 64	337	196 10	58 19	813	154 60	19 02	1,282	474 30	37 00
Benton	190	134 60	70 84	235	129 60	55 15	261	106 00	40 61	686	370 20	53 97
Cass	107	75 20	70 28	577	351 73	60 96	1,084	265 45	24 49	1,768	692 38	39 16
Crow Wing	114	71 10	62 37	259	127 60	49 27	788	204 45	25 95	1,161	403 15	34 72
Isanti	122	76 70	62 87	218	135 65	62 22	471	199 50	42 36	811	411 85	50 78
Kanabec	114	33 30	29 21	294	116 80	39 73	235	79 10	33 66	643	229 20	35 65
Mille Lacs	116	90 70	78 19	221	195 70	88 55	399	182 20	45 66	736	468 60	63 67
Morrison	238	141 50	59 45	372	267 80	71 99	916	353 90	38 64	1,526	763 20	50 01
Sherburne	152	55 05	36 22	259	86 90	33 55	305	60 06	19 69	716	202 01	28 21
Stearns	336	151 00	44 94	476	287 60	60 42	1,370	191 80	14 00	2,182	630 40	28 89
Todd	287	214 90	74 88	301	167 95	55 80	974	197 25	20 25	1,562	580 10	37 14
Wadena	121	89 60	74 05	324	259 90	80 22	309	136 00	44 01	754	485 50	64 39
Wright	249	114 20	45 86	175	52 80	30 17	855	282 15	33 00	1,279	449 15	35 12
Total	2,278	1,371 46	60 20	4,048	2,376 13	58 70	8,780	2,412 46	27 48	15,106	6,160 04	40 78
District IV												
Becker	164	81 80	49 88	360	261 45	72 63	1,306	165 85	12 70	1,830	509 10	27 82
Big Stone	127	39 70	31 26	267	209 00	78 28	442	96 50	21 83	836	345 20	41 29
Clay	213	118 75	55 75	473	131 10	27 72	1,067	189 00	17 71	1,753	438 85	25 03
Douglas	324	185 23	57 17	259	146 01	56 37	479	84 80	17 70	1,062	416 04	38 18
Grant	116	29 00	25 00	329	92 45	28 10	428	44 30	10 35	873	165 75	18 99
Mahnomen	91	37 25	40 93	160	104 69	65 43	304	96 25	31 66	555	238 19	42 92
Otter Tail	324	170 10	52 50	698	339 60	48 65	1,950	163 20	8 37	2,972	672 90	22 64
Pope	172	73 90	42 97	132	119 80	90 76	555	241 50	43 51	859	435 20	50 66
Stevens	171	77 85	45 53	203	137 00	67 49	531	168 00	31 64	905	382 85	42 30
Swift	181	147 90	81 71	422	170 70	40 45	594	197 25	33 21	1,197	515 85	43 10
Traverse	139	106 10	76 33	318	115 30	36 26	594	58 70	9 88	1,051	280 10	26 65
Wilkin	162	93 10	57 47	293	117 30	40 03	734	93 70	12 77	1,189	304 10	25 58
Total	2,184	1,160 68	53 14	3,914	1,944 40	49 68	8,984	1,599 05	17 80	15,082	4,704 13	31 19

TABLE 1 (Cont)

DEFICIENT MILES BY COUNTY AND DISTRICT

County	State Aid Miles Exist	State Aid Miles Def	State Aid % Def	Co Aid & Co Miles Exist	Co Aid & Co Miles Def	Co Aid & Co % Def	Township Miles Exist	Township Miles Def	Township % Def	Total Miles Exist	Total Miles Def	Total % Def
District V												
Anoka	113	76 84	68 00	169	104 34	61 74	395	173 54	43 93	677	354 72	52 40
Carver	124	68 30	55 08	103	43 10	41 84	366	104 70	28 61	593	216 10	36 44
Chicago	116	87 80	75 69	164	111 40	67 93	386	144 70	37 49	666	343 90	51 64
Dakota	226	105 10	46 50	146	95 90	65 68	475	124 45	26 20	847	325 45	38 42
Hennepin	252	98 00	38 89	189	32 20	17 04	506	128 45	25 39	947	258 65	27 31
Ramsey	97	13 95	14 38	46	6 31	13 72	96	5 35	5 57	239	25 61	10 72
Scott	144	113 54	78 85	153	31 75	20 75	230	32 50	14 13	527	177 79	33 74
Washington	104	40 90	39 33	140	92 50	66 07	422	194 00	45 97	666	327 40	49 16
Total	1,176	604 43	51 40	1,110	517 50	46 62	2,876	907 69	31 56	5,162	2,029 62	39 32
District VI												
Dodge	136	56 90	41 84	151	26 10	17 28	430	91 65	21 31	717	174 65	24 36
Fillmore	252	49 70	19 72	137	47 70	34 82	914	214 20	23 44	1 303	311 60	23 91
Freeborn	254	110 00	43 31	329	88 25	26 82	633	148 90	23 52	1,216	347 15	28 55
Goodhue	248	110 20	44 44	137	8 30	6 06	828	230 10	27 79	1,213	348 60	28 73
Houston	77	77 45	100 58	153	9 20	6 01	458	101 85	22 24	688	188 50	27 40
Mower	209	59 10	28 28	114	35 30	32 09	921	104 50	11 35	1,244	198 90	15 99
Olmstead	279	119 92	42 98	42	19 85	47 26	733	307 80	41 99	1,054	447 57	42 46
Rice	217	117 30	54 06	221	107 35	48 57	375	117 30	31 28	813	341 95	42 06
Steele	160	37 50	23 44	105	20 00	19 05	419	46 90	11 19	684	104 40	15 26
Wabasha	151	62 00	41 06	148	54 75	36 99	432	133 60	30 93	731	250 35	34 25
Winona	157	71 40	45 48	186	107 00	57 53	452	131 18	29 02	795	309 58	38 94
Total	2,140	871 47	40 72	1,723	523 80	30 40	6,595	1,627 98	24 69	10,458	3,023 25	28 91
District VII												
Blue Earth	286	207 60	72 59	377	211 85	56 19	579	123 90	21 40	1,242	543 35	43 75
Brown	202	148 40	73 47	67	39 40	58 81	693	253 00	36 51	962	440 80	45 82
Cottonwood	210	131 10	62 43	197	127 50	64 72	706	349 40	49 49	1,113	608 00	54 63
Faribault	138	75 20	54 49	237	92 20	38 90	828	289 90	35 01	1,203	457 30	38 01
Jackson	244	108 40	44 43	205	35 80	17 46	769	172 95	22 49	1,218	317 15	26 04
Le Sueur	281	136 90	48 72	201	15 00	7 46	256	51 85	20 25	738	203 75	27 61
Martin	185	83 30	45 03	350	147 05	42 01	730	137 80	18 88	1,265	368 15	29 10
Nicollet	151	104 80	69 40	133	86 20	64 81	380	96 50	25 39	664	287 50	43 30
Nobles	216	129 40	59 91	155	70 80	45 68	927	268 69	28 98	1,298	468 89	36 12
Rock	132	90 95	68 90	170	108 90	64 06	570	147 90	25 95	872	347 75	39 88
Sibley	194	110 40	56 91	171	104 40	61 05	570	211 90	37 18	935	426 70	45 64
Waseca	204	163 55	80 17	159	76 79	48 30	334	126 85	37 98	697	367 19	52 68
Watonwan	176	34 70	19 72	175	14 00	8 00	406	96 90	23 87	757	145 60	19 23
Total	2,619	1,524 70	58 22	2,597	1,129 89	43 51	7,748	2,327 54	30 04	12,964	4,982 13	38 43
District VIII												
Chippewa	138	82 90	60 07	102	72 70	71 27	779	117 10	15 03	1,019	272 70	26 76
Kandiyohi	259	142 20	54 90	428	228 20	53 32	577	117 05	20 29	1,264	487 45	38 56
Lac qui Parle	216	84 30	39 03	271	210 90	77 82	784	97 17	12 39	1,271	392 37	30 87
Lincoln	188	111 25	59 18	242	84 55	34 94	517	75 90	14 68	947	271 70	28 69
Lyon	282	37 40	13 26	158	119 40	75 57	753	148 55	19 73	1,193	305 35	25 60
Mc Leod	140	67 20	48 00	156	61 30	39 29	518	78 00	15 06	814	206 50	25 37
Meeker	152	117 05	77 01	805	486 30	60 41	77	8 80	11 43	1,034	612 15	59 20
Murray	179	71 40	39 89	217	149 00	68 66	816	221 71	27 17	1,212	442 11	36 48
Pipestone	192	121 85	63 46	228	111 90	49 08	393	91 60	23 31	813	325 35	40 02
Redwood	197	75 90	38 53	271	123 95	45 74	975	213 05	21 85	1,443	412 90	28 61
Renville	260	114 45	44 02	381	56 45	14 82	1,032	77 50	7 51	1,673	248 40	14 85
Yellow Medicine	214	55 00	25 70	247	43 31	17 53	818	67 50	8 25	1,279	165 81	12 96
Total	2,417	1,080 90	44 72	3,506	1,747 96	49 86	8,039	1,313 93	16 34	13,962	4,142 79	29 67
State Total	15,496	7,836 35	50 57	26,167	11,552 34	44 15	57,713	14,002 37	24 26	99,376	33,391 06	33 60

CONCLUSIONS

These investigations did not attempt to show that an accurate needs estimate could be obtained for a large area by sampling the needs in a few small areas. This probably could be done for a reasonably homogeneous large area. However, if the large area is heterogeneous, this estimate could probably be accomplished by taking a random sample of 10 percent of the area of each county and thereby having conditions applicable to every county represented in the total sample.

If time and cost are important considerations in the estimate procedure, if the desired result is to obtain a long range estimate of the total needs of a large area, and if the estimate is to be used for long range financial planning which is flexible rather than

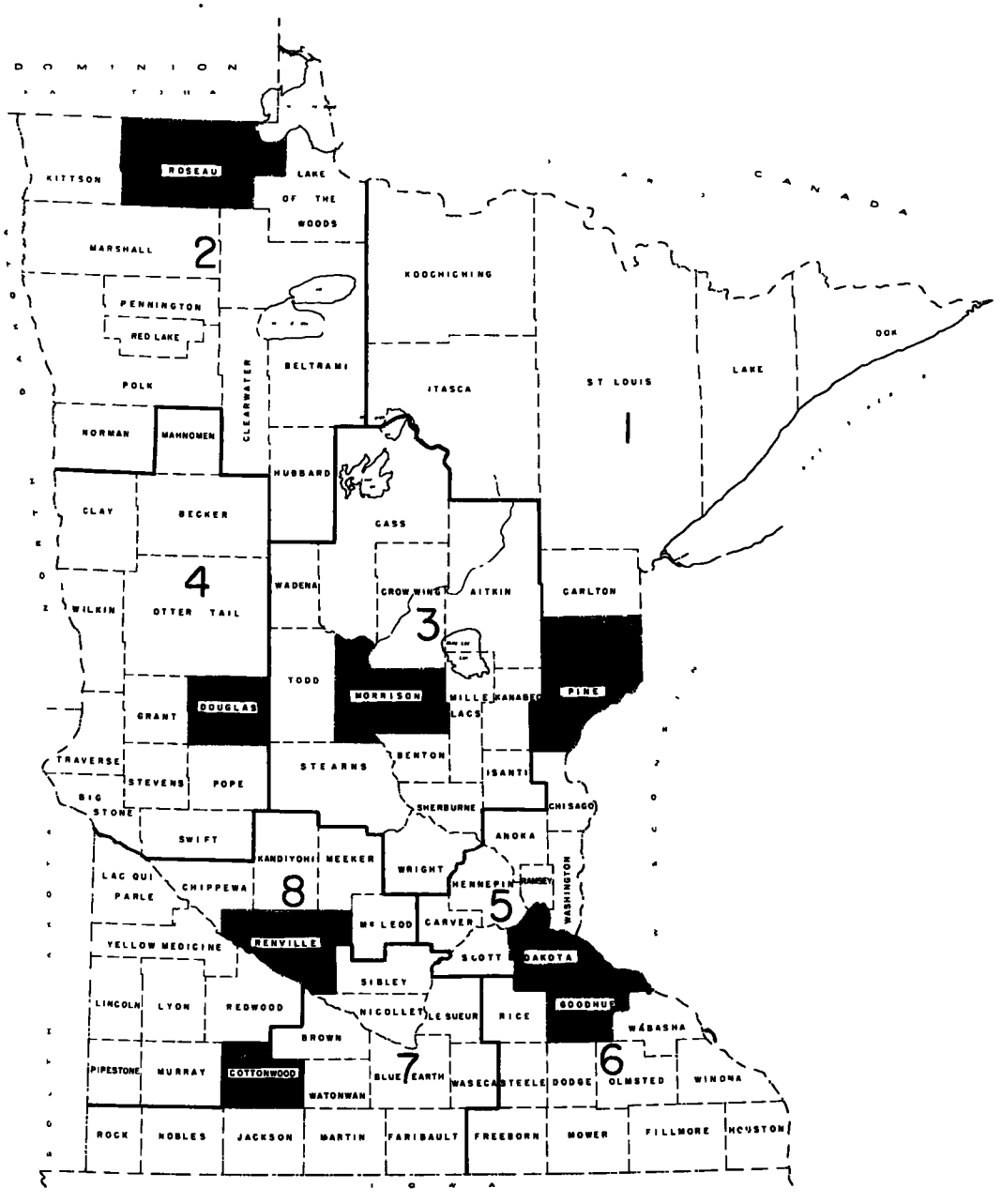

Figure 1. Map of Minnesota district boundaries and counties selected for sample A.

TABLE 2

SAMPLE A

Dist. No.	Sample County	Counties Total Miles	Counties Def. Miles	Counties % Def.	District Total Miles	District Def. Miles Expan.	District Def. Miles Actual
			STATE AID SYSTEM				
1	Pine	175	114.80	65.60	1,085	712	485
2	Roseau	137	24.80	18.10	1,597	286	738
3	Morrison	238	141.50	59.45	2,278	1,354	1,371
4	Douglas	324	185.23	57.17	2,184	1,249	1,161
5	Dakota	226	105.10	46.50	1,176	547	604
6	Goodhue	248	110.20	44.44	2,140	951	871
7	Cottonwood	210	131.10	62.43	2,619	1,635	1,525
8	Renville	260	114.45	44.02	2,417	1,064	1,081
	Total				15,497	7,798	7,836
	Sample Error					-0.49%	
			COUNTY AID AND COUNTY SYSTEM				
1	Pine	443	237.20	53.54	4,321	2,313	1,569
2	Roseau	617	78.45	12.71	4,948	629	1,743
3	Morrison	372	267.80	71.99	4,048	3,582	2,376
4	Douglas	259	146.01	56.37	3,914	2,206	1,944
5	Dakota	146	95.90	65.68	1,110	729	518
6	Goodhue	137	8.30	6.06	1,723	104	524
7	Cottonwood	197	127.50	64.72	2,597	1,681	1,130
8	Renville	381	56.40	14.82	3,506	520	1,748
	Total				26,167	11,764	11,552
	Sample Error					+1.83%	
			TOWNSHIP SYSTEM				
1	Pine	775	226.95	29.28	4,531	1,327	1,087
2	Roseau	1,040	180.30	17.34	10,160	1,762	2,727
3	Morrison	916	353.90	38.64	8,780	3,393	2,412
4	Douglas	479	84.80	17.70	8,984	1,590	1,599
5	Dakota	475	124.45	26.20	2,876	754	908
6	Goodhue	828	230.10	27.79	6,595	1,833	1,628
7	Cottonwood	706	349.40	49.49	7,748	3,834	2,328
8	Renville	1,032	77.50	7.51	8,039	604	1,314
	Total				57,713	15,097	14,003
	Sample Error					+7.81%	

TABLE 3

SAMPLE B

Dist. No.	Sample County	Counties Total Miles	Counties Def. Miles	Counties % Def.	District Total Miles	District Def. Miles Expan.	District Def. Miles Actual
			STATE AID SYSTEM				
1	Pine	175	114.80	65.60	1,085	712	485
2	Marshall	193	51.50	26.68	1,597	426	738
3	Todd	287	214.90	74.88	2,278	1,706	1,371
4	Clay	213	118.75	55.75	2,184	1,218	1,161
5	Washington	104	40.90	39.33	1,176	463	604
6	Mower	209	59.10	28.28	2,140	605	871
7	Brown	202	148.40	73.47	2,619	1,924	1,525
8	Redwood	197	75.90	38.53	2,417	931	1,081
	Total				15,496	7,985	7,836
	Sample Error					+1.90%	
			COUNTY AID AND COUNTY SYSTEM				
1	Pine	443	237.20	53.54	4,321	2,313	1,569
2	Marshall	549	155.30	28.29	4,948	1,400	1,743
3	Todd	301	167.95	55.80	4,048	2,259	2,376
4	Clay	473	131.10	27.72	3,914	1,085	1,944
5	Washington	140	92.50	66.07	1,110	733	518
6	Mower	114	35.30	32.09	1,723	553	524
7	Brown	67	39.40	58.81	2,597	1,023	1,130
8	Redwood	271	123.95	45.74	3,506	1,604	1,748
	Total				26,167	10,970	11,552
	Sample Error					-5.04%	
			TOWNSHIP SYSTEM				
1	Pine	775	226.95	29.28	4,531	1,327	1,087
2	Marshall	1,790	930.00	51.96	10,160	5,279	2,727
3	Todd	974	197.25	20.25	8,780	1,778	2,412
4	Clay	1,067	189.00	17.71	8,984	1,591	1,599
5	Washington	422	194.00	45.97	2,876	1,322	908
6	Mower	921	104.50	11.35	6,595	749	1,628
7	Brown	693	253.00	36.51	7,748	2,829	2,328
8	Redwood	975	213.05	21.85	8,039	1,757	1,314
	Total				57,713	16,632	14,003
	Sample Error					+18.77%	

rigid, then it is entirely feasible and desirable to resort to sampling technics as an economy measure. The state could be resampled every three years with approximately the same cash outlay for needs estimates over a 30-year period as a single total needs estimate would cost. It is almost essential that there be reappraisals of needs at short intervals. If these reappraisals are each to be on a total basis, the expenditure of money and engineering manpower becomes excessive. Sampling tecnics, if acceptable, would be a conservation measure and produce the desired result.

Assembled Data

The data assembled in this investigation includes, two state maps showing the con-

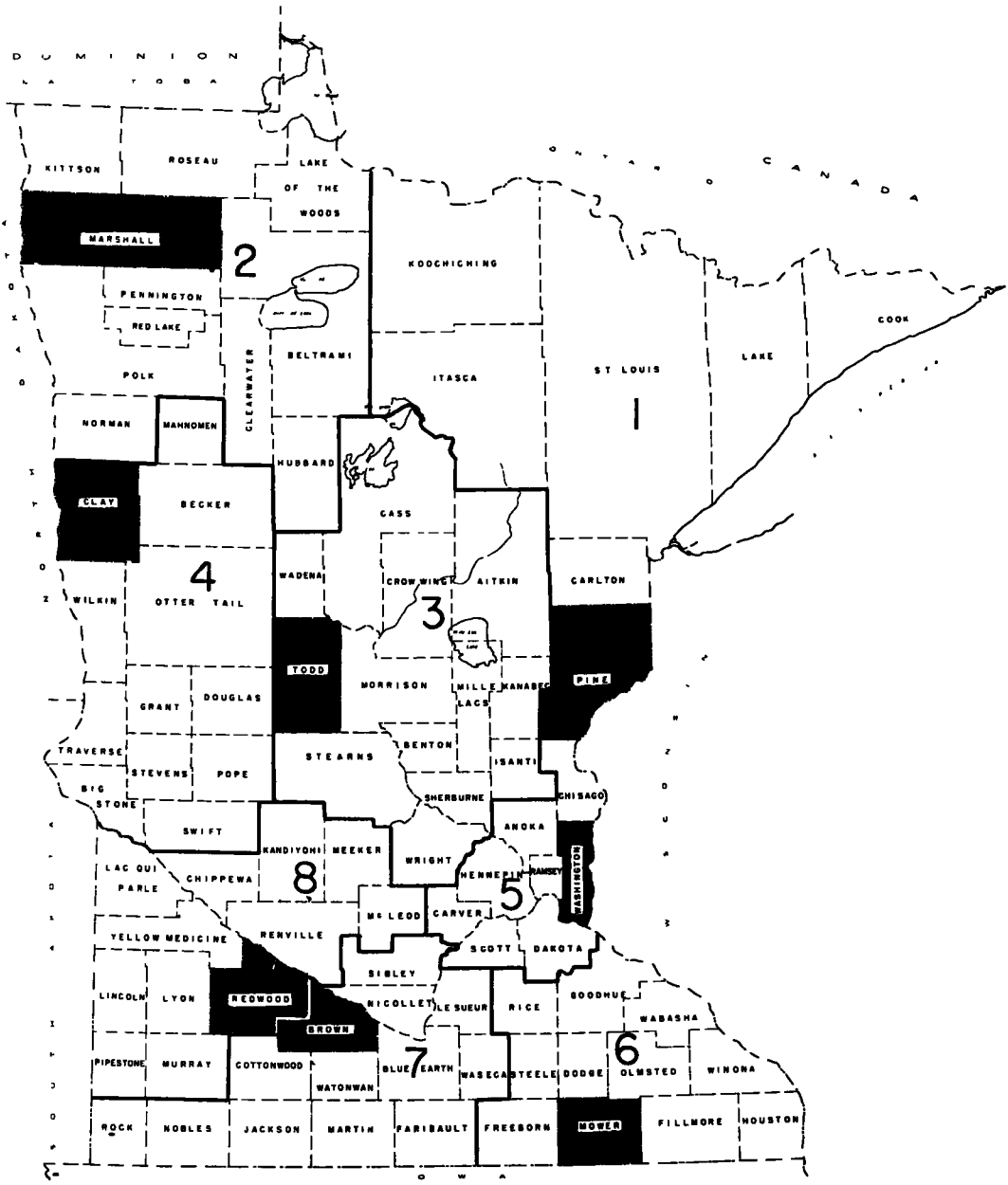

Figure 2. Map of Minnesota district boundaries and counties selected for sample B.

TABLE 4

EXPANSION OF ALL SYSTEMS

		Counties			District		
Dist. No.	Sample County	Total Miles	Def. Miles	% Def.	Total Miles	Def. Expan.	Miles Actual
			SAMPLE A				
1	Pine	1,393	579	41.56	9,937	4,130	3,141
2	Roseau	1,794	284	15.81	16,705	2,641	5,208
3	Morrison	1,526	763	50.01	15,106	7,555	6,160
4	Douglas	1,062	416	39.18	15,082	5,909	4,704
5	Dakota	847	325	38.42	5,162	1,983	2,030
6	Goodhue	1,213	349	28.73	10,458	3,005	3,023
7	Cottonwood	1,113	608	54.63	12,964	7,082	4,982
8	Renville	1,673	248	14.85	13,962	2,073	4,143
	Totals				99,376	34,378	33,391
	Sample Error					+2.96%	
			SAMPLE B				
1	Pine	1,393	579	41.56	9,937	4,130	3,141
2	Marshall	2,532	1,137	44.90	16,705	7,500	5,208
3	Todd	1,562	580	37.14	15,106	5,610	6,160
4	Clay	1,753	439	25.03	15,082	3,775	4,704
5	Washington	666	327	49.16	5,162	2,538	2,030
6	Mower	1,244	199	15.99	10,458	1,672	3,023
7	Brown	962	441	45.82	12,964	5,940	4,982
8	Redwood	1,443	413	28.61	13,962	3,995	4,143
	Total				99,376	35,160	33,391
	Sample Error					+5.30%	

struction district boundaries and the counties selected for samples A and B; a tabulation of deficient miles by county, district and system as determined from the actual needs study; two tabulations in which the deficient miles for each sample were expanded into state totals by system; and one tabulation in which each sample was expanded into state totals for all systems.