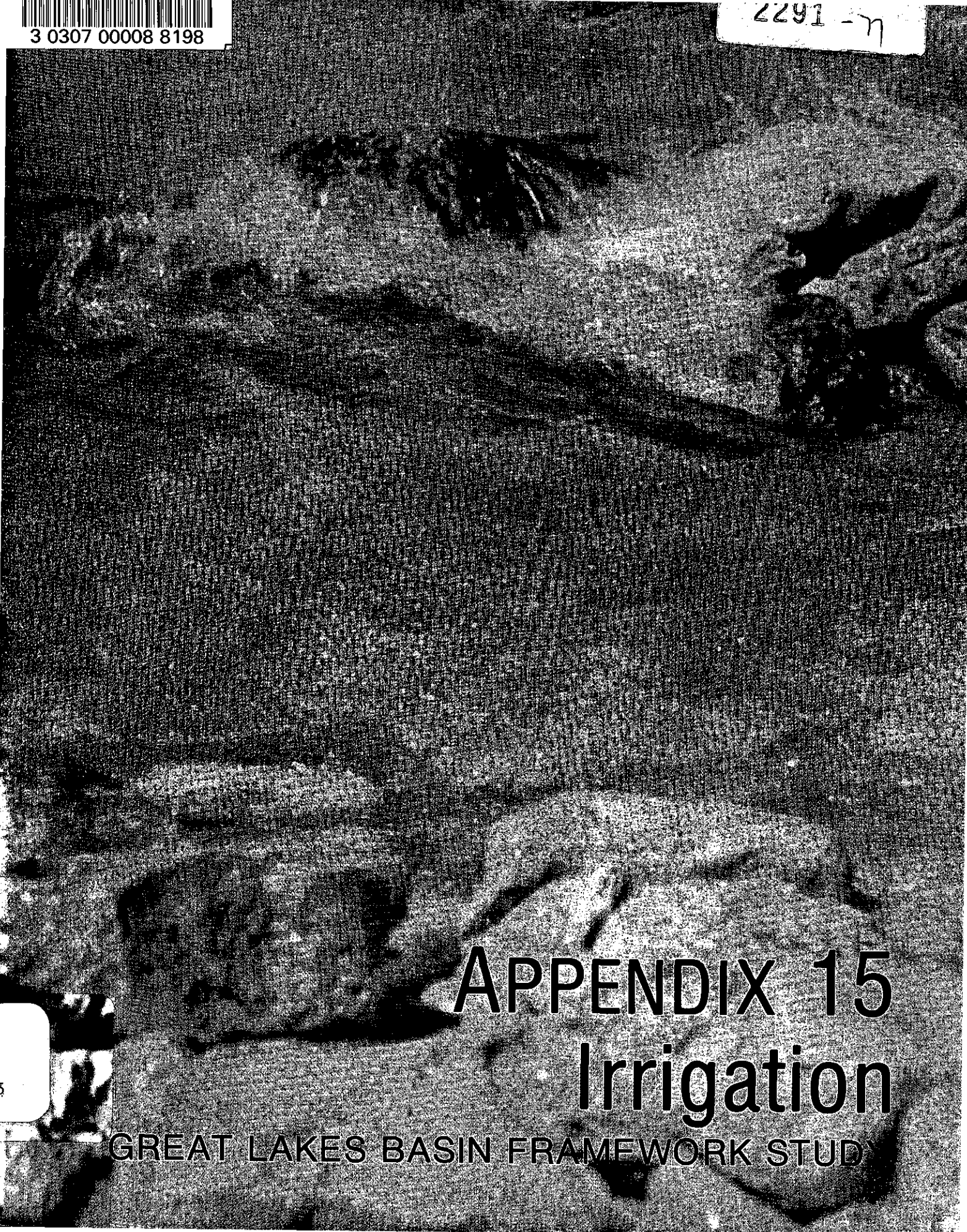

APPENDIX 15
Irrigation

GREAT LAKES BASIN FRAMEWORK STUDY

Great Lakes Basin Framework Study

APPENDIX 15

IRRIGATION

GREAT LAKES BASIN COMMISSION

Prepared by Irrigation Work Group

Sponsored by Soil Conservation Service

U.S. Department of Agriculture

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This appendix to the *Report* of the *Great Lakes Basin Framework Study* was prepared at field level under the auspices of the Great Lakes Basin Commission to provide data for use in the conduct of the Study and preparation of the *Report*. The conclusions and recommendations herein are those of the group preparing the appendix and not necessarily those of the Basin Commission. The recommendations of the Great Lakes Basin Commission are included in the *Report*.

OUTLINE

SYNOPSIS

In the Great Lakes Basin 221,000 acres of crops are irrigated. Vegetables, fruits, and sod are grown on 80 percent of this acreage. Most Basin irrigation occurs in the Lake Michigan area. Projections indicate 522,000 agricultural acres will be irrigated by 2020. Vegetables will be grown on 60 percent and fruits on 20 percent of these acres. Future irrigation will involve approximately four percent of the acres considered potentially irrigable.

In 1968 water use for irrigation was approximately 106,700 acre-feet per season. By 2020 approximately 484,000 acre-feet of water per season will be required. Planning Subarea 2.3 will use 151,000 acre-feet. Golf courses will require an additional 467,000 acre-feet.

Irrigation development is limited by certain soil associations, whose location and relative limitations are indicated in Figures 15–3 through 15–17. In many planning subareas there are moderate soil limitations. Severe limitations are prevalent in the Lake Erie area. In New York State there is a small amount of soil with slight limits. Other maps show areas with adequate ground water supplies as well as soil limitations. Surface water, which is a major irrigation source, is expected to fill approximately half the future needs. Studies that show the potential for developing surface water supplies have not been reported.

If irrigation were increased, few acres would be needed for crop production. Farmers would be able to produce more specialty crops of better quality and raise their incomes.

Waste water disposal by irrigation is now being used in limited cases and is being considered for extensive areas in the Basin. By this method treated effluent would be recycled and purified. Irrigation benefits would be secondary. This type of irrigation has not been included in the projections, and such proposals are not discussed in this report.

Several irrigation reports that concern parts of the Basin are reviewed in this appendix. Information from these reports has been tabulated for comparison or as a supplement to data in this appendix.

FOREWORD

This appendix was prepared by the Irrigation Work Group under the chairmanship of Ralph S. Wadleigh of the Soil Conservation Service, U.S. Department of Agriculture.

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INTRODUCTION

Objective and Scope

The purpose of this appendix is to identify and evaluate the requirements and potentials of present and future irrigation in the Great Lakes Basin (Figure 15–1). Included are an inventory of present irrigation, future needs, soil limitations, and a review of other irrigation reports.

Basin irrigation was evaluated as to irrigated crops, amount of water used, source of water, and present trends in irrigation. These were used to estimate future irrigation needs and potential for development.

Basin soils were studied in order to determine potential for irrigation, and availability of ground water. Well yield data for surficial deposits were used to determine where plentiful supplies of ground water exist, and to indicate the most favorable areas for irrigation.

Previous irrigation reports on segments of the Basin were reviewed. Data and projections from these reports are presented for comparison with the inventory and projections reported in this appendix.

Relation to Other Appendixes

Directly related material will be found in the following appendixes: Appendix 13, *Land Use and Management*; Appendix 6, *Water Supply–Municipal, Industrial, and Rural*; Appendix 14, *Flood Plains*; Appendix 16, *Drainage*; Appendix 17, *Wildlife*; Appendix 18, *Erosion and Sedimentation;* Appendix 19, *Economic and Demographic Studies*; and Appendix 21, *Outdoor Recreation.*

Section 1

INVENTORY

1.1 Inventory

In 1969 meetings were held with the U.S. Department of Agriculture's Soil Conservation Service (SCS) district conservationists from all Basin counties. Participants gathered information about crops, soils, and crop yield primarily for the economic base study used in Appendix 19, *Economic and Demographic Studies.* District conservationists based their estimates on 1968 cropping patterns and then estimated the number of acres irrigated for each crop.

A similar base was used to obtain an analysis by crop and soil types for all Basin counties. Some of the other inventories discussed in this report are more detailed, and some cover the entire Basin, but none has a soil and crop analysis for the entire Basin. This inventory is assumed to be reasonable and up to date for use in the study.

Irrigated acreage in the Great Lakes Basin totals 220,616 acres. The amount of irrigation reported in each county is given in Figure 15–2. The largest amount of irrigation (25,200 acres) was reported for Waushara County, Wisconsin. Montcalm County, Michigan, reported 20,000 irrigated acres. Manistee, Mecosta, Ottawa, Van Buren, and Wayne Counties in Michigan each had 10,000 or more irrigated acres. There were no other counties in the Great Lakes Basin with more than 10,000 irrigated acres.

1.1.1 Methodology

In tabulating the crops irrigated, all fruit categories were combined. Many Great Lakes Basin areas produce tree fruits and small fruit. To improve fruit yield 15,864 acres of strawberries and 2,425 acres of apples have been irrigated. No estimate was made of the amount of irrigation practiced for frost protection. Irrigated vegetables were also grouped together because the number of acres reported was small and because often two or three crops may be grown on the same acre in one year. Acreages of snap beans, sweet corn, cucumbers, tomatoes, and onions were tabulated together. White potatoes, dry navy beans, and sugar beets were tabulated separately. This methodology includes commercially grown irrigated sod but not irrigated lawns and golf courses. Golf course acreage was taken from Appendix 21, *Outdoor Recreation.* Corn is the only grain crop tabulated in this report.

1.1.2 Summary of Inventory

Table 15–1 lists totals of irrigated acres by planning subarea. Planning Subarea 2.3 contains the most irrigated acres. It has nearly 75,000 irrigated acres, 28 percent of which yields vegetables, 21 percent yields potatoes, and 18 percent yields fruits. Approximately 94 percent of the irrigation in this planning subarea is in Michigan, and the remainder is in Indiana. The four planning subareas surrounding Lake Michigan contain 155,000 acres of irrigation, or 70 percent of the Basin total. Planning Subareas 3.2 and 4.1 also have many irrigated acres. These six areas contain nearly 87 percent of the Basin's irrigation. The other planning subareas reported having less than 8,000 irrigated acres each. Most of the irrigated sod is in Planning Subareas 2.2 and 4.1. No irrigation was inventoried for Planning Subareas 1.1 and 5.3.

Table 5–2 summarizes the inventory for each Lake plan area and State. Michigan reported more than 139,000 acres, or 63 percent, of the 221,000 Basin irrigated acres. Michigan contains 40 percent of the total cropland in the Basin. Approximately 1.2 percent of the total cropland in Michigan is irrigated. Wisconsin has 40,000 acres of irrigation, which is less than one percent of its cropland. Substantial irrigated acreage is found in New York and Ohio, while Indiana, Illinois, and Pennsylvania have less irrigated acreage.

Vegetables, including potatoes, are grown on 130,000 (60 percent) of the total acres. Corn (for grain), fruits, and sod each occupy approx-

imately 10 percent of the total irrigated acres. Approximately 0.7 percent of all Basin cropland is irrigated. Approximately four percent of all Basin fruit (acres) are irrigated. Thirty-four percent of the potatoes and 15 percent of the vegetables are irrigated.

TABLE 15–1 Present Irrigation, Workshop Estimates (Acres)[1]

Planning Sub-area	CROP IRRIGATED								
	Corn (Grain)	Fruits	Dry Beans	Sugar Beets	Potatoes	Vegetables	Sod	Misc.	Total
1.2	------	653	-----	---	1,060	20	------	-----	1,733
2.1	3,500	25	-----	---	9,012	19,245	------	-----	31,782
2.2	1,417	650	-----	---	3,240	1,039	9,760	500	16,606
2.3	10,400	13,444	8,350	---	16,045	21,293	3,824	1,400	74,756
2.4	3,777	8,112	1,723	---	8,924	9,040	------	-----	31,576
3.1	------	200	-----	---	400	50	------	-----	650
3.2	1,300	100	400	800	4,000	3,000	2,000	-----	11,600
4.1	130	100	-----	---	6,450	6,275	10,612	-----	23,567
4.2	------	100	-----	978	300	3,391	200	200	5,169
4.3	------	805	-----	---	------	4,130	------	-----	4,935
4.4	160	1,040	-----	---	850	3,330	------	120	5,500
5.1	500	250	-----	---	100	4,142	------	-----	4,992
5.2	200	680	200	---	800	5,670	------	200	7,750
Total	21,384	26,159	10,673	1,778	51,181	80,625	26,396	2,420	220,616

TABLE 15–2 Present Irrigation, Summary of Workshop Estimates by Lake Plan Area and State[1]

Lake Plan Area	State	CROP ACRES								
		Corn (Grain)	Fruits	Dry Beans	Sugar Beets	Potatoes	Vegetables	Sod	Misc.	Total Acres
Superior	Mich.	------	653	------	---	1,060	20	------	-----	1,733
Michigan	Ill.	500	------	------	---	------	------	3,100	-----	3,600
	Ind.	3,717	540	------		1,740	1,437	260	600	8,294
	Mich.	11,377	21,041	10,073		25,681	29,063	3,824	1,300	102,359
	Wisc.	3,500	650	------	---	9,800	20,117	6,400	-----	40,467
	Total	19,094	22,231	10,073	---	37,221	50,617	13,584	1,900	154,720
Huron	Mich.	1,300	300	400	800	4,400	3,050	2,000	-----	12,250
Erie	Mich.	130	100	------	---	6,450	6,275	10,612	-----	23,567
	N. Y.	160	975	------	---	350	2,895	------	120	4,500
	Ohio	------	905	------	978	300	7,521	200	200	10,104
	Pa.	------	65	------	---	500	435	------	-----	1,000
	Total	290	2,045	------	978	7,600	17,126	10,812	320	39,171
Ontario	N. Y.	700	930	200	---	900	9,812	------	200	12,742
	Ill.	500	------	------	---	------	------	3,100	-----	3,600
Total	Ind.	3,717	540	------	---	1,740	1,437	260	600	8,294
By	Mich.	12,807	22,094	10,473	800	37,591	38,408	16,436	1,300	139,909
State	N. Y.	860	1,905	200	---	1,250	12,707	------	320	17,242
	Ohio	------	905	------	978	300	7,521	200	200	10,104
	Pa.	------	65	------	---	500	435	------	-----	1,000
	Wisc.	3,500	650	------	---	9,800	20,117	6,400	-----	40,467
GLB	Total	21,384	26,159	10,673	1,778	51,181	80,625	26,396	2,420	220,616

[1] Workshops held with SCS District Conservationists. Base year was 1968.

Section 2

FUTURE IRRIGATION NEEDS

2.1 Methodology

Because soils currently irrigated are the most favorable for irrigation, future irrigation probably will occur on the same soil types (Section 4), and the percentage of irrigation for a specific crop on a particular soil will probably increase. Projections were for the following specialty or high-value crops: sugar beets, dry edible beans, potatoes, fruits, sod, and vegetables. Because irrigation of field crops is not generally economical, it is not expected to be developed and it is not included in these projections.

Information used for this projection was obtained from the economic base study (Section 1). Projections are made for total acres of crops that will be grown in 1980, 2000, and 2020. Projections for selected crops for each soil resource group are available. Soil resource groups (SRGs) are combinations of land capability units and soils that were grouped according to similarities of texture and management problems. (See Appendix 16, *Drainage,* for further description.)

The rate of irrigation acreage increase for each crop (except dry edible beans and sugar beets) was established by assuming that the percentage of that crop irrigated on each SRG would double in 10 years. This rate is believed to be reasonable. For example, if in 1968 10 percent of the total acreage producing a certain crop was irrigated, the projected amount of irrigated acreage would increase to 20 percent by 1980. If the projection for acreage in a particular crop decreased between 1968 and 1980, the number of acres irrigated was not doubled. The increases in percentages of crops irrigated for the years 1980–2000 and 2000–2020 were estimated to continue at a rate that doubles the percentage every 10 years. According to this procedure, the acres of crops grown on a particular SRG may be 100 percent irrigated by 2020, but because other SRGs may not be, less than 100 percent of the total acreage would be irrigated.

The steps of this procedure are listed below and are demonstrated using data from Planning Subarea 2.3, Vegetables, SRG 21:

(1) Percent irrigated in 1968 is 4,052 divided by 17,060 = 23.8 percent.

(2) Percent irrigated in 1980 is double that of 1968, or 47.6 percent.

(3) Irrigation rate will increase by 47.6 percent each 20 years until 2020 or until 100 percent is irrigated.

(4) Apply the percentage to the estimated acres cultivated for each projection year to calculate acres irrigated for this crop.

(5) This procedure was repeated for each SRG that reported irrigated acreage.

(6) The projected irrigation acres by soil resource group is totaled to obtain total projection for the crop by years.

Irrigated acres of dry edible beans and sugar beets probably will not increase as much as irrigation of other specialty or high-value crops. Therefore, a variation of the projection procedure described in the example table was used for these two crops. In this procedure the percentage of any irrigated soil group remained constant throughout the 52-year study period. This percentage can be used to compute total projected irrigated acres.

The procedure provides a consistent, resonable estimate for the future. It indicates an increase in irrigation of specialty crops without assuming that all of any crop will be irrigated. The projection indicates that soils with a high probability of being irrigated will experience an increase even without developments that may result from the *Great Lakes Basin Framework Study* or other planning studies.

Example Table

	1968	1980	2000	2020
Total Acres Farmed (all soil groups)	59,828	51,700	57,900	73,500
Percent Irrigated	35.6	55.8	79.3	80.6
Total Acres Irrigated	21,293	33,332	45,892	59,262

Data concerning irrigated golf courses were made available by the Outdoor Recreation Work Group in Appendix 21, *Outdoor Recreation.*

2.2 Projections

Projected irrigated acres are listed by planning subarea in Table 15–3. Planning Subarea 2.3 will experience the greatest increase, from 63,000 to 143,000 acres. Summaries of projections for plan areas and various crops are presented in Tables 15–4 and 15–5. Basin totals indicate an increase of 61,500 acres from 1968 to 1980, a 31 percent increase. In 2020, an estimated 522,000 acres will be irrigated, a 165 percent increase in a 52-year period. The rate increases from 5,100 acres per year for the first 12 years to 6,300 acres by 2000 and to 6,900 acres by 2020. The Lake Michigan basin is expected to continue to have the largest acreage in irrigation with 319,000 acres in 2020, a 140 percent increase. Lake Ontario basin irrigation will increase by 430 percent. Lake Huron basin has a two-fold increase, and Lake Erie basin a 175 percent increase.

A substantial amount of irrigated land consists of golf courses. It is assumed that under both present and projected conditions all golf course acreage is irrigated, and water sources are private or nonmunicipal systems (Table 15–6 and Appendix 21, *Outdoor Recreation*).

2.3 Potentially Irrigable Land

Potentially irrigable acres were identified only in the planning subarea for which irrigation was projected and only on the SRGs that were used in projecting irrigated acreage. Land with dry soil under present conditions in each of these groups was considered as potentially irrigable land, because no additional improvements would be required for flood prevention or improved drainage. Approximately 39 percent of all agricultural land in the planning subareas considered consists of this kind of soil. Table 15–7 gives a summary of potentially irrigable acres and their relation to projected acreage. The projected irrigation acreage for the entire Basin in 2020 is approximately 4.4 percent of the total land that is potentially irrigable (dry soil conditions). It has been assumed that adequate water sources can be located to meet needs by 2020. Considerably larger Basin acreage could be irrigated if flood prevention and drainage improvements were made.

TABLE 15–3 Projected Irrigation by Planning Subarea (Acres)[1]

Crop	1968	1980	2000	2020
Planning Subarea 1.2				
Fruits	653	74	106	117
Potatoes	1,060	465	509	758
Vegetables	20	53	53	27
Total	1,733	592	668	902
Planning Subarea 2.1				
Potatoes	9,012	10,449	16,046	19,479
Fruits	25	26	26	29
Vegetables	19,245	33,368	44,063	60,663
Total	28,282	43,843	60,135	80,171
Planning Subarea 2.2				
Potatoes	3,240	2,912	2,970	3,255
Sod	9,760	13,134	13,134	13,134
Fruits	650	491	810	1,182
Vegetables	1,039	2,653	6,283	11,763
Total	14,689	19,190	23,197	29,334
Planning Subarea 2.3				
Dry Edible Beans	8,350	8,339	9,878	12,781
Potatoes	16,045	7,589	9,905	13,185
Fruits	13,444	14,390	28,081	46,531
Sod	3,824	6,638	10,869	10,869
Vegetables	21,293	33,332	45,892	59,262
Total	62,956	70,288	104,625	142,628
Planning Subarea 2.4				
Fruits	8,112	17,098	31,876	42,233
Dry Edible Beans	1,723	1,146	847	498
Potatoes	8,924	1,281	1,187	989
Vegetables	9,040	12,789	17,720	23,341
Total	27,799	32,314	51,630	67,061
Planning Subarea 3.1				
Fruits	200	81	133	153
Potatoes	400	363	584	727
Vegetables	50	50	84	95
Total	650	494	801	975

[1] There is no present or projected irrigation for Planning Subareas 1.1 and 5.3.

TABLE 15–3(continued) Projected Irrigation by Planning Subarea (Acres)[1]

Crop	1968	1980	2000	2020
Planning Subarea 3.2				
Fruits	100	35	74	154
Dry Edible Beans	400	370	418	501
Sugar Beets	800	1,570	1,767	1,933
Sod	2,000	2,440	2,440	2,440
Potatoes	4,000	4,386	7,465	3,873
Vegetables	3,000	10,041	13,973	22,603
Total	10,300	18,842	26,137	31,504
Planning Subarea 4.1				
Fruits	100	317	674	1,256
Potatoes	6,450	1,889	1,537	1,953
Sod	10,612	16,103	17,054	17,054
Vegetables	6,275	10,161	17,527	22,565
Total	23,437	28,470	36,792	42,828
Planning Subarea 4.2				
Sugar Beets	978	1,738	1,709	1,738
Potatoes	300	531	774	1,523
Fruits	100	89	187	313
Vegetables	3,391	5,521	10,510	18,234
Sod	200	400	450	450
Total	4,969	8,279	13,630	22,258
Planning Subarea 4.3				
Fruits	805	892	1,559	2,621
Vegetables	4,130	4,801	5,560	5,604
Total	4,935	5,693	7,119	8,225
Planning Subarea 4.4				
Fruits	1,040	1,535	3,149	5,282
Potatoes	850	1,121	1,717	3,263
Vegetables	3,330	6,439	13,635	24,951
Total	5,220	9,095	18,501	33,496
Planning Subarea 5.1				
Fruits	250	278	565	951
Potatoes	100	129	196	384
Vegetables	4,142	9,741	20,773	35,220
Total	4,492	10,148	21,534	36,555
Planning Subarea 5.2				
Fruits	680	1,024	2,053	3,389
Dry Edible Beans	200	162	153	149
Potatoes	800	929	1,447	3,235
Vegetables	5,670	8,949	15,798	19,577
Total	7,350	11,064	19,451	26,350

[1] There is no present or projected irrigation for Planning Subareas 1.1 and 5.3.

TABLE 15–4 Summary of Projected Irrigation by Plan Area (Acres)

Crop	1968	1980	2000	2020
Lake Superior				
Fruits	653	74	106	117
Potatoes	1,060	465	509	758
Vegetables	20	53	53	27
Total	1,733	592	668	902
Lake Michigan				
Fruits	22,231	32,005	60,793	89,975
Potatoes	37,221	22,231	30,108	36,908
Vegetables	50,617	82,142	113,958	155,029
Sod	13,584	19,772	24,003	24,003
Dry Edible Beans	10,073	9,485	10,725	13,279
Total	133,726	165,635	239,587	319,194
Lake Huron				
Fruits	300	116	207	307
Potatoes	4,400	4,749	8,049	4,600
Vegetables	3,050	10,091	14,057	22,698
Dry Edible Beans	400	370	418	501
Sugar Beets	800	1,570	1,767	1,933
Sod	2,000	2,440	2,440	2,440
Total	10,950	19,336	26,938	32,479
Lake Erie				
Fruits	2,045	2,833	5,569	9,472
Potatoes	7,600	3,541	4,028	6,739
Vegetables	17,126	26,922	47,232	71,354
Sugar Beets	978	1,738	1,709	1,738
Sod	10,812	16,503	17,504	17,504
Total	38,561	51,537	76,042	106,807
Lake Ontario				
Fruits	930	1,302	2,618	4,340
Potatoes	900	1,058	1,643	3,619
Vegetables	9,812	18,690	36,571	54,797
Dry Edible Beans	200	162	153	149
Total	11,842	21,212	40,985	62,905

TABLE 15–5 Summary of Projected Irrigation by Crop (Acres)

Crop	1968	1980	2000	2020
Fruits	26,159	36,330	69,293	104,211
Potatoes	51,181	32,044	44,337	52,624
Vegetables	80,625	137,898	211,871	303,905
Sod	26,396	38,715	43,947	43,947
Dry Edible Beans	10,673	10,017	11,296	13,929
Sugar Beets	1,778	3,308	3,476	3,671
Basin Total	196,812	258,312	384,220	522,287

TABLE 15–6 Golf Course Acreage—Demand, Supply, and Needs

Planning Subarea	1970			1980			2000			2020		
	Demand	Supply	Needs	Demand	Supply	Needs	Demand	Supply	Needs	Demand	Supply	Needs
1.1	2,160	1,650	510	3,000	1,780	1,220	4,850	1,780	3,070	6,600	1,780	4,820
1.2	720	150	570	1,100	150	950	1,480	150	1,330	2,020	150	1,870
2.1	6,000	4,700	1,300	8,700	6,200	2,500	15,000	6,200	8,800	23,160	6,200	16,960
2.2	23,600	12,100	11,500	34,700	13,900	20,800	59,400	13,900	45,500	86,700	13,900	72,800
2.3	11,000	4,600	6,400	16,300	4,600	11,700	28,500	4,600	23,900	42,600	4,600	38,000
2.4	1,600	190	1,400	2,300	190	2,100	3,600	190	3,400	5,500	190	5,300
3.1	1,200	600	600	1,760	600	1,160	3,040	600	2,440	4,480	600	3,880
3.2	4,320	460	3,860	6,420	460	5,960	10,060	460	9,600	16,340	460	15,880
4.1	11,800	2,200	9,600	17,700	2,200	15,500	30,500	2,200	28,300	44,700	2,200	42,500
4.2	6,420	12,620	------	8,380	12,620	------	15,340	12,620	2,720	23,560	12,620	10,940
4.3	8,160	18,600	------	11,820	18,600	------	20,000	18,600	1,400	29,300	18,600	10,700
4.4	3,840	2,400	1,440	5,520	2,400	3,120	9,160	2,400	6,760	13,100	2,400	10,700
5.1	1,720	1,000	720	2,440	1,000	1,440	3,800	1,000	2,800	5,600	1,000	4,600
5.2	5,020	4,200	820	7,300	4,200	3,100	12,440	4,200	8,240	18,160	4,200	13,960
5.3	1,240	570	670	1,780	570	1,210	2,980	570	2,410	4,280	570	3,710

Source: Outdoor Recreation Work Group (Appendix 21).

TABLE 15–7 Potentially Irrigable Acres by Planning Subarea

Planning Subarea	Potentially Irrigable Acres	Irrigation in 2020	
		Projected Acres	Percent of Potential
1.2	93,345	902	1.0
2.1	1,231,285	80,171	6.5
2.2	1,680,429	29,334	1.7
2.3	2,413,489	142,628	5.9
2.4	937,703	67,061	7.2
3.1	199,551	975	0.5
3.2	1,019,482	31,504	3.1
4.1	766,495	42,828	5.6
4.2	1,711,490	22,258	1.3
4.3	173,806	8,225	4.7
4.4	353,957	33,496	9.5
5.1	507,971	36,555	7.2
5.2	883,018	26,350	3.0
Totals	11,972,021	522,287	4.4

Section 3

WATER REQUIREMENTS

3.1 Present Irrigation Water Use

The amount of present water used for Basin irrigation was determined so that a comparison could be made with future irrigation requirements. It is assumed that an adequate supply of water is available for all present irrigation. Present average rates of use were obtained from Michigan inventory data (Table 15–31). The rates for corn, dry beans, and sugar beets were assumed to be the same as for field crops (0.43 feet per year). Sod and potato rates used were 0.47 and 0.50 feet per year. The rate for fruits (0.48 feet per year) is a weighted average of all fruits listed in the table. A weighted average of tomatoes and truck crops was used for vegatables (0.48 feet per year). Miscellaneous use rate (1.23 feet per year) was computed from a weighted average for flowers and nurseries, cemeteries and parks, golf courses, and miscellaneous. The product of these rates and the acreage of the crops listed in Table 15–3 shows present irrigation use. Table 15–8 gives a summary of these volumes by planning subarea.

3.2 Future Water Requirements

Many factors operate singly or in combination to influence the amount of water required for irrigation. The effects of these factors are not necessarily constant and may vary with locality.

The amount and rate of precipitation are important. Precipitation may range from a series of light showers to heavy storms. Most of the moisture from a light shower may be lost through evaporation. A large portion of precipitation from a heavy storm may be lost by runoff, especially if it rains shortly after an irrigation application. An area with adequate precipitation may still require irrigation to meet the consumptive needs of a crop.

Other factors that influence the amount of irrigation water required include temperature and its distribution, length of the growing season, sunlight, humidity, wind movement, advection, and the stage of plant growth. Soil fertility and water quality may have a minor influence on consumptive use by a plant.

In order to project and plan water needs for the Basin, a computer analysis was made. A modified Blaney-Criddle method described in Soil Conservation Service Technical Release 21 was used to estimate irrigation water requirements.

The method uses data concerning average monthly temperatures and precipitation, planting and harvesting dates, soil moisture carry-over, plant consumptive use, length of day, and the growth stage of the crop. Conservation irrigation guides developed for each State were used as a basis for determining the depth of irrigation and the available moisture

TABLE 15–8 Summary of Present Irrigation Volumes Per Season, by Planning Subarea

Planning Subarea	Volume (acre-feet)
1.2	850
2.1	15,260
2.2	8,240
2.3	36,280
2.4	15,060
3.1	320
3.2	5,500
4.1	11,330
4.2	2,610
4.3	2,370
4.4	2,740
5.1	2,370
5.2	3,870
Total	106,700

capacity for various depths of each soil under consideration. Soil and weather data representative of various portions of each planning subarea were obtained. Water requirements were developed for various crops and these requirements were averaged for each portion of a planning subarea in order to obtain a requirement for the planning subarea (Table 15–9). These requirements are for a normal year with a 75-percent efficiency of application. Consumptive use of the crop would be three-fourths of the total requirement. If all other factors are favorable, these water requirements would meet optimum production.

Table 15–10 gives monthly irrigation water requirements, expressed as percentages of total seasonal use, and indicates when irrigation demands are the greatest and how they are distributed throughout the irrigation season.

The volume of water needed for each of the projected years is shown in Table 15–11. This requirement was obtained by multiplying the annual requirement value by the number of projected acres. Because volumes of water needed for leaching, frost protection, temperature control, and similar needs vary, they were not computed. During the irrigation season, these needs arise when other irrigation demands are low. By using 75-percent efficiency, the volume of water shown will be the volume needed from storage and/or ground water sources. Tables 15–10 and 15–11 were developed for only the specialty or high-value crops listed in Table 15–3.

In some areas, and especially for high-income crops, it may be desirable to provide for extreme conditions rather than for a normal year. Therefore, water requirements during the growing season were computed for high-value crops with an effective rainfall as determined from the 80 percent chance growing season rain-fall. These requirements would provide enough water for proper irrigation for eight years out of 10. These requirements were compared to those of a normal year. A multiplier factor to be used with normal-year requirements was determined for each crop. The computed factors were then averaged for the entire Great Lakes Basin. It was determined that a factor of 1.1 could be used for all crops except fruits, which would have a factor of 1.25. To determine how much water would be required in 8 of 10 years, multiply the factor times the projected water needs listed in Table 15–11.

Water requirements for golf courses were not computed by this method because several different and additional variables are involved. The volume of water required was computed by multiplying the acres of demand (Table 15–6) by the average application rate per year for each planning subarea. The application rate used was taken from "Irrigation in Michigan, 1970"[3] (Tables 15–31 through 15–38). Table 15–12 gives the volume of water needed for each of the projected years.

Water requirements for lawns and other types of nonagricultural irrigation (except golf course irrigation) were not computed. These types of water needs are considered in Appendix 6, *Water Supply—Municipal, Industrial, and Rural.*

TABLE 15–9 Gross Irrigation Requirements, Normal Year 75% Efficiency (Inches)

CROP	PLANNING SUBAREA												
	1.2	2.1	2.2	2.3	2.4	3.1	3.2	4.1	4.2	4.3	4.4[2]	5.1[2]	5.2[2]
Corn (Grain)	-----	12.44	14.71	16.99	15.39	16.62	17.38	18.18	16.17	15.11	-----	-----	-----
Strawberries	5.56	6.68	6.61	6.55	5.76	5.91	6.23	5.80	5.99	6.16	-----	-----	-----
Sweet Corn	9.84	9.11	11.00	12.89	11.09	11.79	12.51	13.00	11.43	10.14	-----	-----	-----
Small Vegetables	-----	7.30	8.32	9.35	8.58	8.93	9.28	9.31	8.11	7.53	5.05	6.16	7.27
Tomatoes	-----	-----	12.04	12.04	-----	-----	-----	12.38	10.63	9.52	4.00	-----	-----
Potatoes	13.01	13.64	15.50	17.37	15.07	15.56	17.10	18.23	15.53	14.80	13.85	16.80	19.75
Sod	-----	-----	22.48	22.48	-----	-----	22.07	23.02	23.74	21.65	-----	-----	-----
Deciduous Orchards	-----	9.77	10.66	11.55	9.41	10.27	11.58	12.25	11.75	12.00	-----	-----	-----
Soybeans	-----	-----	-----	14.76	-----	12.44	14.10	15.36	13.75	12.92	-----	-----	-----
Sugar Beets	-----	-----	-----	-----	-----	16.91	20.05	21.68	19.52	-----	-----	-----	-----
Beans (Dry)	-----	-----	-----	15.15	12.32	13.06	13.69	14.01	-----	12.01	-----	-----	-----
Wheat	-----	-----	-----	-----	-----	-----	10.61	12.21	14.26	-----	-----	-----	-----
Alfalfa	10.80	14.35	-----	-----	13.79	14.49	16.95	18.11	16.50	15.72	-----	-----	-----
Melons & Cantaloupes	-----	-----	-----	12.32	-----	-----	-----	10.10	12.19	-----	-----	-----	-----
Corn (Silage)	-----	10.69	-----	-----	13.70	14.51	15.33	-----	-----	12.43	-----	-----	-----
Blueberries	1.53	-----	-----	-----	1.98	-----	-----	-----	-----	-----	-----	-----	-----
Raspberries	2.25	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Snap Beans	-----	6.63	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pickles & Cucumbers	-----	8.21	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pasture Grasses	-----	-----	-----	-----	-----	-----	-----	-----	-----	15.71	-----	-----	-----
Grapes	-----	-----	-----	-----	-----	-----	-----	-----	5.84	-----	-----	-----	-----

TABLE 15–10 Monthly Irrigation Water Requirements, Percentage of Total Seasonal Use, Normal Year 75% Efficiency[1]

Crop	Percentage					
	May	June	July	August	September	October
Planning Subarea 1.2						
Fruits	----	63.0	37.0	----	----	---
Vegetables	----	----	49.2	50.8	----	---
Potatoes	----	0.4	36.6	47.5	15.5	---
Planning Subarea 2.1						
Fruits	12.1	29.7	24.8	33.4	----	---
Vegetables	----	8.6	40.0	40.7	10.7	---
Potatoes	----	----	31.7	46.5	21.8	---
Planning Subarea 2.2						
Fruits	9.8	26.7	30.4	31.6	1.5	---
Vegetables	----	9.8	48.3	36.9	5.0	---
Potatoes	----	1.1	31.2	43.2	24.4	0.1
Sod	7.5	23.4	30.3	24.8	13.7	0.3
Planning Subarea 2.3						
Fruits	8.1	24.4	34.7	30.2	2.6	---
Vegetables	----	10.8	55.7	33.5	----	---
Potatoes	----	2.0	30.8	40.7	26.3	0.2
Sod	7.5	23.4	30.3	24.8	13.7	0.3
Beans	----	12.2	45.9	32.3	9.6	---
Planning Subarea 2.4						
Fruits	13.5	30.0	24.4	32.1	----	---
Vegetables	----	13.6	55.0	31.4	----	---
Potatoes	----	8.1	39.0	42.9	10.0	---
Beans	----	10.5	45.2	37.4	6.9	---
Planning Subarea 3.1						
Fruits	11.5	34.5	24.4	29.6	----	---
Vegetables	----	16.7	53.8	29.5	----	---
Potatoes	----	8.5	41.2	42.4	7.9	---
Planning Subarea 3.2						
Fruits	15.8	22.6	37.1	24.5	----	---
Vegetables	----	20.7	55.8	23.5	----	---
Potatoes	----	9.9	40.9	40.5	8.7	---
Sod	10.5	23.3	29.9	23.7	12.4	0.2
Beans	----	11.2	39.1	27.6	2.1	---
Sugar Beets	----	12.0	31.7	33.9	19.5	2.9

[1]Monthly breakdown not available for Planning Subareas 4.4, 5.1, and 5.2.

TABLE 15-10(continued) Monthly Irrigation Water Requirements, Percentage of Total Seasonal Use, Normal Year 75% Efficiency[1]

Crop	Percentage					
	May	June	July	August	September	October
Planning Subarea 4.1						
Fruits	18.6	20.7	37.1	21.4	2.2	---
Vegetables	----	17.7	54.5	27.8	----	---
Potatoes	----	11.0	39.3	39.5	10.2	---
Sod	9.6	22.6	29.2	24.2	14.0	0.4
Planning Subarea 4.2						
Fruits	20.8	15.5	35.2	24.7	3.8	---
Vegetables	----	14.9	48.3	31.0	5.8	---
Potatoes	----	20.4	45.4	34.2	----	---
Sod	10.9	21.8	28.1	24.5	14.3	0.4
Sugar Beets	----	5.7	28.2	34.6	24.6	6.9
Planning Subarea 4.3						
Fruits	11.1	24.1	34.2	27.7	2.9	---
Vegetables	----	17.1	46.4	31.2	5.3	---

[1]Monthly breakdown not available for Planning Subareas 4.4, 5.1, and 5.2.

TABLE 15–11 Projected Irrigation Water Needs

	Projection Year		
	1980	2000	2020
	Volume Per Season (acre-feet)		
Planning Subarea 1.2			
Fruits	19	27	30
Potatoes	504	552	822
Vegetables	43	43	22
Total	566	622	874
Planning Subarea 2.1			
Potatoes	11,876	18,238	22,140
Fruits	18	18	20
Vegetables	21,716	28,676	39,479
Total	33,610	46,932	61,639
Planning Subarea 2.2			
Potatoes	3,727	3,802	4,166
Sod	24,560	24,560	24,560
Fruits	447	737	1,076
Vegetables	2,361	5,592	10,469
Total	31,095	34,691	40,271
Planning Subarea 2.3			
Dry Edible Beans	10,507	12,446	16,104
Potatoes	10,985	14,337	19,085
Fruits	12,159	23,728	39,319
Sod	12,435	20,361	20,361
Vegetables	31,749	43,712	56,447
Total	77,835	114,584	151,316
Planning Subarea 2.4			
Fruits	8,149	15,192	20,128
Dry Edible Beans	1,180	872	513
Potatoes	1,608	1,490	1,242
Vegetables	10,487	14,530	19,140
Total	21,424	32,084	41,023
Planning Subarea 3.1			
Fruits	55	90	103
Potatoes	471	757	943
Vegetables	43	73	82
Total	569	920	1,128

TABLE 15-11(continued) Projected Irrigation Water Needs

	Projection Year		
	1980	2000	2020
	Volume Per Season (acre-feet)		
Planning Subarea 3.2			
Fruits	26	55	114
Dry Edible Beans	421	476	571
Sugar Beets	2,622	2,951	3,228
Sod	4,487	4,487	4,487
Potatoes	6,250	10,638	16,677
Vegetables	9,120	12,692	20,530
Total	22,926	31,299	45,607
Planning Subarea 4.1			
Fruits	248	527	982
Potatoes	2,870	2,334	2,967
Sod	30,890	32,715	32,715
Vegetables	9,788	16,883	21,737
Total	43,796	52,459	58,401
Planning Subarea 4.2			
Sugar Beets	2,833	2,786	2,833
Potatoes	687	1,002	1,971
Fruits	66	139	233
Vegetables	4,628	8,811	15,286
Sod	791	890	890
Total	9,005	13,628	21,213
Planning Subarea 4.3			
Fruits	675	1,180	1,983
Vegetables	3,632	4,206	4,240
Total	4,307	5,386	6,223
Planning Subarea 4.4			
Fruits	1,017	2,086	3,499
Potatoes	1,294	1,982	3,766
Vegetables	2,710	5,738	10,499
Total	5,021	9,806	17,764
Planning Subarea 5.1			
Fruits	184	374	630
Potatoes	181	274	538
Vegetables	5,000	10,663	18,078
Total	5,365	11,311	19,246
Planning Subarea 5.2			
Fruits	678	1,360	2,245
Dry Edible Beans	185	175	170
Potatoes	1,529	2,381	5,324
Vegetables	5,421	9,570	11,860
Total	7,813	13,486	19,599

TABLE 15-12 Projected Irrigation Water Needs, Golf Courses

Planning Subarea	Projection Year 1980	2000	2020
	Volume Per Season (Acre-Feet)		
1.1[1]	3,720	6,014	8,184
1.2	1,364	1,835	2,504
2.1	11,484	19,800	30,571
2.2[2]	50,315	86,130	125,715
2.3	22,657	39,615	59,214
2.4	2,553	3,996	6,105
3.1	2,147	3,709	5,466
3.2	7,126	11,167	18,137
4.1	29,559	50,935	74,649
4.2[2]	12,151	22,243	34,162
4.3[2]	17,139	29,000	42,485
4.4[2]	8,004	13,282	18,995
5.1[2]	3,538	5,510	8,120
5.2[2]	10,585	18,038	26,332
5.3[2]	2,581	4,321	6,206

[1]Volume computed using application rate of Planning Subarea 1.2, 1.24 Ft/Yr

[2]Volume computed using average application rate for Michigan, 1.45 Ft/Yr

Section 4

SOIL INTERPRETATIONS FOR IRRIGATION

Soil associations are groupings of two or more similar or dissimilar soil series naturally occurring together as combinations of soils and land units. The soil association is given the names of the predominant soil series within the association, such as "Miami, Conover." The dominant soil series is listed first. Soil series other than those listed may occur within the association.

4.1 Methodology

In order to determine which soils are best for irrigation, soil limitations were identified. Soils in each association were rated according to texture in the root zone; permeability of most restrictive layer; water intake rate; available water capacity; drainage; and slope. Three degrees of limitation were established: slight, moderate, and severe (Table 15–13).

4.2 Limitations for Soil Associations

Each soil association limitation is based on the rating of all the soil series within the association. Greater value was placed on the dominant soil series. Each rating (slight, moderate, or severe) is applied to soils that are irrigable but have varying degrees of limitations. A slight rating for an association indicates there are no, or only slight, soil limitations to irrigation. Desirable soils with some limitations have been rated as moderate. A severe rating indicates that the association contains soils less desirable, or not recommended, for irrigation.

Irrigation limitation ratings are based solely upon soil conditions. They do not include an analysis of the availability of water of suitable quantity or quality, nor development potential. Tables 15–14 through 15–28 list the limitation rating for each characteristic in a soil series, each soil series within the association, and each association in a planning subarea. In these tables, the soil series and associations not recommended for agricultural use are labeled as nonagricultural.

Soil associations with slight limitations only appear in Planning Subareas 4.4, 5.1, and 5.2. Although some of the soil characteristics and series within an association may have slight limitations, due to the limitations of other characteristics or series, the association may still not be rated as having a slight limitation.

Planning subarea maps were developed from soil association maps of the eight Basin States. Figures 15–3 through 15–17 show the relative conditions of predominant soils and irrigation limitations of soil associations. Onsite investigations would be necessary before irrigation systems are prepared. These maps only show the best irrigation locations based on natural soil conditions.

TABLE 15–13 Soil Characteristics to Determine Irrigation Limitations

	Slight	Moderate	Severe
Texture in Root Zone	Medium and Moderately Fine	Moderately Coarse	Fine and Coarse
Permeability of Most Limiting Horizon	2.0 to 6.3 in/hr	0.2 to 2.0 in/hr	Less than 0.2 in/hr More than 6.3 in/hr
Water Intake Rate	More than 0.5 in/hr	0.5 to 0.3 in/hr	Less than 0.3 in/hr
Available Water Capacity	More than 0.15 in/hr	0.10 to 0.15 in/hr	Less than 0.10 in/hr
Drainage	Well Drained	Moderately Well Drained	Somewhat Poorly Drained
Slope	0–6 percent	7–12 percent	More than 12 percent

TABLE 15–14 Irrigation Limitations, Planning Subarea 1.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MINNESOTA									
24	NEBISH	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
	ROCKWOOD	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
28	MILACA	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
	CHETEK	Moderate	Slight	Slight	Severe	Slight	Slight	Moderate	
29	MILACA	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
	MORA	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	RONNEBY	Slight	Moderate	Slight	Moderate	Severe	Slight	Severe	
31	HIBBING	Severe	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	ZIM	Severe	Moderate	Moderate	Slight	Severe	Slight	Severe	
32	ONTONAGON	Slight	Severe	Moderate	Slight	Slight	Slight	Severe	Severe
	BERGLAND	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
40	HIWOOD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	PEAT	Slight	Severe	Slight	Slight	Severe	Slight	Severe	
41	INDUS	Severe	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	TAYLOR	Severe	Severe	Severe	Slight	Moderate	Slight	Severe	
	PEAT	Slight	Severe	Slight	Slight	Severe	Slight	Severe	
43	SPOONER	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	Severe
	PEAT	Slight	Severe	Slight	Slight	Severe	Slight	Severe	
	SWATARA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
45	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
	SPOONER	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	
46	AHMEEK	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	ROCK OUTCROPS			NON-AGRICULTURAL					
47	CLOQUET	Moderate	Slight	Slight	Severe	Slight	Moderate	Severe	Severe
	TAYLOR	Severe	Severe	Severe	Slight	Moderate	Slight	Severe	
	ROCK OUTCROPS			NON-AGRICULTURAL					
48	ONTONAGON	Slight	Severe	Moderate	Slight	Slight	Slight	Severe	Severe
	ROCK OUTCROPS			NON-AGRICULTURAL					
49	(ROUGH ROCK OUTCROP AREAS)			NON-AGRICULTURAL					
52	CHETEK	Moderate	Slight	Slight	Severe	Slight	Slight	Moderate	Severe
	MENAHGA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
55	MENAGHA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	MARQUETTE	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
56	OMEGA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	CLOQUET	Moderate	Slight	Slight	Severe	Slight	Moderate	Severe	
WISCONSIN									
53	SANTIAGO	Slight	Moderate	Moderate	Slight	Slight	Slight	Moderate	Moderate
	FREEON	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
	FREER	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
56	MILACA	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
	CLOQUET	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	VILAS	Severe	Slight	Slight	Severe	Slight	Slight	Severe	
69	IRON RIVER	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	GOGEBIC	Moderate	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	MARENISCO	Severe	Slight	Slight	Severe	Slight	Moderate	Severe	
	WAKEFIELD	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	

TABLE 15–14(continued) Irrigation Limitations, Planning Subarea 1.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
WISCONSIN									
70	ELDERON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	CLOQUET	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	KALKASKA	Severe	Slight	Slight	Severe	Slight	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
71	KALKASKA	Severe	Slight	Slight	Severe	Slight	Slight	Severe	Moderate
	CLOQUET	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	IRON RIVER	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	MARENISCO	Severe	Slight	Slight	Severe	Slight	Moderate	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
77	GOODMAN	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	IRON RIVER	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	ELDERON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	ADOLPH	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
106	OMEGA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	CRIVITZ	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PENCE	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
122	ONTONAGON	Slight	Severe	Moderate	Slight	Slight	Slight	Severe	Severe
	PICKFORD	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
	BERGLAND	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
123	ONTONAGON	Slight	Severe	Moderate	Slight	Slight	Slight	Severe	Severe
	SUPERIOR	Severe	Severe	Severe	Slight	Moderate	Moderate	Severe	
	MANISTEE	Severe	Slight	Slight	Severe	Slight	Slight	Severe	
	HIBBING	Severe	Severe	Severe	Slight	Slight	Moderate	Severe	
125	ORGANIC SOILS OVER CLAY	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	Moderate

TABLE 15–15 Irrigation Limitations, Planning Subarea 1.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
1	MUNISING	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	KEWEENAW	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	SKANEE	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
2	IRON RIVER (Silt Loam)	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
3	IRON RIVER (Loam)	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
4	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	WAKEFIELD	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate	
	TULA	Moderate	Moderate	Slight	Moderate	Moderate	Slight	Moderate	
5	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	TRENARY	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
6	MUNISING	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	KEWEENAW	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
7	KEWEENAW	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
8	KEWEENAW	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	MUNISING	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
9	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	OMEGA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PENCE	Moderate	Severe	Slight	Severe	Slight	Moderate	Severe	
10	ONOTA	Moderate	Slight	Slight	Severe	Slight	Slight	Severe	Severe
	WAISKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
11	BARAGA	Slight	Severe	Slight	Moderate	Slight	Slight	Severe	Severe
	CHAMPION	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
12	CHAMPION	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate
	ROCK KNOBS			NON-AGRICULTURAL					
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
13	IRON RIVER	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	ROCK KNOBS			NON-AGRICULTURAL					
14	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	ROCK KNOBS			NON-AGRICULTURAL					
	AHMEEK	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
15	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	MUNISING	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	ROCK KNOBS			NON-AGRICULTURAL					
16	ONTONAGON	Slight	Severe	Moderate	Slight	Slight	Slight	Severe	Severe
	PICKFORD	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
17	PICKFORD	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	BERGLAND	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
18	WATTON	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	ONTONAGON	Slight	Severe	Moderate	Slight	Slight	Slight	Severe	
	BOHEMIAN	Slight	Slight	Moderate	Slight	Slight	Slight	Moderate	

TABLE 15–15(continued) Irrigation Limitations, Planning Subarea 1.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
22	ONAWAY	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Moderate
	McBRIDE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GUELPH	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
23	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	Moderate
	RICHTER	Moderate	Moderate	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
24	BRUCE	Slight	Moderate	Moderate	Moderate	Severe	Slight	Moderate	Moderate
	BRIMLEY	Slight	Moderate	Moderate	Moderate	Severe	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
26	MONTCALM	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	EMMET (undulating)	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
27	MONTCALM	Severe	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Severe	Severe	
	EMMET (hilly)	Moderate	Moderate	Slight	Moderate	Slight	Severe	Severe	
28	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GRAYLING	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
29	ROSCOMMON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
30	LONGRIE	Slight	Moderate	Slight	Moderate	Slight	Moderate	Severe	Severe
	SUMMERVILLE	Slight	Severe	Moderate	Severe	Slight	Moderate	Severe	
	ST. IGNACE	Slight	Severe	Moderate	Severe	Slight	Moderate	Severe	
43	ORGANIC SOILS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	Severe

TABLE 15–16 Irrigation Limitations, Planning Subarea 2.1

SOIL ASSOCIATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERMEABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAINAGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCIATION
WISCONSIN									
21	DODGE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	KENDELL	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	KOKOMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
22	McHENRY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	KOKOMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	MUCK	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	
23	McHENRY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	LAPEER	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	CASCO	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	WYOCENA	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
24	RIPON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Severe
	CORWIN	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	KOKOMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
25	WYOCENA	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	COLOMA	Severe	Slight	Slight	Severe	Slight	Moderate	Severe	
	ROSEMOUNT	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
26	PECATONICA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	WESTVILLE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	ROCKTON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
31	ELLIOT	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	MORLEY	Slight	Severe	Moderate	Slight	Slight	Moderate	Severe	
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	ASKUM	Slight	Moderate	Severe	Slight	Severe	Slight	Severe	
37	ONAWAY	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
38	ONAWAY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	SOLONA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
39	ONAWAY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	KEWAUNEE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	SOLONA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
40	SOLONA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	OSHKOSH	Severe	Severe	Severe	Moderate	Moderate	Slight	Severe	
	ONAWAY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
41	LONGRIE	Slight	Moderate	Moderate	Moderate	Moderate	Slight	Moderate	Moderate
	ONAWAY	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	DETOUR	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate	
	RUSE	Severe	Slight	Slight	Severe	Severe	Slight	Severe	
42	TRENARY	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	EMMET	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
44	KEWAUNEE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	OSHKOSH	Severe	Severe	Severe	Moderate	Moderate	Slight	Severe	
	MANAWA	Severe	Moderate	Moderate	Slight	Severe	Slight	Severe	
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	

TABLE 15–16(continued) Irrigation Limitations, Planning Subarea 2.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
WISCONSIN									
45	OTTAWA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	OSHKOSH	Severe	Severe	Severe	Moderate	Moderate	Slight	Severe	
	WAUSEON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	
47	OTTAWA	Severe	Slight	Slight	Severe	Slight	Moderate	Severe	Moderate
	OSHKOSH	Severe	Severe	Severe	Moderate	Moderate	Slight	Severe	
	KEWAUNEE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	
54	KENNAN	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	NORRIE	Slight	Moderate	Moderate	Slight	Slight	Slight	Moderate	
	ELDERON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
64	AUBURNDALE	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	WITHEE	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	DOLPH	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
	ADOLPH	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
74	MEDIUM TEX-TURE POORLY DRAINED	Slight	Moderate	Moderate	Severe	Slight	Moderate	Severe	Severe
75	GRANITE ROCK L.			NON-AGRICULTURAL					Severe
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	OMEGA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
77	GOODMAN	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	IRON RIVER	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	ELDERON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	ADOLPH	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
78	KENNAN	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	IRON RIVER	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	ELDERON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
80	IRON RIVER	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	ELDERON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
84	BURKHARDT	Moderate	Moderate	Slight	Severe	Slight	Slight	Severe	Severe
	SPARTA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
100	ANTIGO	Slight	Moderate	Moderate	Slight	Slight	Slight	Moderate	Moderate
	BRILL	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
	POSKIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
101	POSKIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	BRILL	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
	ANTIGO	Slight	Moderate	Moderate	Slight	Slight	Slight	Moderate	
102	BURKHARDT	Moderate	Moderate	Slight	Severe	Slight	Slight	Severe	Severe
	ONAMIA	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate	
	CHETEK	Moderate	Moderate	Slight	Severe	Slight	Slight	Severe	
105	OMEGA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	CHETEK	Moderate	Moderate	Slight	Severe	Slight	Slight	Severe	

TABLE 15–16(continued) Irrigation Limitations, Planning Subarea 2.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
WISCONSIN									
106	OMEGA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	CRIVITZ	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PENCE	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
107	NEEKOOSA	Severe	Severe	Slight	Severe	Moderate	Slight	Severe	Severe
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	MORROCCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PEAT & MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
109	STAMBAUGH	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate
	PENCE	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
120	OSHKOSH	Severe	Severe	Severe	Moderate	Slight	Slight	Severe	Severe
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	
	WAUSEON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
126	GRANBY	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	BERRIEN	Severe	Severe	Slight	Severe	Moderate	Slight	Severe	
	OTTAWA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	SHIOCTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	SURING	Severe	Slight	Slight	Severe	Severe	Slight	Severe	
	SHAWANO	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
127	SHAWANO	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	OCONTO	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	SURING	Severe	Slight	Slight	Severe	Severe	Slight	Severe	
	GRANBY	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
128	SHAWANO	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	LEEMAN	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	GRANBY	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
129	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	
	KEOWNS	Slight	Slight	Moderate	Moderate	Severe	Slight	Severe	
	PELLA	Slight	Slight	Moderate	Slight	Severe	Slight	Severe	
130	TUSCOLA	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Severe
	SHIOCTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	KEOWNS	Slight	Slight	Moderate	Moderate	Severe	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
131	LEEMAN	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	SHAWANO	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	EMMET	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate	
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
MICHIGAN									
2	IRON RIVER (Silt Loam)	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
3	IRON RIVER (Loam)	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	

TABLE 15–16(continued) Irrigation Limitations, Planning Subarea 2.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
5	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Severe
	TRENARY	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
7	MARENISCO	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
9	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	OMEGA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PENCE	Moderate	Severe	Slight	Severe	Slight	Moderate	Severe	
11	BARAGA	Slight	Severe	Slight	Moderate	Slight	Slight	Severe	Severe
	CHAMPION	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
13	IRON RIVER	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	ROCK KNOBS			NON-AGRICULTURAL					
22	ONAWAY	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Moderate
	McBRIDE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GUELPH	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
26	MONTCALM	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	EMMET (undulating)	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
29	ROSCOMMON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	

TABLE 15–17 Irrigation Limitations, Planning Subarea 2.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
31	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ST. CLAIR	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
37	FOX	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate
	OSHTEMO	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
39	FOX	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	BOYER	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
41	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	OTTAWA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
INDIANA									
1	GENESEE	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	Moderate
5	FOX	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate
	OSHTEMO	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
7	ALIDA	Slight	Moderate	Moderate	Moderate	Severe	Slight	Severe	Severe
	DEL REY	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	
	WHITAKER	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
8	DOOR	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	BYRON	Slight	Severe	Slight	Moderate	Slight	Moderate	Severe	
9	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	WATSEKA	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
9A	OAKVILLE	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	TAWAS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
9B	OAKVILLE	Severe	Severe	Slight	Severe	Slight	Severe	Severe	Severe
9C	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	CHELSEA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
10	GILFORD	Severe	Slight	Slight	Moderate	Severe	Slight	Severe	Severe
	RENSSELAER	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
10A	BONO	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	WARNERS	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	MAUMEE	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
10B	MAUMEE	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	TRACY	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	HOUGHTON	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
10C	MAUMEE	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	GILFORD	Severe	Slight	Slight	Moderate	Severe	Slight	Severe	
	RENSSELAER	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
12	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
	PEWAMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
12A	TRACY	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GALENA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	

TABLE 15-17(continued) Irrigation Limitations, Planning Subarea 2.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
INDIANA									
16	BROOKSTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	GALENA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	OTIS	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
19	ELLIOT	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	MARKHAM	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEWAMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
ILLINOIS									
B	SIDELL	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	Moderate
	CATLIN	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	
	FLANAGAN	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	
	DRUMMER	Moderate	Moderate	Slight	Slight	Severe	Slight	Severe	
G	WARSAW	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	CARMI	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	RODMAN	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
H	RINGWOOD	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	Moderate
	GRISWOLD	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
	DURAND	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
I	LAROSE	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
	SAYBROOK	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	
	LISBON	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	
J	ELLIOT	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	Severe
	ASHKUM	Moderate	Moderate	Moderate	Slight	Severe	Slight	Severe	
	ANDRES	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	
K	SWYGERT	Slight	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	BRYCE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
	CLARENCE	Slight	Severe	Severe	Slight	Severe	Slight	Severe	
	ROWE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
M	BIRKBECK	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	Moderate
	WARD	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	RUSSELL	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
S	FOX	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	HOMER	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
	CASCO	Moderate	Moderate	Slight	Severe	Slight	Moderate	Severe	
T	McHENRY	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
	LAPEER	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	PECATONICA	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
U	STRAWN	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
	MIAMI	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
V	MORLEY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	BEECHER	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
W	LITTLETON	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	Moderate
	PROCTOR	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	
	PLANO	Slight	Moderate	Slight	Slight	Slight	Slight	Slight	
	CAMDEN	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	
	HURST	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	GINAT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	

TABLE 15–17(continued) Irrigation Limitations, Planning Subarea 2.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
ILLINOIS									
X	SPARTA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	RIDGEVILLE	Slight	Slight	Slight	Moderate	Severe	Slight	Severe	
	BLOOMFIELD	Severe	Moderate	Slight	Severe	Slight	Moderate	Severe	
	ALVIN	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
Y	CHANNAHON	Slight	Moderate	Slight	Severe	Slight	Moderate	Severe	Severe
	DODGEVILLE	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	DUBUQUE	Slight	Moderate	Moderate	Severe	Slight	Moderate	Severe	
	DERINDA	Slight	Severe	Moderate	Severe	Slight	Moderate	Severe	
WISCONSIN									
21	DODGE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	KENDELL	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	KOKOMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
22	McHENRY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	KOKOMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	MUCK	Slight	Moderate	Slight	Slight	Severe	Slight	Severe	
24	RIPON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	CORWIN	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	KOKOMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
26	PECATONICA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	WESTVILLE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	ROCKTON	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
28	PECATONICA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PELLA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
32	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	ELLIOT	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	ASHKUM	Slight	Moderate	Severe	Slight	Severe	Slight	Severe	
43	KEWAUNEE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	MORLEY	Slight	Moderate	Severe	Slight	Moderate	Moderate	Severe	
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
44	KEWAUNEE	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	OSHKOSH	Severe	Severe	Severe	Moderate	Moderate	Slight	Severe	
	MANAWA	Severe	Moderate	Moderate	Slight	Severe	Slight	Severe	
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	
91	WEA	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	WARSAW	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	
	MATHERTON	Slight	Moderate	Moderate	Moderate	Severe	Slight	Severe	
	SEBEWA	Slight	Moderate	Moderate	Moderate	Severe	Slight	Severe	
93	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	CASCO	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	
	OSHTEMO	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	CHELSEA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
94	CASCO	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	McHENRY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	RODMAN	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	

TABLE 15–17(continued) Irrigation Limitations, Planning Subarea 2.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
WISCONSIN									
95	CASCO	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	McHENRY	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	
	RODMAN	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
120	OSHKOSH	Severe	Severe	Severe	Moderate	Slight	Slight	Severe	Severe
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	
	WAUSEON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
128	SHAWANO	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	LEEMAN	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	GRANBY	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEAT	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
129	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
	POYGAN	Severe	Moderate	Severe	Slight	Severe	Slight	Severe	
	KEOWNS	Slight	Slight	Moderate	Moderate	Severe	Slight	Severe	
	PELLA	Slight	Slight	Moderate	Slight	Severe	Slight	Severe	

TABLE 15–18 Irrigation Limitations, Planning Subarea 2.3

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
19	NESTER	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	SELKIRK	Severe	Severe	Moderate	Slight	Moderate	Moderate	Severe	
20	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	CAPAC	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
22	ONAWAY	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Moderate
	McBRIDE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GUELPH	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
25	BREVORT	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
26	MONTCALM	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	EMMET (undulating)	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
27	MONTCALM	Severe	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Severe	Severe	
	EMMET (hilly)	Moderate	Moderate	Slight	Moderate	Slight	Severe	Severe	
28	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GRAYLING	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
29	ROSCOMMON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
31	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ST. CLAIR	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
32	BROOKSTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	HOYTVILLE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
34	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	CONOVER	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
35	COLDWATER	Slight	Moderate	Moderate	Moderate	Severe	Slight	Severe	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
36	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	FOX	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	SPINKS	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
37	FOX	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate
	OSHTEMO	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
38	WARSAW	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate
39	FOX	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	BOYER (hilly)	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
41	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	OTTAWA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	

TABLE 15–18(continued) Irrigation Limitations, Planning Subarea 2.3

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
42	COLOMA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	SPINKS	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
43	ORGANIC SOILS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	Moderate
INDIANA									
3	CARLISLE	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
	HOUGHTON	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
	EDWARDS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
3A	CARLISLE	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
	HOUGHTON	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
4	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	OCKLEY	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
4A	FOX, kame phase	Slight	Moderate	Moderate	Moderate	Slight	Severe	Severe	Severe
5	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	OSHTEMO	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
5A	BREMS	Moderate	Severe	Slight	Severe	Moderate	Slight	Severe	Moderate
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	
	OSHTEMO	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
5C	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	OSHTEMO	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
8A	TRACY	Slight	Moderate	Slight	Moderate	Slight	Severe	Severe	Moderate
	HANNA	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	DOOR	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	LYDICK	Slight	Moderate	Slight	Moderate	Slight	Severe	Severe	
9D	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GILFORD	Severe	Slight	Slight	Moderate	Severe	Slight	Severe	
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
9E	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
9F	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	CHELSEA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	TYNER	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
10C	MAUMEE	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	GILFORD	Severe	Slight	Slight	Moderate	Severe	Slight	Severe	
	RENSSELAER	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
11	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	PEWAMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
12B	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	ST. CLAIR	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
13	BROOKSTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	CROSBY	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	GALENA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
13A	BROOKSTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	CROSBY	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	

TABLE 15–18(continued) Irrigation Limitations, Planning Subarea 2.3

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
INDIANA									
13B	BROOKSTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ST. CLAIR	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
13C	BROOKSTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	CROSBY	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
15A	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
15B	CROSBY	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
15C	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Severe
	CROSBY	Slight	Severe	Moderate	Slight	Severe	Moderate	Severe	
	BROOKSTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
15D	PARR	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
16	BROOKSTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	GALENA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	OTIS	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	HILLSDALE	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
16A	BREMEN	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	CROSBY	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
16B	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	HILLSDALE	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
40	VOLINIA	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	DICKINSON	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
41	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	FOX	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	KENDALLVILLE	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
42	HOMER	Slight	Moderate	Slight	Severe	Severe	Slight	Severe	Severe
	GILFORD	Severe	Slight	Slight	Moderate	Severe	Slight	Severe	
	WESTLAND	Slight	Severe	Slight	Moderate	Severe	Slight	Severe	
	SEBEWA	Slight	Moderate	Slight	Moderate	Severe	Slight	Severe	
43	BOYER	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	OSHTEMO	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	VOLINIA	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	

TABLE 15–19 Irrigation Limitations, Planning Subarea 2.4

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
1	MUNISING	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	KEWEENAW	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	SKANEE	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
5	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	TRENARY	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
7	MARENISCO	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	VILAS	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
8	KEWEENAW	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	MUNISING	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
9	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	OMEGA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	PENCE	Moderate	Severe	Slight	Severe	Slight	Moderate	Severe	
10	ONOTA	Moderate	Slight	Slight	Severe	Slight	Slight	Severe	Severe
	WAISKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
12	CHAMPION	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	Moderate
	ROCK KNOBS			NON-AGRICULTURAL					
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
13	IRON RIVER	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	GOGEBIC	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
	ROCK KNOBS			NON-AGRICULTURAL					
16	ONTONAGON	Severe	Severe	Severe	Slight	Moderate	Moderate	Severe	Severe
	PICKFORD	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
17	PICKFORD	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	BERGLAND	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
18	WATTON	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	ONTONAGON	Severe	Severe	Severe	Slight	Moderate	Moderate	Severe	
	BOHEMIAN	Slight	Slight	Moderate	Slight	Slight	Slight	Moderate	
19	NESTER	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	SELKIRK	Severe	Severe	Moderate	Slight	Moderate	Moderate	Severe	
20	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	CAPAC	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
22	ONAWAY	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Moderate
	McBRIDE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GUELPH	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
23	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	Moderate
	RICHTER	Moderate	Moderate	Slight	Severe	Severe	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
25	BREVORT	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	

TABLE 15-19(continued) Irrigation Limitations, Planning Subarea 2.4

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
26	MONTCALM	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
27	MONTCALM	Severe	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Severe	Severe	
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Severe	Severe	
28	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GRAYLING	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
29	ROSCOMMON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
30	LONGRIE	Slight	Moderate	Slight	Moderate	Slight	Moderate	Severe	Severe
	SUMMERVILLE	Slight	Severe	Moderate	Severe	Slight	Moderate	Severe	
	ST. IGNACE	Slight	Severe	Moderate	Severe	Slight	Moderate	Severe	
43	ORGANIC SOILS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	Moderate

TABLE 15–20 Irrigation Limitations, Planning Subarea 3.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
MICHIGAN									
16	ONTONAGON	Severe	Severe	Severe	Slight	Moderate	Moderate	Severe	Severe
	PICKFORD	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
17	PICKFORD	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	BERGLAND	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
19	NESTER	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	SELKIRK	Severe	Severe	Moderate	Slight	Moderate	Moderate	Severe	
20	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	CAPAC	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
21	WISNER	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	ESSEXVILLE	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	MARSH	NON-AGRICULTURAL							
22	ONAWAY	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Moderate
	McBRIDE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GUELPH	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
23	ANGELICA	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	Moderate
	RICHTER	Moderate	Moderate	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
24	BRUCE	Slight	Moderate	Moderate	Moderate	Severe	Slight	Moderate	Moderate
	BRIMLEY	Slight	Moderate	Moderate	Moderate	Severe	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
25	BREVORT	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
26	MONTCALM	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
27	MONTCALM	Severe	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Severe	Severe	
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Severe	Severe	
28	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GRAYLING	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
29	ROSCOMMON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
30	LONGRIE	Slight	Moderate	Slight	Moderate	Slight	Moderate	Severe	Severe
	SUMMERVILLE	Slight	Severe	Moderate	Severe	Slight	Moderate	Severe	
	ST. IGNACE	Slight	Severe	Moderate	Severe	Slight	Moderate	Severe	
43	ORGANIC SOILS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	Moderate

TABLE 15-21 Irrigation Limitations, Planning Subarea 3.2

SOIL ASSOCIATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERMEABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAINAGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCIATION
MICHIGAN									
19	NESTER	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	SELKIRK	Severe	Severe	Moderate	Slight	Moderate	Moderate	Severe	
20	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	CAPAC	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
21	WISNER	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	ESSEXVILLE	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	MARSH			NON-AGRICULTURAL					
22	ONAWAY	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Moderate
	McBRIDE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GUELPH	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
25	BREVORT	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
26	MONTCALM	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
27	MONTCALM	Severe	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Severe	Severe	
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Severe	Severe	
28	RUBICON	Severe	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	GRAYLING	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
29	ROSCOMMON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
31	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ST. CLAIR	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
32	BROOKSTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	HOYTVILLE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
34	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	CONOVER	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
36	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	SPINKS	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
39	FOX	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	BOYER	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
43	ORGANIC SOILS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	Moderate

TABLE 15–22 Irrigation Limitations, Planning Subarea 4.1

SOIL ASSOCIATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERMEABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAINAGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCIATION
MICHIGAN									
20	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	Moderate
	KAWKAWLIN	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	CAPAC	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
22	ONAWAY	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Moderate
	McBRIDE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	GUELPH	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
25	BREVORT	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	IOSCO	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	SIMS	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
27	MONTCALM	Severe	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	KALKASKA	Severe	Severe	Slight	Severe	Slight	Severe	Severe	
	EMMET	Moderate	Moderate	Slight	Moderate	Slight	Severe	Severe	
29	ROSCOMMON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	AU GRES	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	PEATS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	
31	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ST. CLAIR	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
32	BROOKSTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	HOYTVILLE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
33	TOLEDO	Moderate	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	COLWOOD	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
34	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	CONOVER	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
36	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	SPINKS	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
37	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	OSHTEMO	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	
39	FOX	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	BOYER	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
40	BERRIEN	Moderate	Severe	Moderate	Severe	Moderate	Slight	Severe	Severe
	WAUSEON	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	
41	PLAINFIELD	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	NEWTON	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
	OTTAWA	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
43	ORGANIC SOILS	Slight	Slight	Slight	Slight	Severe	Slight	Moderate	Moderate

TABLE 15–23 Irrigation Limitations, Planning Subarea 4.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
OHIO									
1	HOYTVILLE	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
3	LATTY	Moderate	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
4	PAULDING	Severe	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	ROSELMS	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
5	TOLEDO	Moderate	Severe	Slight	Slight	Severe	Slight	Severe	Severe
	LENAWEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	FULTON	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
6	TUSCOLA	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate
	KIBBIE	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
	COLWOOD	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
8	MIXED SANDS	Severe	Severe	Slight	Severe	Moderate	Slight	Severe	Severe
9	MILTON	Slight	Moderate	Moderate	Slight	Slight	Slight	Moderate	Severe
	MILLSDALE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
10	WARNER'S LOAM	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
11	BLOUNT	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	PEWAMO	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	MORLEY	Severe	Severe	Moderate	Slight	Moderate	Moderate	Severe	
12	MORLEY	Severe	Severe	Moderate	Slight	Moderate	Moderate	Severe	Severe
	BLOUNT	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
	PEWAMO	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
14	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	CELINA	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
15	CROSBY	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Moderate
	BROOKSTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
30	PAINESVILLE	Moderate	Moderate	Slight	Slight	Slight	Slight	Moderate	Severe
	CANEADEA	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
	CANADICE	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
32	ALLIS	Severe	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	WICKLIFFE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
	FRIES	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
33	LORAIN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	MONROEVILLE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
36	MAHONING	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	TRUMBULL	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
41	ALEXANDRIA	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	CARDINGTON	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
	BENNINGTON	Severe	Moderate	Moderate	Slight	Severe	Slight	Severe	
42	BENNINGTON	Severe	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	MARENGO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
	CONDIT	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
57	ORGANIC SOILS	Slight	Moderate	Slight	Slight	Severe	Slight	Moderate	Moderate
INDIANA									
1A	GENESEE	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	Moderate
	MARTINSVILLE	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
	BOYER	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	OSHTEMO	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	

TABLE 15–23(continued) Irrigation Limitations, Planning Subarea 4.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
INDIANA									
1B	EEL	Slight	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate
	MARTINSVILLE	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
	GENESEE	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	
	OSHTEMO	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
1C	EEL	Slight	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate
	GENESEE	Slight	Moderate	Slight	Slight	Slight	Slight	Moderate	
	MARTINSVILLE	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	
3B	CARLISLE	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
5B	BELMORE	Moderate	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Slight	Moderate	
11	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	PEWAMO	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
11E	HOYTVILLE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	NAPPANEE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
12C	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
16C	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Slight	Moderate	Moderate
	CROSBY	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
35	RENSSELEAR	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	WHITAKER	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
36	LENAWEE	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	MONTGOMERY	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	RENSSELEAR	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
37	CARLISLE	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
	WILLET	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
MICHIGAN									
31	ST. CLAIR	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	MORLEY	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
32	BROOKSTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe
	BLOUNT	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	HOYTVILLE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
34	MIAMI	Slight	Moderate	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	CONOVER	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
35	COLDWATER	Slight	Moderate	Moderate	Moderate	Severe	Slight	Severe	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
36	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	FOX	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	
	SPINKS	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
39	FOX	Slight	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	HILLSDALE	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	BOYER	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	

TABLE 15–24 Irrigation Limitations, Planning Subarea 4.3

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
OHIO									
8	MIXED SANDS	Severe	Severe	Slight	Severe	Moderate	Slight	Severe	Severe
15	CROSBY	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	Moderate
	BROOKSTON	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	
30	PAINESVILLE	Moderate	Moderate	Slight	Slight	Slight	Slight	Moderate	Severe
	CANEADEA	Slight	Severe	Moderate	Slight	Moderate	Slight	Severe	
	CANADICE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
31	RUGGLES	Slight	Severe	Moderate	Slight	Slight	Moderate	Severe	Severe
	WILMER	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	OLMSTEAD	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
32	ALLIS	Severe	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	WICKLIFFE	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
	FRIES	Severe	Severe	Severe	Slight	Severe	Slight	Severe	
33	LORAIN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	MONROEVILLE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
34	PLATEA	Slight	Severe	Slight	Moderate	Severe	Slight	Severe	Severe
	FRENCHTOWN	Slight	Severe	Slight	Moderate	Severe	Slight	Severe	
	SHEFFIELD	Slight	Severe	Slight	Moderate	Severe	Slight	Severe	
35	CAMBRIDGE	Moderate	Severe	Moderate	Moderate	Moderate	Moderate	Severe	Severe
	VENANGO	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	
	FRENCHTOWN	Slight	Severe	Slight	Moderate	Severe	Slight	Severe	
36	MAHONING	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	TRUMBULL	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
37	ELLSWORTH	Severe	Severe	Moderate	Slight	Moderate	Slight	Severe	Severe
	MAHONING	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
38	WAYNE	Slight	Severe	Moderate	Slight	Slight	Severe	Severe	Severe
	RITTMAN	Slight	Severe	Moderate	Slight	Moderate	Moderate	Severe	
	WADSWORTH	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
39	WOOSTER	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	CHILI	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	CANFIELD	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight	
40	WOOSTER	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	CANFIELD	Slight	Slight	Slight	Moderate	Moderate	Moderate	Moderate	
	RAVENNA	Slight	Slight	Slight	Moderate	Severe	Slight	Severe	
44	CHAGRIN	Slight	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate
	LOBDELL	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate	
	PAPAKATING	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
45	WHEELING	Slight	Moderate	Slight	Moderate	Slight	Slight	Moderate	Moderate
	CHILI	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	WEINBACH	Slight	Moderate	Slight	Moderate	Severe	Slight	Severe	
46	MENTOR	Slight	Moderate	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	FITCHVILLE	Slight	Moderate	Slight	Moderate	Severe	Moderate	Moderate	
	LURAY	Slight	Moderate	Moderate	Slight	Severe	Slight	Moderate	
PENNSYLVANIA									
CB	CANADICE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	CANEADEA	Slight	Severe	Moderate	Slight	Moderate	Slight	Severe	
	BIRDSALL	Slight	Severe	Severe	Slight	Severe	Slight	Severe	

TABLE 15–24(continued) Irrigation Limitations, Planning Subarea 4.3

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
PENNSYLVANIA									
CF	CONOTTON	Moderate	Slight	Slight	Severe	Slight	Slight	Moderate	Moderate
	OTTAWA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	FREDON	Slight	Slight	Slight	Moderate	Severe	Slight	Severe	
EL	ERIE	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	LANGFORD	Slight	Severe	Slight	Moderate	Moderate	Moderate	Moderate	
	ELLERY	Slight	Severe	Slight	Moderate	Severe	Slight	Moderate	
PB	PLATEA	Slight	Severe	Slight	Moderate	Severe	Moderate	Severe	Severe
	BIRDSALL	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	
RB	RIMER	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	WAUSEON	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	
	BERRIEN	Moderate	Severe	Moderate	Moderate	Moderate	Moderate	Severe	
TM	TRUMBULL	Slight	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	MAHONING	Slight	Severe	Severe	Slight	Severe	Slight	Severe	
	MINER	Slight	Severe	Severe	Slight	Severe	Slight	Severe	

TABLE 15–25 Irrigation Limitations, Planning Subarea 4.4

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
A	ALTON	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	COLONIE	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
BC	BATH	Slight	Severe	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	
CC	CANEADEA	Slight	Severe	Moderate	Slight	Moderate	Severe	Moderate	Moderate
	CANADICE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
CD	COLLAMER	Slight	Moderate	Moderate	Slight	Moderate	Moderate	Moderate	Moderate
	RHINEBECK	Severe	Severe	Moderate	Severe	Severe	Slight	Severe	
	WILLIAMSON	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
CT	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Slight
	TIOGA	Slight	Slight	Slight	Slight	Slight	Slight	Slight	
	HOWARD	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate	
	HAMLIN	Slight	Slight	Slight	Slight	Slight	Slight	Slight	
DR	DARIEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ROMULUS	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	REMSEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	ILION	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
DS	DARIEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	DANLEY	Slight	Severe	Moderate	Slight	Moderate	Severe	Severe	
EL	ERIE	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	LANGFORD	Slight	Severe	Moderate	Moderate	Moderate	Slight	Moderate	
ES	ELMWOOD	Moderate	Moderate	Slight	Moderate	Moderate	Slight	Moderate	Moderate
	SWANTON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
F	FARMINGTON	Slight	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
FT	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	FONDA	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
Hh	HOWARD	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	HOOSIC	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Moderate	Severe	
	ARKPORT	Moderate	Slight	Slight	Moderate	Slight	Moderate	Severe	
HK	HILTON	Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight
HL	HONEOYE	Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight
	LIMA	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate	
Ls	LORDSTOWN	Slight	Slight	Slight	Severe	Slight	Severe	Moderate	Severe
Mu	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
OH	ONTARIO	Slight	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight
	HILTON	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight	
OS	ODESSA	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	SCHOHARIE	Moderate	Severe	Moderate	Slight	Slight	Moderate	Severe	
	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	
	HUDSON	Severe	Severe	Moderate	Slight	Slight	Moderate	Severe	
P	PALMYRA	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Slight
	KARS	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	WAMPSVILLE	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	
T	FONDA	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	CANANDAIGUA	Slight	Moderate	Moderate	Slight	Severe	Slight	Severe	

TABLE 15–25(continued) Irrigation Limitations, Planning Subarea 4.4

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
U	UNDIFFERENTIATED URBAN LAND				NON-AGRICULTURAL				
VM	VOLUSIA	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	Severe
	MARDIN	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	
PENNSYLVANIA									
CB	CANADICE	Slight	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	CANEADEA	Slight	Severe	Severe	Slight	Severe	Slight	Severe	
	BIRDSALL	Slight	Severe	Severe	Slight	Severe	Slight	Severe	
CF	CONOTTON	Moderate	Slight	Slight	Severe	Slight	Slight	Moderate	Moderate
	OTTAWA	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	FREDON	Slight	Slight	Slight	Moderate	Severe	Slight	Severe	
EL	ERIE	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	LANGFORD	Slight	Severe	Slight	Moderate	Moderate	Moderate	Moderate	
	ELLERY	Slight	Severe	Slight	Moderate	Severe	Slight	Moderate	
PB	PLATEA	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	Severe
	BIRDSALL	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	
PH	HOWARD	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	PHELPS	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate	
	FREDON	Slight	Slight	Slight	Moderate	Severe	Slight	Severe	
	HALSEY	Slight	Slight	Slight	Moderate	Severe	Slight	Severe	
RB	RIMER	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	WAUSEON	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	
	BERRIEN	Moderate	Slight	Moderate	Moderate	Moderate	Moderate	Severe	
TM	TRUMBULL	Slight	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	MAHONING	Slight	Severe	Severe	Slight	Severe	Slight	Severe	
	MINER	Slight	Severe	Severe	Slight	Severe	Slight	Severe	

TABLE 15–26 Irrigation Limitations, Planning Subarea 5.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
A	ALTON	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	COLONIE	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
Ah	ALTON	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	COLOSSE	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe	
	HINCKLEY	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
	COLTON	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
BC	BATH	Slight	Severe	Moderate	Moderate	Slight	Moderate	Moderate	Moderate
	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	
BL	BATH	Slight	Severe	Moderate	Moderate	Slight	Moderate	Moderate	Severe
	MARDIN	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Severe	
	LORDSTOWN	Slight	Slight	Slight	Severe	Slight	Severe	Severe	
CC	CANEADEA	Slight	Severe	Moderate	Slight	Moderate	Severe	Moderate	Moderate
	CANADICE	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
CCM	LACKAWANNA	Slight	Severe	Moderate	Moderate	Slight	Severe	Severe	Severe
	WELLSBORO	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	
	MORRIS	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	
CD	COLLAMER	Slight	Moderate	Moderate	Slight	Moderate	Moderate	Moderate	Moderate
	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	
	WILLIAMSON	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
CH	CAZENOVIA	Slight	Severe	Slight	Moderate	Slight	Moderate	Severe	Slight
	OVID	Slight	Severe	Slight	Moderate	Severe	Moderate	Severe	
CO	CAZENOVIA	Slight	Severe	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	OVID	Slight	Severe	Moderate	Slight	Severe	Moderate	Severe	
CT	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Slight
	TIOGA	Slight	Slight	Slight	Slight	Slight	Slight	Slight	
	HOWARD	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate	
	HAMLIN	Slight	Slight	Slight	Slight	Slight	Slight	Slight	
DR	DARIEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ROMULUS	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	REMSEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	ILION	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
DS	DARIEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	DANLEY	Slight	Severe	Moderate	Slight	Moderate	Severe	Severe	
EL	ERIE	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	LANGFORD	Slight	Severe	Moderate	Moderate	Moderate	Slight	Moderate	
ES	ELMWOOD	Moderate	Moderate	Slight	Moderate	Moderate	Slight	Moderate	Moderate
	SWANTON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
F	FARMINGTON	Slight	Severe	Slight	Severe	Slight	Slight	Severe	Severe
FT	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	FONDA	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
GE	HAMLIN	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Slight
	TEEL	Slight	Slight	Slight	Slight	Moderate	Slight	Slight	
Hh	HOWARD	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	HOOSIC	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Moderate	Severe	
	ARKPORT	Moderate	Slight	Slight	Moderate	Slight	Moderate	Severe	
HK	HILTON	Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight

TABLE 15–26(continued) Irrigation Limitations, Planning Subarea 5.1

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
HL	HONEOYE	Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight
	LIMA	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate	
L	LOCKPORT	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
LC	LANSING	Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight
	CONESUS	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate	
LE	LANGFORD	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	ERIE	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	
LS	LORDSTOWN	Slight	Slight	Slight	Moderate	Slight	Severe	Moderate	Severe
LV	LORDSTOWN	Slight	Slight	Slight	Moderate	Slight	Severe	Moderate	Severe
	MARDIN	Slight	Severe	Moderate	Severe	Moderate	Moderate	Severe	
	VOLUSIA	Slight	Severe	Moderate	Severe	Severe	Moderate	Severe	
Mu	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
Od	ONTARIO	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
OH	ONTARIO	Slight	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight
	HILTON	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight	
OL	OQUAGA	Slight	Severe	Moderate	Severe	Slight	Severe	Severe	Severe
OS	ODESSA	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	SCHOHARIE	Moderate	Severe	Moderate	Slight	Slight	Moderate	Severe	
	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	
	HUDSON	Severe	Severe	Moderate	Slight	Slight	Moderate	Severe	
P	PALMYRA	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Slight
	KARS	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	WAMPSVILLE	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
SI	SODUS	Moderate	Severe	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	IRA	Moderate	Severe	Moderate	Moderate	Moderate	Slight	Moderate	
U	UNDIFFERENTIATED URBAN LAND				NON-AGRICULTURAL				
VM	VOLUSIA	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	Severe
	MARDIN	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	
WH	WAYLAND	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Moderate
	TEEL	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate	
	PAPAKATING	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
	MIDDLEBURY	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate	

TABLE 15–27 Irrigation Limitations, Planning Subarea 5.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
A	ALTON	Moderate	Severe	Slight	Severe	Slight	Slight	Severe	Severe
	COLONIE	Severe	Severe	Slight	Severe	Slight	Slight	Severe	
Ah	ALTON	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	COLOSSE	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe	
	HINCKLEY	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
	COLTON	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
C	COLTON	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	ADAMS	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	HINCKLEY	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	WINDSOR	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
CD	COLLAMER	Slight	Moderate	Moderate	Slight	Moderate	Moderate	Moderate	Moderate
	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	
	WILLIAMSON	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
CM	BURDETT	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	Severe
	ILION	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	
CO	CAZENOVIA	Slight	Severe	Moderate	Slight	Slight	Moderate	Moderate	Moderate
	OVID	Slight	Severe	Moderate	Slight	Severe	Moderate	Severe	
CT	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Slight
	TIOGA	Slight	Slight	Slight	Slight	Slight	Slight	Slight	
	HOWARD	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate	
	HAMLIN	Slight	Slight	Slight	Slight	Slight	Slight	Slight	
DR	DARIEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ROMULUS	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	REMSEN	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
	ILION	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
EL	ERIE	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	LANGFORD	Slight	Severe	Moderate	Moderate	Moderate	Slight	Moderate	
ES	ELMWOOD	Moderate	Moderate	Slight	Moderate	Moderate	Slight	Moderate	Moderate
	SWANTON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
EW	EMPEYVILLE	Moderate	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	WESTBURY	Moderate	Severe	Moderate	Moderate	Severe	Moderate	Severe	
F	FARMINGTON	Slight	Severe	Slight	Severe	Slight	Slight	Severe	Severe
FT	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	FONDA	Severe	Severe	Moderate	Slight	Severe	Slight	Severe	
G	GLOUCESTER	Moderate	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	ESSEX	Slight	Severe	Slight	Severe	Slight	Moderate	Severe	
	ROCKLAND				NON-AGRICULTURAL				
	HERMON	Moderate	Slight	Slight	Moderate	Slight	Moderate	Moderate	
	BECKET	Moderate	Severe	Slight	Moderate	Slight	Moderate	Moderate	
GE	HAMLIN	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Slight
	TEEL	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate	
Hh	HOWARD	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	HOOSIC	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	CHENANGO	Slight	Slight	Slight	Moderate	Slight	Moderate	Severe	
	ARKPORT	Moderate	Slight	Slight	Moderate	Slight	Moderate	Severe	
HK	HILTON	Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Slight
HL	HONEOYE	Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight
	LIMA	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate	
JG	MINOA	Severe	Severe	Slight	Moderate	Severe	Slight	Severe	Severe
	LAMSON	Severe	Severe	Slight	Moderate	Severe	Slight	Severe	

TABLE 15–27(continued) Irrigation Limitations, Planning Subarea 5.2

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
L	LOCKPORT	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
LC	LANSING	Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight
	CONESUS	Slight	Slight	Slight	Slight	Moderate	Slight	Slight	
LE	LANGFORD	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	ERIE	Slight	Severe	Moderate	Moderate	Severe	Slight	Severe	
LV	LORDSTOWN	Slight	Slight	Slight	Moderate	Slight	Severe	Moderate	Severe
	MARDIN	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Severe	
	VOLUSIA	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	
M	MADRID	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Moderate
	BOMBAY	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate	
	COLLAMER	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
Mu	MUCK	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Severe
NA	NELLIS	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Moderate
	AMENIA	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate	
	LOWVILLE	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	
Od	ONTARIO	Slight	Moderate	Slight	Slight	Slight	Moderate	Moderate	Moderate
OR	OVID	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	ROMULUS	Slight	Severe	Moderate	Slight	Severe	Slight	Severe	
OS	ODESSA	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	SCHOHARIE	Moderate	Severe	Moderate	Slight	Slight	Moderate	Severe	
	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	
	HUDSON	Severe	Severe	Moderate	Slight	Slight	Moderate	Severe	
P	PALMYRA	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Slight
	KARS	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate	
	WAMPSVILLE	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate	
PT	LANSING	Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate
	APPLETON	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
	MOHAWK	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	
	MANHEIM	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
Rg	ROCKLAND (Level to Sloping)			NON-AGRICULTURAL					
SI	SODUS	Slight	Severe	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	IRA	Slight	Severe	Moderate	Moderate	Moderate	Slight	Moderate	
U	UNDIFFERENTIATED URBAN LAND			NON-AGRICULTURAL					
VM	VOLUSIA	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	Severe
	MARDIN	Slight	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	
WH	WAYLAND	Slight	Slight	Slight	Slight	Severe	Slight	Severe	Moderate
	TEEL	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate	
	PAPAKATING	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
	MIDDLEBURY	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate	
WV	WORTH EMPEYVILLE WESTBURY			NON-AGRICULTURAL					

TABLE 15–28 Irrigation Limitations, Planning Subarea 5.3

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
Ah	ALTON	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	Severe
	COLOSSE	Moderate	Moderate	Slight	Severe	Slight	Severe	Severe	
	HINKLEY	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
	COLTON	Moderate	Severe	Slight	Severe	Slight	Severe	Severe	
BM	BRAYTON	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	MOIRA	Moderate	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	
C	COLTON	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	ADAMS	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	HINCKLEY	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
	WINDSOR	Severe	Severe	Slight	Severe	Slight	Moderate	Severe	
CD	COLLAMER	Slight	Moderate	Moderate	Slight	Moderate	Moderate	Moderate	Moderate
	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	
	WILLIAMSON	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
CM	BURDETT	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	Severe
	ILION	Slight	Severe	Moderate	Moderate	Severe	Moderate	Severe	
CV	COVEYTOWN	Severe	Severe	Slight	Severe	Severe	Slight	Severe	Severe
	COOK	Severe	Severe	Slight	Severe	Severe	Slight	Severe	
ES	ELMWOOD	Moderate	Moderate	Slight	Moderate	Moderate	Slight	Moderate	Moderate
	SWANTON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
EW	EMPEYVILLE	Moderate	Severe	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	WESTBURY	Moderate	Severe	Moderate	Moderate	Severe	Moderate	Severe	
F	FARMINGTON	Slight	Severe	Slight	Severe	Slight	Slight	Severe	Severe
G	GLOUCESTER	Moderate	Severe	Slight	Severe	Slight	Moderate	Severe	Severe
	ESSEX	Slight	Severe	Slight	Severe	Slight	Moderate	Severe	
	ROCKLAND			NON-AGRICULTURAL					
	HERMON	Moderate	Moderate	Slight	Moderate	Slight	Moderate	Moderate	
	BECKET	Moderate	Severe	Slight	Moderate	Slight	Moderate	Moderate	
GP	GRENVILLE	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Severe
	KINGSBURY	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	
GS	GRENVILLE	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	Moderate
	SWANTON	Moderate	Moderate	Slight	Moderate	Severe	Slight	Severe	
LG	LIVINGSTON	Severe	Severe	Severe	Slight	Severe	Slight	Severe	Severe
	GRENVILLE	Slight	Slight	Slight	Moderate	Slight	Moderate	Moderate	
M	MADRID	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Moderate
	BOMBAY	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate	
	COLLAMER	Slight	Moderate	Moderate	Slight	Moderate	Slight	Moderate	
NA	NELLIS	Slight	Slight	Slight	Moderate	Slight	Slight	Slight	Moderate
	ARMENIA	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate	
	LOWVILLE	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	
OS	ODESSA	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	SCHOHARIE	Moderate	Severe	Moderate	Slight	Slight	Moderate	Severe	
	RHINEBECK	Severe	Severe	Moderate	Moderate	Severe	Slight	Severe	
	HUDSON	Severe	Severe	Moderate	Slight	Slight	Moderate	Severe	
PR	KINGSBURY	Moderate	Severe	Moderate	Moderate	Severe	Slight	Severe	Severe
	ROCKLAND			NON-AGRICULTURAL					
PT	LANSING	Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Moderate
	APPLETON	Slight	Slight	Slight	Slight	Severe	Slight	Severe	
	MOHAWK	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	
	MANHEIM	Slight	Slight	Slight	Slight	Severe	Slight	Severe	

TABLE 15–28(continued) Irrigation Limitations, Planning Subarea 5.3

SOIL ASSOCI-ATIONS	SOIL SERIES	TEXTURE OF ROOT ZONE	PERME-ABILITY	WATER INTAKE RATE	AVAILABLE WATER CAPACITY	DRAIN-AGE	SLOPE	RATING FOR SERIES	RATING FOR ASSOCI-ATION
NEW YORK									
PV	KINGSBURY	Moderate	Severe	Moderate	Slight	Severe	Slight	Severe	Severe
	VERGENNES	Severe	Severe	Moderate	Slight	Moderate	Moderate	Severe	
Rg	ROCKLAND (Level to Sloping)			NON-AGRICULTURAL					
SI	SODUS	Slight	Severe	Moderate	Moderate	Slight	Slight	Moderate	Moderate
	IRA	Slight	Severe	Moderate	Moderate	Moderate	Slight	Moderate	
SN	SALMON	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate
	NICHOLVILLE	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate	
	HARTLAND	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	
	BELGRADE	Slight	Slight	Slight	Slight	Moderate	Moderate	Moderate	
WV	WORTH			NON-AGRICULTURAL					
	EMPEYVILLE								
	WESTBURY								

Section 5

WATER SUPPLY AND QUALITY

Irrigation depends upon adequate quantities and quality of water. Half of the water supply usually comes from ground water, and the remainder from above-ground sources. The location of these sources is important when determining the practicality of irrigation.

5.1 Ground Water Supplies

Maps that indicate well yields from surficial deposits have been developed for each planning subarea (Appendix 3, *Geology and Ground Water*). There are four well yield categories: less than 10 gallons per minute (gpm), 10 to 100 gpm, 100 to 500 gpm, and more than 500 gpm. Criteria for these categories are discussed in Appendix 3.

Locations most favorable for irrigation development are determined by a combination of soil limitations and well yields. Four categories describing soil and ground-water conditions are: moderate soil limitations with well yields of 100 to 500 gpm, moderate soil limits with well yields of more than 500 gpm, severe soil limitations with 100 to 500 gpm well yields, and severe soil limits with more than 500 gpm. Well yields of less than 100 gpm were not considered an adequate or dependable irrigation supply. Four categories were mapped, including moderate and severe soil limitations and where well yields of 100–500 gpm and 500+ gpm are available.

Maps were developed for each planning subarea and show the four categories (Figures 15–18 through 15–32), and locate the better combinations of soil and ground-water conditions for irrigation development. These soil limitation and well-yield maps should be used only as nonspecific indicators because they were developed from generalized data and there may be large variations within an area. Field analysis is necessary before any development can be shown to be feasible. Where yield from surficial deposits is poor, bedrock potential should be checked. Bedrock ground-water potential is shown in Appendix 3 maps by planning subareas.

There are only a few soil associations with slight limitations, and the area of these is small. Soil associations with slight limitations appear in Planning Subareas 4.4, 5.1, and 5.2. In this section soil associations with slight limitations have been included with those having moderate limitations.

5.2 Surface Water Supplies

A review of "Irrigation in Michigan, 1970"[3] indicates that approximately two-thirds of all applied irrigation water was derived from surface water sources. Stream flows are a major source. Smaller amounts come from reservoirs.

Appendix 2, *Surface Water Hydrology*, lists flows at selected stations on various streams throughout the Basin. An annual volume of runoff can be determined for each stream by converting the average annual discharge from cubic feet per second (cfs) to acre-feet. Appendix 2 contains a table that shows the average monthly distribution of runoff for each of the selected stations, which may be used to determine the quantity of water available each month to meet the total needs of a given area. The maximum amount of runoff that allows practical development is related to the monthly, seasonal, and yearly variations in runoff, duration of droughts or low-flow periods, evaporation and other losses from surface water runoff, diversions, locations of potential and existing storage sites, and the total volume of consumptive use.

Reservoirs with sufficient capacity are potential irrigation sources. More than 2,500 existing and potential reservoir sites in the Basin were analyzed. In Appendix 2, *Surface Water Hydrology*, only sites with more than 500 acres of available surface area have been listed, because smaller sites would not have significant impact in the study.

Table 15–29 lists the number of existing and

TABLE 15–29 Existing and Potential Reservoirs

Planning Subarea	Number of Reservoir Sites	Total Storage (ac-ft x 1,000)	Projected Irrigated Acres 2020[1]
1.1	11	905	-------
1.2	11	339	902
2.1	11	270	80,171
2.2	---	-----	29,334
2.3	165	4,401	142,628
2.4	11	70	67,061
3.1	6	76	975
3.2	48	966	31,504
4.1	54	971	42,828
4.2	166	2,399	22,258
4.3	83	2,394	8,225
4.4	12	871	33,496
5.1	19	778	36,555
5.2	36	441	26,350
5.3	29	4,749	-------

[1]From Table 15-3.

Source: Appendix 2, Surface Water Hydrology.

potential reservoir sites and total storage available by planning subarea. Because water from these reservoirs may be used for several purposes depending on the need, location, and quantity of water available, each site should be analyzed to determine availability and potential.

If factors such as area to be irrigated, location, and cost of pumping are favorable, the Great Lakes could become sources for irrigation.

5.3 Water Quality

Appendix 3, *Geology and Ground Water*, contains ground-water quality characteristics for each planning subarea and for the Basin. The chemical quality of the ground water in the Basin is variable. Water of satisfactory quality, although hard, is contained in at least one of the bedrock aquifers in each planning subarea of the Basin.

Water is highly saline in some parts of the Basin. The saline zone varies in depth and is sometimes difficult to delineate. Known saline zones of each aquifer system are given for each planning subarea in Appendix 3.

Information about surface water quality is limited. Quality varies with use, location, amount and duration of flows, and other factors.

The quality of the water of a potential supply should be analyzed when considering irrigation development.

Section 6

RECOMMENDATIONS, ALTERNATIVES, AND IMPACTS

6.1 Recommendations

Because the Great Lakes Basin is a humid region irrigation needs are not extreme. Supplemental irrigation would, however, improve product quality, increasing yields and reducing harvesting and marketing problems. Irrigation may increase farm income without increasing acreage.

If irrigation development increases at its present rate, approximately 72,000 acres would be needed by 2020. If the rate of increase of the historical trend is applied to data obtained during workshops (Table 15–1), only 20,000 acres would be needed by 2020. These acreages, based on the historical trend of the Basin, indicate that continuation of the present rate of irrigation development will nearly supply the needs for the projected years. Assuming the rate of development will increase as competition for land becomes greater, the irrigation needs for the projected years will be met.

Favorable combinations of soil and groundwater conditions are shown in Figures 15–18 through 15–32. Before action is taken, an onsite investigation should be made in every case to determine soil conditions and the quantity and quality of surface or ground water. Each planning subarea has more potentially irrigable land than is necessary to meet projected needs. Before irrigation is developed for areas larger than one individual farm, studies should be made to determine the most economical water sources.

6.2 Alternatives

Unless irrigation is developed, approximately 98,000 acres not in cropland would be required. If farmers cannot increase their incomes they may be forced to change jobs.

6.3 Impacts

Projections for irrigation were made only for specialty or high-value crops because these will give the best returns when irrigated. A yield increase of approximately 30 percent can be expected. A study made in New York indicated the net benefits to be approximately $21 per acre for vegetables. Irrigation can increase yield and reduce land conflicts, increase agricultural commerce, raise standards of living, and increase property tax base.

Waste waters may be recycled. According to recent studies polluted effluent from secondary sewage treatment plants can be renovated almost completely when sprayed on forage crops and forested land. This technique would increase production of forage crops, increase growth of certain trees, recharge ground water, and break down toxic materials before effluent reaches the water table. These studies have disclosed both favorable and unfavorable ecological relationships affecting sewage disposal and food and timber production. In the future agricultural and forest land may become a medium for absorbing, using, and cleaning sewage and other waste water as well as providing food and fibers. However, certain precautions are mandatory. An adequate area of land is a primary requisite. The quantity, quality, and timing control of waste waters should be regulated so as not to exceed the capacity of the resource. Soils, vegetation, and climate may limit the practicality of this technique. Even though this recycling process is valuable it must be designed to operate within certain ecologic parameters. This practice is being considered in several locations. In Muskegon County, Michigan, a program is now in existence, developed with the aid of the Environmental Protection Agency.

Section 7

REVIEW OF OTHER IRRIGATION REPORTS

7.1 Agricultural Census

Census of Agriculture[8] reports every five years on acres irrigated. For this purpose, irrigated land is defined as land artifically watered for agricultural purposes. A summary by planning subarea for 1954, 1959, and 1964 is given in Table 15–30.

Projections may be developed based upon these historic trends. Census records show an increase of 59,000 acres of irrigated land from 1954 to 1964. Slightly more than 50 percent (31,000 acres) was added from 1959 to 1964.

Assuming an average increase of 6,000 acres per year, projected acreages would be: 210,000 in 1980, 330,000 in 2000, and 450,000 in 2020. This projection is considerably lower (450,000 acres versus 522,000 acres) than the one developed in this report, due primarily to variations in the base survey. According to the workshop estimate discussed in Section 1, irrigation actually covers 202,000 acres, but census values extrapolated to 1970 indicate only 149,000 irrigated acres. If the increase rate of 6,000 acres per year is applied to the 202,000 acres, the result is more than 500,000 acres by the year 2020. It would be reasonable to have an increasing rate of irrigation development as land use conflicts increase.

7.2 Michigan Irrigation Inventory

In 1970 the Michigan Water Resources Commission completed an inventory of irrigation practices.[3] Calendar year 1967 was selected as the base. A complete field survey, not a random sample, was made. A 1958 irrigators' list was augmented with data from county agents, the Soil Conservation Service, and irrigation equipment suppliers in the State. All irrigators (agricultural, recreational, and commercial) were included.

In 1969 the Commission interviewed more than 90 percent (more than 2,300) of all irrigators in Michigan. Approximately 200 irrigators who were not available for interviews returned questionnaires by mail. Questionnaires and the ensuing computer program were established in terms of reflected watershed areas and county boundaries. The inventory included: sources of water, acres irrigated for each crop, volume of water applied per acre each year, and the average rate of water use for each acre. Data are summarized in Table 15–31. Data for each planning subarea or portions of planning subareas in Michigan were summarized (Tables 15–32 through 15–38). Table 15–39 is a summary of all Michigan planning subareas.

Approximately two-thirds of the 2,600 irrigation systems use surface water sources (Table 15–31). In Michigan 102,625 irrigated acres include parks, cemeteries, nursery crops, and golf courses. Average water use on vegetables and fruits is usually between four and six inches per acre each year. Sod irrigation averages 5.6 inches on 8,200 acres. Golf courses had the highest water use (17.4 inches). The most highly irrigated crop is the potato (22,432 acres). More than half of the irrigated acres in Michigan are in the southwest. Most of the remaining irrigation occurs in the northwest Lower Peninsula, Saginaw Bay, and southeast Michigan.

7.3 Ohio

7.3.1 Northwest Ohio Water Development Plan

A comprehensive program for many phases of water management was prepared for the Ohio Water Commission.[6] Based on that study Table 15–40 gives the average daily irrigation water use by county in 1965 for the Ohio portion of Planning Subarea 4.2.

According to this plan, it is feasible to irrigate high-value crops such as vegetables, potatoes, and fruits. Projections of the acres of each crop to be irrigated were made for each county. Water requirements for each crop were determined by using a water balance model, components of which were precipita-

TABLE 15–30 Acres Irrigated[1] for Agricultural Purposes, by Planning Subarea, Basin Total, and U.S. Total, 1954, 1959, and 1964

Planning Subarea	1954	1959	1964
1.1	341	510	328
1.2	327	350	675
2.1	5,476	12,397	23,123
2.2	3,394	5,579	9,057
2.3	15,371	27,042	33,743
2.4	2,861	5,703	6,289
3.1	320	390	405
3.2	2,106	2,727	2,887
4.1	2,730	4,544	5,453
4.2	2,824	1,879	5,024
4.3	4,147	2,984	4,292
4.4	6,305	6,461	5,337
5.1	4,702	7,271	8,425
5.2	3,128	4,394	8,170
5.3	327	134	179
Basin Total	54,359	82,365	113,387
U.S. Total	29,552,000	31,630,000	37,056,083

[1]Irrigated land is defined as land watered for agricultural purposes using artificial means, including subirrigation and applying water to the ground by either direct or sprinkler systems. Data for irrigated land refer only to that part of irrigated farms watered by artificial means at any time in 1954, 1959, or 1964.

Source: Census of Agriculture, 1954, 1959, 1964, County Data Aggregations.

tion, evapotranspiration, soil storage capacity, excess water, water deficit, and change in water storage. Annual water deficits were computed for four groups of crops, three soil storage capacities, and three percentages (10, 50, and 90) of probability of occurrence. The deficits affect the amount of water required annually to meet crop requirements (Table 15–41).

The projected irrigation water requirements for counties are shown in Table 15–42. These volumes are the product of the number of projected acres and the water deficit.

7.3.2 Northeast Ohio Water Development Plan

Data similar to those shown in Tables 15–40 through 15–42 are available for Planning Subarea 4.3 at repository public libraries in Ohio and at the Ohio Department of Natural Resources. Tables 15–43 and 15–44 list data from this plan, showing agricultural water use in 1969 by use and agricultural water withdrawal by county, respectively.

7.4 Indiana Irrigation Inventory

In conjunction with its State water plan, Indiana took an inventory to determine the agriculture acreage under irrigation and the relative quantities of irrigation water applied or consumed in 1967. A questionnaire was sent to each known agricultural irrigator in the State. Useable information was obtained from

TABLE 15-31 Summary of Irrigation Water Use Survey in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	108	108	216	4,616	2,922	0.63
Sod	34	52	86	8,230	4,051	0.47
Strawberries	75	273	348	6,476	3,968	0.62
Raspberries	14	51	65	777	245	0.32
Blueberries	86	47	133	2,303	983	0.42
Tree Fruits	33	102	135	5,302	2,030	0.38
Other Small Fruits	5	12	17	349	111	0.32
Potatoes	96	123	219	22,432	11,250	0.50
Tomatoes	17	54	71	1,588	611	0.38
Truck Crops	165	260	425	17,097	8,442	0.49
Field Crops	40	129	169	11,600	5,037	0.43
Melons & Pickles	42	119	161	4,801	1,679	0.35
Hay, Pasture, Silage	8	22	30	700	294	0.42
Cemeteries & Parks	22	36	58	1,172	991	0.84
Golf Courses	202	227	429	14,805	21,445	1.45
Miscellaneous	13	17	30	377	518	1.38
Total	960	1,632	2,592	102,625	64,579	0.62

[1] "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15-32 Summary of Irrigation Water Use Survey, Planning Subarea 1.2 in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	-	5	5	120	74	0.62
Sod	-	--	--	---	---	----
Strawberries	2	14	16	167	93	0.56
Raspberries	-	4	4	4	2	0.48
Blueberries	-	--	--	---	---	----
Tree Fruits	-	--	--	---	---	----
Other Small Fruits	-	--	--	---	---	----
Potatoes	2	8	10	474	161	0.34
Tomatoes	-	1	1	1	1	0.42
Truck Crops	-	2	2	46	36	0.78
Field Crops	-	1	1	3	1	0.42
Melons & Pickles	-	--	--	---	---	----
Hay, Pasture, Silage	-	1	1	25	11	0.42
Cemeteries & Parks	1	1	2	15	9	0.58
Golf Courses	4	8	12	125	155	1.24
Miscellaneous	-	--	--	---	---	----
Total	9	48	57	985	543	0.55

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15–33 Summary of Irrigation Water Use Survey, Planning Subarea 2.1 in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	-	1	1	30	20	0.67
Sod	-	--	--	---	---	----
Strawberries	-	2	2	5	2	0.46
Raspberries	-	--	--	---	---	----
Blueberries	-	--	--	---	---	----
Tree Fruits	-	--	--	---	---	----
Other Small Fruits	-	--	--	---	---	----
Potatoes	1	8	9	658	248	0.38
Tomatoes	-	--	--	---	---	----
Truck Crops	-	--	--	---	---	----
Field Crops	3	--	3	36	16	0.44
Melons & Pickles	-	--	--	---	---	----
Hay, Pasture, Silage	-	--	--	---	---	----
Cemeteries & Parks	-	2	2	29	36	1.23
Golf Courses	-	4	4	9	12	1.32
Miscellaneous	-	--	--	---	---	----
Total	4	17	21	767	334	0.43

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15-34 Summary of Irrigation Water Use Survey, Planning Subarea 2.3 in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	79	66	145	3,625	2,326	0.64
Sod	18	21	39	3,443	1,832	0.53
Strawberries	39	90	129	3,959	2,409	0.61
Raspberries	12	39	51	725	221	0.31
Blueberries	76	38	114	1,976	802	0.41
Tree Fruits	20	70	90	3,854	1,482	0.38
Other Small Fruits	5	10	15	269	71	0.27
Potatoes	68	45	113	12,167	6,207	0.51
Tomatoes	16	46	62	1,187	391	0.34
Truck Crops	147	131	278	9,156	5,238	0.57
Field Crops	22	97	119	8,649	3,995	0.46
Melons & Pickles	27	75	102	2,793	975	0.35
Hay, Pasture, Silage	6	15	21	436	199	0.46
Cemeteries & Parks	11	18	29	810	575	0.71
Golf Courses	68	85	153	6,107	8,787	1.39
Miscellaneous	8	8	16	230	276	1.20
Total	622	854	1,476	59,386	35,786	0.60

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15–35 Summary of Irrigation Water Use Survey, Planning Subarea 2.4 in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	9	7	16	135	76	0.56
Sod	---	---	---	-----	-----	----
Strawberries	17	110	127	1,738	1,159	0.67
Raspberries	1	5	6	22	14	0.64
Blueberries	10	4	14	312	176	0.56
Tree Fruits	9	22	31	758	306	0.40
Other Small Fruits	---	---	---	-----	-----	----
Potatoes	15	18	33	4,452	2,658	0.59
Tomatoes	---	3	3	168	125	0.74
Truck Crops	12	36	48	3,868	1,583	0.41
Field Crops	2	17	19	887	285	0.32
Melons & Pickles	6	32	38	917	336	0.37
Hay, Pasture, Silage	1	3	4	84	28	0.32
Cemeteries & Parks	5	6	11	75	45	0.59
Golf Courses	36	20	56	1,592	1,773	1.11
Miscellaneous	2	2	4	46	61	1.32
Total	125	285	410	15,054	8,625	0.57

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15-36 Summary of Irrigation Water Use Survey, Planning Subarea 3.1 in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	1	--	1	5	3	0.62
Sod	--	1	1	85	41	0.51
Strawberries	3	22	25	319	181	0.54
Raspberries	--	--	--	-----	-----	----
Blueberries	--	--	--	-----	-----	----
Tree Fruits	--	--	--	-----	-----	----
Other Small Fruits	--	2	2	80	40	0.50
Potatoes	3	6	9	596	238	0.39
Tomatoes	1	1	2	3	2	0.58
Truck Crops	--	3	3	25	12	0.50
Field Crops	2	3	5	620	270	0.43
Melons & Pickles	--	2	2	51	26	0.51
Hay, Pasture, Silage	--	--	--	-----	-----	----
Cemeteries & Parks	--	--	--	-----	-----	----
Golf Courses	4	13	17	436	532	1.22
Miscellaneous	--	4	4	10	9	0.88
Total	14	57	71	2,225	1,354	0.61

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15–37 Summary of Irrigation Water Use Survey, Planning Subarea 3.2 in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	4	9	13	77	46	0.60
Sod	5	5	10	1,010	673	0.67
Strawberries	3	10	13	206	85	0.41
Raspberries	1	1	2	16	5	0.30
Blueberries	--	2	2	10	4	0.42
Tree Fruits	3	3	6	385	132	0.34
Other Small Fruits	--	---	---	-----	-----	----
Potatoes	4	27	31	3,320	1,529	0.46
Tomatoes	--	2	2	224	91	0.41
Truck Crops	6	17	23	1,237	421	0.34
Field Crops	3	11	14	962	309	0.32
Melons & Pickles	2	6	8	648	182	0.28
Hay, Pasture, Silage	--	2	2	105	35	0.33
Cemeteries & Parks	--	2	2	37	25	0.67
Golf Courses	14	28	42	1,443	1,601	1.11
Miscellaneous	--	1	1	3	3	0.92
Total	45	126	171	9,683	5,141	0.53

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15–38 Summary of Irrigation Water Use Survey, Planning Subarea 4.1 in Michigan, 1970[1]

Crops Irrigated	Number of Systems By Source of Water			Total Acres Irrigated	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total			
Flowers & Nurseries	15	20	35	624	377	0.60
Sod	11	25	36	3,697	1,506	0.41
Strawberries	8	7	15	82	38	0.49
Raspberries	---	2	2	10	3	0.30
Blueberries	---	---	---	------	------	----
Tree Fruits	1	7	8	305	110	0.36
Other Small Fruits	---	---	---	------	------	----
Potatoes	7	11	18	765	210	0.28
Tomatoes	---	1	1	5	2	0.40
Truck Crops	21	71	92	2,765	1,152	0.42
Field Crops	8	---	8	443	161	0.33
Melons & Pickles	4	4	8	392	160	0.41
Hay, Pasture, Silage	1	1	2	50	22	0.42
Cemeteries & Parks	5	7	12	206	302	0.38
Golf Courses	57	87	144	5,093	8,584	1.67
Miscellaneous	3	2	5	88	169	1.92
Total	141	245	386	14,525	12,796	0.88

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission.

TABLE 15–39 Summary of Irrigation Water Use Survey, Planning Subareas in Michigan, 1970[1]

Planning Subarea	Source of Water			Acres of Land Irrigated	Percentage	Total Volume of Water Use (ac-ft/yr)	Avg Rate of Water Use (ft/yr)
	Ground	Surface	Total				
1.2	9	48	57	985	1%	543	0.55
2.1	4	17	21	677	1%	334	0.43
2.3	622	854	1,476	59,386	58%	35,786	0.60
2.4	125	285	410	15,054	15%	8,625	0.57
3.1	14	57	71	2,225	2%	1,354	0.61
3.2	45	126	171	9,683	9%	5,141	0.53
4.1	141	245	386	14,525	14%	12,796	0.88
State Total	960	1,632	2,592	102,625	100%	64,579	0.62

[1] Supplementary report of "Irrigation In Michigan, 1970" by Michigan Water Resources Commission

approximately 95 percent of those who irrigated 10 or more acres in 1967.

The report indicates that four of the 10 most heavily irrigated counties in Indiana are within the Great Lakes Basin: St. Joseph, La Porte, Elkhart, and Lake Counties. Table 15-45 gives a summary of the irrigation information for Basin counties in Indiana. The table indicates the number of irrigators and the acres irrigated by surface or subsurface methods. Subsurface irrigation means supplying water crops by regulating the level of the water table through the use of control structures in drainage ditches. This method consumes an estimated 15 inches per acre per year.

Quantities used for both surface and subsurface irrigation for each crop were derived from the questionnaires. Data were summarized by county and the rates for each crop were applied to the acreage in that county to find the total quantity of water applied. Table 15–46 shows the acre-feet estimates of water used for Great Lakes Basin counties.

The Statewide average for the application of surface irrigation is approximately nine inches of water per acre. Four counties, one of which is in the Great Lakes Basin, have a sizeable amount of subsurface irrigation.

7.5 New York

7.5.1 Genesee River Basin

The irrigation of the Genesee River basin and Ontario lake plains (Planning Subarea 5.1) was studied by the Department of Agriculture in conjunction with the Genesee River Basin Comprehensive Study.[8,4]

Large-scale supplemental irrigation of farmlands to improve product quality and to increase yields is relatively new in the State of New York, but has accelerated since 1940. Irrigation data was obtained from the *Census of Agriculture* and the "Report of the Temporary State Commission on Irrigation."[10] In all counties studied (except Allegany and Steuben, New York, and Potter, Pennsylvania), irrigation increased from 1954 to 1959. Genesee, Livingston, and Monroe Counties have the most irrigation. Irrigation in Livingston County has nearly doubled since 1954, and the Genesee County increase is approximately 60 percent. Increase in Monroe County has been slower due to urban expansion. Most commonly irrigated are truck crops (snap beans, cabbage, peas, tomatoes, and sweet corn).

Approximately 49,600 acres generally scattered in small parcels throughout northern Genesee basin could be irrigated with little or no drainage work. No drainage would be required on approximately 11,200 of these acres.

In 1964, approximately 5,200 acres were irrigated primarily from natural stream flow, probably the maximum that can be adequately served from existing Basin systems. The Ontario lake plain is north of the New York State Barge Canal and west of the Genesee River basin. Approximately 38 percent (183,000) of its 482,000 acres have soil types, slopes, and drainage conditions adapt-

TABLE 15–40 Daily Agricultural Water Withdrawal, 1965, Northwest Ohio Water Development Plan[1] (Million Gallons Per Day; Private Systems)

County	Farm Irrigation	Golf Course Irrigation	Greenhouse and Nursery Irrigation
Allen	0.015	0.133	0.003
Auglaize	0.015	0.044	0.011
Crawford	-----	0.044	-----
Defiance	0.017	0.022	0.006
Erie	0.096	0.130	0.082
Fulton	0.058	0.044	0.007
Hancock	0.057	0.155	-----
Henry	0.001	0.022	0.027
Huron	0.135	0.044	0.021
Lucas	0.080	0.421	0.595
Mercer	-----	0.066	-----
Ottawa	0.076	0.022	0.013
Paulding	0.008	0.022	0.015
Putnam	0.031	0.022	0.007
Sandusky	0.184	0.066	0.050
Seneca	-----	0.022	-----
Van Wert	0.012	0.044	0.006
Williams	-----	0.044	0.001
Wood	0.010	0.066	0.147
Wyandot	0.006	0.022	-----
Total	0.801	1.455	0.991

[1] The Northwest Ohio Water Development Plan, January 1967. Data covers Ohio portion of Planning Subarea 4.2.

TABLE 15-41 Probable Annual Water Deficits for Northwest Ohio[1]

Crops	Evapo-transpiration (annual), inches	Soil Storage Capacity, inches	Deficit, in inches, by Probability of Occurrence		
			10%	50%	90%
Vegetables	35.59	2.0	19.2	15.4	12.3
		4.0	16.1	11.8	8.7
		6.0	15.1	10.3	7.0
Meadow (hay, alfalfa)	36.97	2.0	20.0	16.6	13.8
		4.0	17.2	12.8	9.3
		6.0	16.0	11.0	7.5
Fruit	41.90	2.0	25.0	21.2	18.0
		4.0	22.5	17.4	13.5
		6.0	21.0	15.7	11.7
Small grain	32.26	2.0	15.6	12.0	9.2
		4.0	12.7	8.2	5.3
		6.0	10.5	5.9	3.3

[1]Based on precipitation records at Napoleon, Ohio, 1894-1957, and evapotranspiration data from lysimeters at Coshocton, Ohio.

Source: The Northwest Ohio Water Development Plan, January, 1967.

TABLE 15-42 Crop Irrigation Water Withdrawal Projections

County	Irrigation Water Demand[1] millions of gallons 1976	1986	1996	2006
Allen	120	140	180	260
Auglaize	90	130	180	330
Defiance	270	370	670	900
Erie	910	1,240	2,070	2,790
Fulton	580	1,020	1,470	2,080
Hancock	190	380	740	1,300
Huron	1,230	1,360	1,610	1,930
Henry	180	380	1,190	2,020
Lucas	920	1,390	1,740	2,030
Mercer	200	410	600	850
Ottawa	460	730	1,100	1,440
Paulding	50	110	180	250
Putnam	290	720	980	1,210
Sandusky	680	1,240	2,380	3,060
Seneca	220	300	370	540
Van Wert	90	150	220	300
Williams	110	200	290	370
Wood	270	520	660	800
Wyandot	40	60	90	210
Total	6,900	10,850	16,720	22,670

[1] Irrigation water requirements based upon probable annual water deficits for 10 percent probability of occurrence indicated in Table 15-41.

Source: The Northwest Ohio Water Development Plan, January 1967.

TABLE 15–43 Agriculture Water Use, 1969[1]

Use	Average Daily Demand (million gallons per day)	Total Water Use (million gallons)
Rural and Suburban Domestic	14.83	5,410
Livestock	3.70	1,350
Greenhouse, Nurseries, & Crop Irrigation	3.21	1,170
Golf Course Irrigation	6.99	2,550
Total	28.73	10,480

[1] Northeast Ohio Water Development Plan

TABLE 15–44 Agriculture Water Withdrawal by County[1] (Million Gallons Per Day)

County	Farm and Suburban Homes	Livestock	Crop Irrigation[2]	Golf Course Irrigation
Ashtabula	0.940	0.703	0.017	0.311
Cuyahoga	------	0.022	0.174	1.487
Geauga	2.841	0.284	0.031	0.333
Lake	1.419	0.033	1.563	0.510
Lorain	1.654	0.368	0.157	0.688
Medina	0.829	0.403	0.147	0.666
Portage	3.016	0.433	0.321	0.533
Summit	0.254	0.060	0.042	1.198
Total	10.953	2.306	2.452	5.726

[1] Northeast Ohio Water Development Plan

[2] Only the counties that are in the Great Lakes Basin Planning Subarea 4.3 are shown.

[3] Based on 365-day use rather than actual use period.

TABLE 15–45 Irrigation—Indiana, 1967,[1] Irrigators and Acres

Planning Subarea	County	No. of Irrigators	Acres Irrigated		
			Surface	Subsurface	Total
2.2	Lake	11	244	530	744
	Laporte	6	1,951	---	1,951
	Porter	2	90	---	90
	Starke	7	160	---	160
	Total	26	2,445	530	2,945
2.3	Elkhart	23	1,734	---	1,734
	Lagrange	8	393	---	393
	Marshall	14	663	---	663
	Noble	4	92	---	92
	Steuben	1	3	---	3
	St. Joseph	17	2,005	---	2,005
	Total	67	4,890	0	4,890
4.2	Adams	1	106	---	106
	Allen	2	70	---	70
	Dekalb	5	499	---	499
	Total	8	675	0	675
State Total		101	8,010	530	8,510

[1] From inventory by State of Indiana.

TABLE 15–46 Irrigation—Indiana, 1967,[1] Water Use (Acre-Feet)

Planning Subarea	County	Consumed by Subsurface Irrigation	Applied by Surface Irrigation	Total Consumed or Applied
2.2	Lake	657	284	941
	Laporte	---	1,788	1,788
	Porter	---	13	13
	Starke	---	88	88
	Total	657	2,173	2,830
2.3	Elkhart	---	1,071	1,071
	Lagrange	---	228	228
	Marshall	---	728	728
	Noble	---	48	48
	Steuben	---	1	1
	St. Joseph	---	853	853
	Total	0	2,929	2,929
4.2	Adams	---	38	38
	Allen	---	16	16
	Dekalb	---	148	148
	Total	0	202	202
State Total		657	5,304	5,961

[1] From inventory by State of Indiana.

able to irrigation. Approximately 23,800 acres would require no drainage and the remaining 159,200 acres would require only random drainage. In 1959 3,800 acres of vegetables were irrigated. By 1964 this figure had increased to 5,450. Irrigation primarily included major truck crops, such as tomatoes, cabbage, peas, beans, cauliflower, onions, beets, and some fruits, for which there is heavy demand and no national surplus. The lake plain is noted for fruit production, but the value of irrigating deep-rooted crops has not been established. It has not been considered further here.

The potential exists for considerable irrigation. Present practices are limited due to insufficient water supplies, uncertainties about technology or possible benefits, lack of capital and management skill, scarcity of labor, and institutional restrictions related to riparian and other water rights. This is true in other parts of the Basin as well. Projections in this appendix have been made assuming that deterrents will be satisfactorily resolved.

Future agricultural production for this area has been estimated based upon national and regional requirements, national projections of population, per capita consumption rates, imports, and exports. According to this estimate crop production will more than double. Regional requirements are evaluated by studying interregional advantages and disadvantages of producing various crops.

Vegetables are the crops most likely to be irrigated. Future irrigation needs were determined by using expected national increase in average yields and the Basin share of national production. In 1970 the Genesee River Basin Study report by the Corps of Engineers projected that 20 percent of the potato and vegetable acreage was to have been irrigated, 50 percent by 1980, and 100 percent by 1990. *Census of Agriculture* (1964) reported that more than 20 percent of Ontario lake plain crops were irrigated.

In order to determine the amount of water necessary to irrigate an acre of cropland, a water budget was made based upon antecedent soil moisture, probable rainfall, and consumptive use by crops. Losses due to inefficiency of application, transportation, storage, and the water needed by the plant are included in the budget. Approximately one acre-foot of water would be needed to irrigate one acre (Tables 15–47 through 15–49).

A New York State supplement was added to the Genesee report, but because different criteria were used, projections in the supplement were higher. Approximately 300,000 Genesee River basin acres could be irrigated. Some development costs were also reported.

7.5.2 Erie-Niagara Basin

A comprehensive water resources plan for the Erie-Niagara basin Planning Subarea 4.4 was prepared by the Erie-Niagara Basin Regional Water Resources Planning Board. In 1960 approximately 4,300 acres were irrigated in this basin. An increase is quite feasible.

Major deterrents to expansion have been an insufficiently developed water supply, no central agency or authority to develop irrigation. use of other means to increase crop yields, a normally humid climate, reluctance to change established agricultural procedure, and uncertainty regarding water rights. However, a series of dry years between 1960 and 1965 stimulated investment in new irrigation systems.

Projections of agricultural production requirements which were made to the year 2020 indicate the basin's contribution to the Middle Atlantic Region and reflect regional and national requirements (Table 15–50).

The basin's irrigation potential was determined by evaluating the economics of irrigation and basic agriculture, i.e., soil association mapping and evaluation of productive capacities of various soils. Irrigability of soils and their drainage requirements were determined. Economic criteria included land and water requirements, response to irrigation, cost of production, and market prices.

According to this evaluation, approximately 180,000 basin acres could be developed for irrigation. Table 15–51 shows distribution of potential development. This irrigation potential exceeds projected basin needs. If market conditions were to support favorable economic returns, need for irrigation would grow.

7.5.3 Oswego River Basin

Table 15–52 lists irrigation demands and opportunities for Oswego River basin based on historical trends, quality, and regional development goals.

Table 15–53 lists potentially irrigable lands in this basin and land that is presently irrigated. Of the total 1,104,100 irrigable acres 443,400 would require no drainage, 385,300 would require moderate drainage, and 275,400 acres would require intense drainage.

TABLE 15–47 Irrigation Water Demand.[1] Genesee River Basin

Land Resource Area	1964	1970	1980	1990	2000	2010	2020
	acre-feet of water and acres irrigated						
Ontario Plain	-----	3,700	9,100	17,800	18,000	18,000	19,200
Allegheny Plateau	-----	2,100	5,400	10,800	10,700	10,900	10,700
Total required	5,200	5,800	14,500	28,600	28,700	28,900	29,900
Deficit	0	600	9,300	23,400	23,500	23,700	24,700

[1] Irrigation water for potatoes and vegetables is based on 1/2 acre-foot per acre on the land, plus an equal amount in storage, transportation and distribution losses.

TABLE 15–48 Irrigation Water Demand,[1] Ontario Lake Plain Area

	1964	1980	1990	2000	2010	2020
Acres in vegetables and potatoes	-----	26,800	27,000	27,700	28,200	27,700
Acres to be irrigated	5,450	13,400	27,000	27,700	28,200	27,700
Deficit in acre-feet of water[2]	0	7,950	21,550	22,250	22,750	22,250

[1] Same as footnote 1 in Table 15–47.

[2] Deficit beyond current irrigation water available and used (5,450 acre-ft which is considered all that is available from existing sources of supply).

TABLE 15–49 Total Irrigation Water Demand, Planning Subarea 5.1

Areas	1964	1980	1990	2000	2010	2020
	acre-feet of water and acres irrigated					
Genesee Basin	5,200	14,500	28,600	28,700	28,900	29,900
Ontario Lake Plain	5,450	13,400	27,000	27,700	28,200	27,700
Total Required	10,650	27,900	56,600	56,400	57,100	57,600
Deficit	0	17,250	44,950	45,750	46,450	46,950

TABLE 15–50 Projected Agricultural Requirements

	1980	2000	2020
Total Cropland Required (acres)	279,000	243,000	216,000
Irrigated Cropland (acres)	17,800	44,700	45,000
Irrigation Water (acre-feet/year)	17,800	44,700	45,000

TABLE 15–51 Potential Irrigation Development

	Net-Irrigable Area (acres)
Potential Irrigation Project Areas	159,000[1]
Potential Upland Reservoir Projects	5,300
Additional Areas with Potential for Ground Water Irrigation Development	13,000
Total	178,100

[1]There are about 7,500 additional acres outside of the "net" irrigable area, but within the "gross" project areas, that could be developed for ground water irrigation.

TABLE 15–52 Irrigation Demands and Opportunities

Year	Historical Trend (acres)	Environmental Quality and Regional Development Goal (acres)
1970	7,543	7,543
1985	15,650	39,000
2020	27,700	114,100

TABLE 15–53 Irrigable Lands in Oswego Basin Summarized by County

County	Irrigable Land[1]	Land Presently Irrigated[1]
Monroe	2,400	0
Steuben	5,600	0
Schuyler	20,300	70
Chemung	4,300	130
Yates	88,700	360
Ontario	150,900	770
Wayne	82,500	1,870
Tompkins	65,200	1,030
Seneca	73,200	410
Cayuga	189,200	440
Onondaga	166,800	1,990
Cortland	6,600	0
Madison	70,900	320
Oneida	82,400	870
Lewis	5,100	0
Oswego	90,000	1,320
Total	1,104,100	9,580

[1]Rounded to nearest 100 acres.

SUMMARY

This appendix reviews studies concerning irrigation uses and future needs in the Great Lakes Basin. These results may be used to develop a comprehensive plan for using the Basin's water and land resources.

Crop and soil type data about irrigated acres were collected. Irrigation occurs on approximately 221,000 acres or one percent of Basin cropland, particularly those acres in high-value vegetables and fruits. Vegetables, including potatoes, account for 60 percent of the acreage. Corn (for grain), fruits, and sod each constitute approximately 10 percent of all irrigated acreage. The remainder includes dry beans, sugar beets, and miscellaneous uses. Planning Subarea 2.3 is most heavily irrigated. Irrigation in the four planning subareas around Lake Michigan equals 70 percent of all Basin irrigation.

Projected irrigated acreage was developed by using the inventory of present irrigation and the projection of specialty crop acreages developed as part of Appendix 19, *Economic and Demographic Studies*. For the purposes of this projection it has been assumed that future irrigation will be practiced on soil types similar to those now being irrigated. Projections were made for only high-value crops (potatoes, fruits, sod, and vegetables). It is believed that field crop irrigation is not economical for the Basin and will not increase. Of the 522,000 acres that have been projected as favorable for irrigation by 2020, more than half will yield vegetables. Fruits will account for approximately 20 percent of the acreage and potatoes and sod each nearly 10 percent. Dry edible beans and sugar beets will be irrigated to a small extent. Future irrigation is projected to cover approximately 2 percent of all cropland. It is expected that this 2 percent will consist of the following crops: 85 percent of the sod, 60 percent of the potatoes, 45 percent of the vegetables, and 23 percent of the fruit. It has been anticipated that all new golf courses will be irrigated. Projections for golf courses are in Appendix 21, *Outdoor Recreation*.

Potentially irrigable land was estimated by using the soil types used for the projections. Land needing no additional improvements for flood prevention and drainage (39 percent of all agricultural land) was inventoried as potentially irrigable. Projected irrigated acreage for 2020 is only four percent of the inventoried irrigation potential.

Irrigation water requirements for each crop for the projected years were determined for a normal year having 75 percent efficiency of application. A multiplier factor was determined to indicate need in drier years. Sod, which seasonally uses 21 to 23 inches, has the largest per-acre irrigation water requirement, followed by sugar beets, potatoes, dry edible beans, vegetables, and fruits. Seasonal distribution of the requirements indicates that most of the irrigation is required during July and August. In 2020 Planning Subarea 2.3 will have the largest projected seasonal volume, 151,000 acre-feet.

Interpretations of soil associations were developed to indicate the limitations for irrigation development. Each association was rated into one of three limitations: slight, moderate, or severe. Soils not recommended for agricultural use are referred to as nonagricultural. These limitations refer only to soil mapping unit conditions and not to the availability of water. Maps developed for each planning subarea can be used to determine general soil conditions for irrigation.

Maps showing combined available well yields and soil limitations were also developed for each planning subarea. The combination of data will generally indicate where both soil and ground-water conditions are most favorable for irrigation development.

In 1969 approximately two-thirds of the irrigation water was derived from surface water sources. It is estimated that half the future water supply will be from these sources. Stream flows are the major source of surface water. Smaller amounts come from ponds and reservoirs. Reservoirs are potential irrigation sources, depending on their locations and the quality and quantity of the water. The Great Lakes are an irrigation source only for areas near the shores.

The quality of Basin ground water is variable. Water of satisfactory quality, although

usually hard, can be located in most of the Basin. Quality of stream flow and reservoirs will vary depending on use, location, and other factors. It is expected that irrigation efficiency will be high and its effects on quality of stream flow and ground water will be minimal.

A field analysis should be made to determine the feasibility of each irrigation development. Soil conditions, location and availability of the water source, water quality, possible crop yield response, and market prices should be considered.

If the past rate of new irrigation developments continues, total development would be slightly less than is projected in this appendix. Assuming the rate of development will increase as competition for land becomes greater, these irrigation projections will be met. If irrigation is not developed, an additional 98,000 acres of cropland would be required to produce the same yields.

Irrigation in the Basin will improve agriculture and enable the farmer to increase his income without buying additional high-value land. An expected increase in yield of approximately 30 percent will reduce the total acres required for agricultural production, thereby freeing additional land for other uses. Some of the long-range benefits of irrigation will be increased agricultural commerce in the Basin, increased standards of living, and increased property taxes on higher-value land.

It has been proposed that effluent from secondary sewage treatment plants be used to irrigate forests and forage crops. This practice, if practical, will increase the amount of irrigated land as well as the types of crops irrigated. Because the effects and merits of the practice have not been completely evaluated, no projection for this type of irrigation has been made. This practice would improve water quality without necessarily improving crops.

Reviewed in this appendix are the following reports: *Census of Agriculture* for 1954, 1959, and 1964,[8] "Irrigation in Michigan, 1970,"[3] "Northwest Ohio Water Development Plan,"[6] "Northeast Ohio Water Development Plan,"[5] "Indiana Agricultural Irrigation in 1967,"[2] and reports on the Genesee River,[9] Erie-Niagara,[1] and the Oswego River.[7]

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1. Erie-Niagara Basin Regional Water Resources Planing Board, "Erie-Niagara Basin Comprehensive Water Resources Plan," December 1969.

2. Indiana Department of Natural Resources, State Water Plan Section, "Indiana Agricultural Irrigation in 1967," May 1969.

3. Michigan Department of Natural Resources, Water Development Services Division, "Irrigation in Michigan 1970," WDS–7, November 1970.

4. New York State, "Report of the Temporary State Commission on Irrigation, 1957," Legislative Document (1957) No. 27.

5. Ohio Department of Natural Resources, "Northeast Ohio Water Development Plan," Unpublished.

6. Ohio Department of Natural Resources, "Northwest Ohio Water Development Plan," January 1967.

7. Oswego River Basin Regional Water Resources Planning Board, "Oswego River Basin Comprehensive Water Resources Plan," Unpublished.

8. U.S. Bureau of Census, *Census of Agriculture*, 1954, 1959, 1964.

9. U.S. Department of Agriculture, *Genesee River Basin Comprehensive Study of the Water and Related Land Resources*, Appendix J, *Agricultural Studies*, 1967.

10. U.S. Department of Agriculture, Soil Conservation Service, "Irrigation Water Requirements, Technical Release Number 21," April 1967.

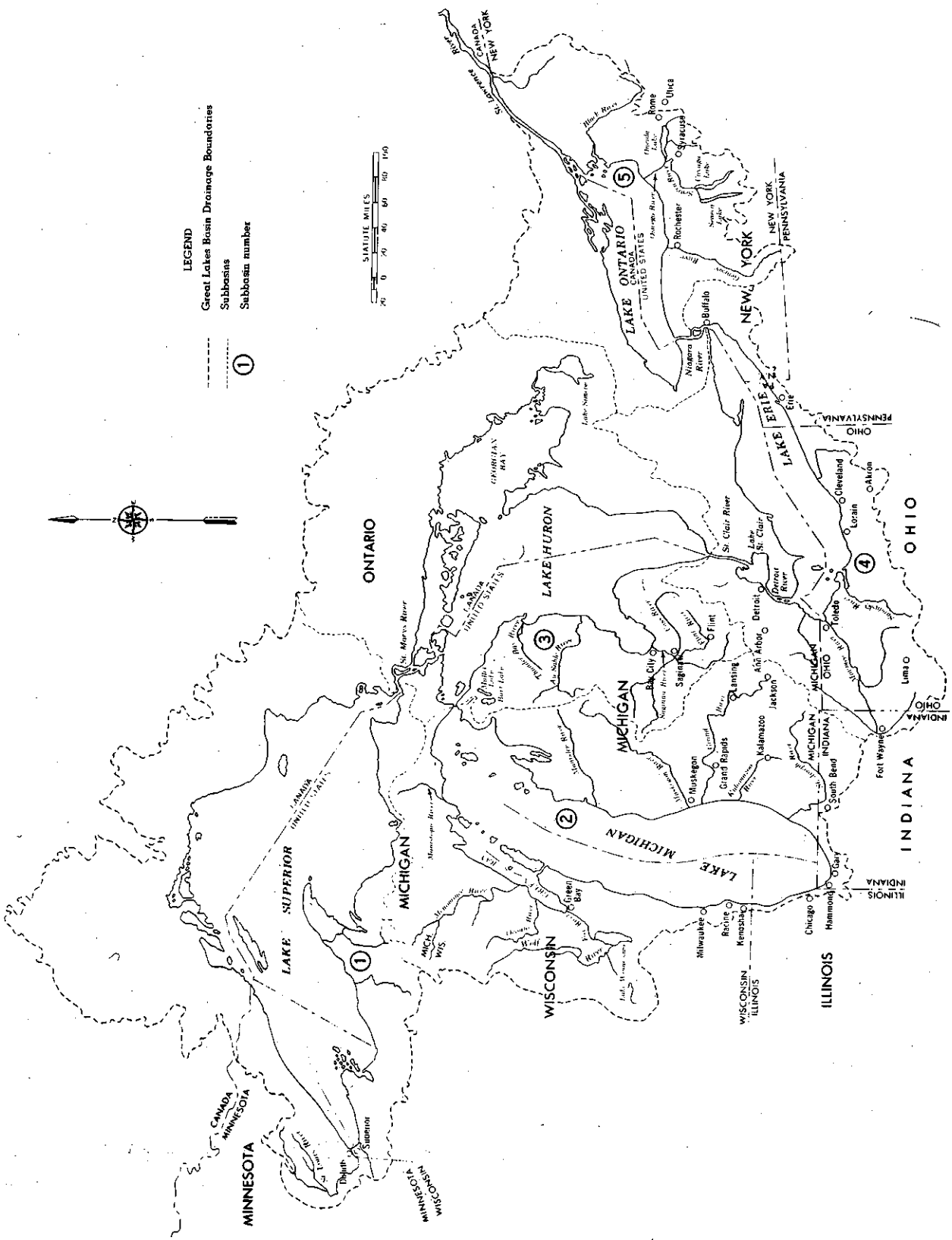


FIGURE 15–1 Great Lakes Region Planning Subareas

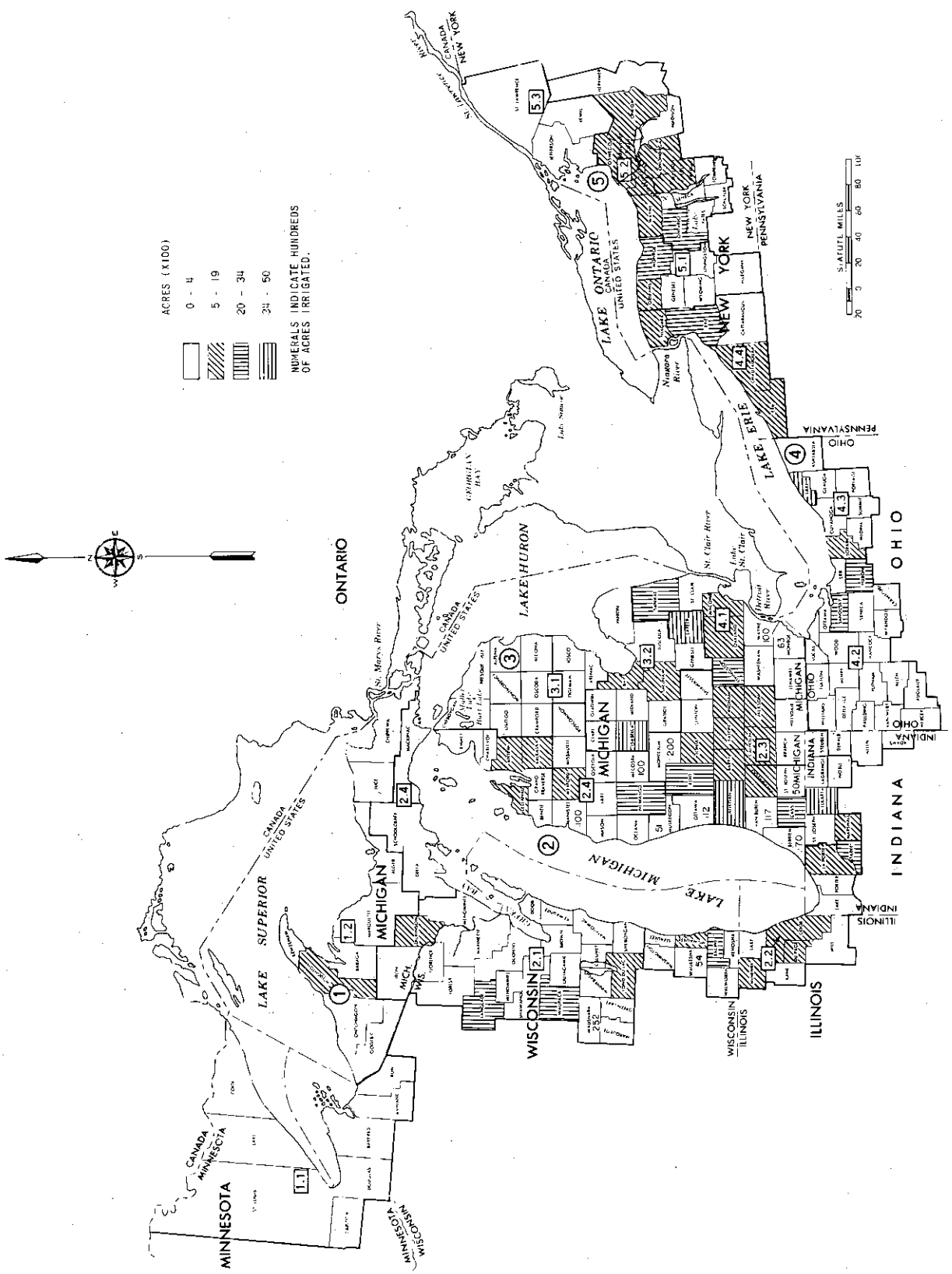


FIGURE 15–2 Acres Irrigated by County

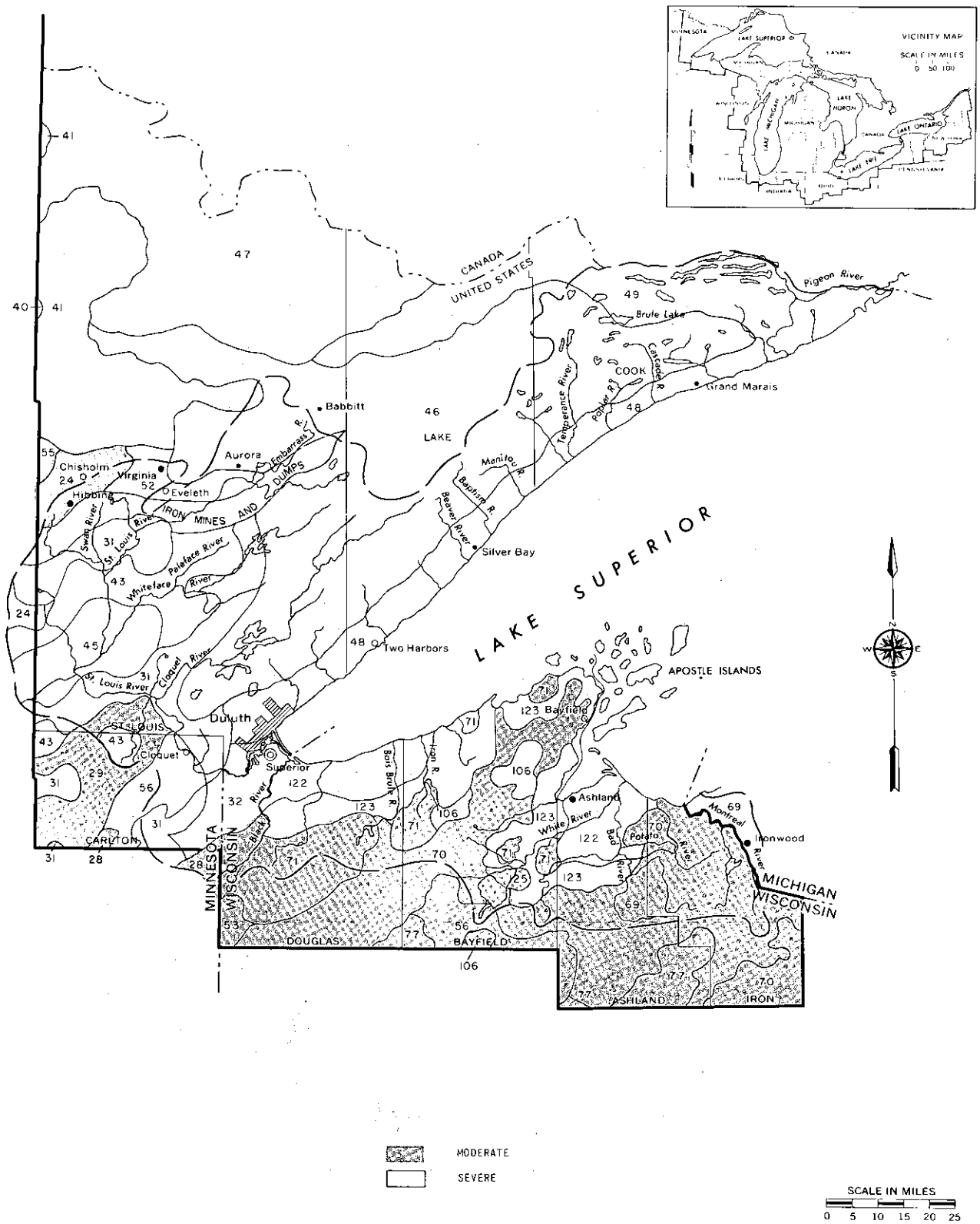


FIGURE 15–3 Soil Irrigation Limitations, Planning Subarea 1.1. Numbers are soil association codes.

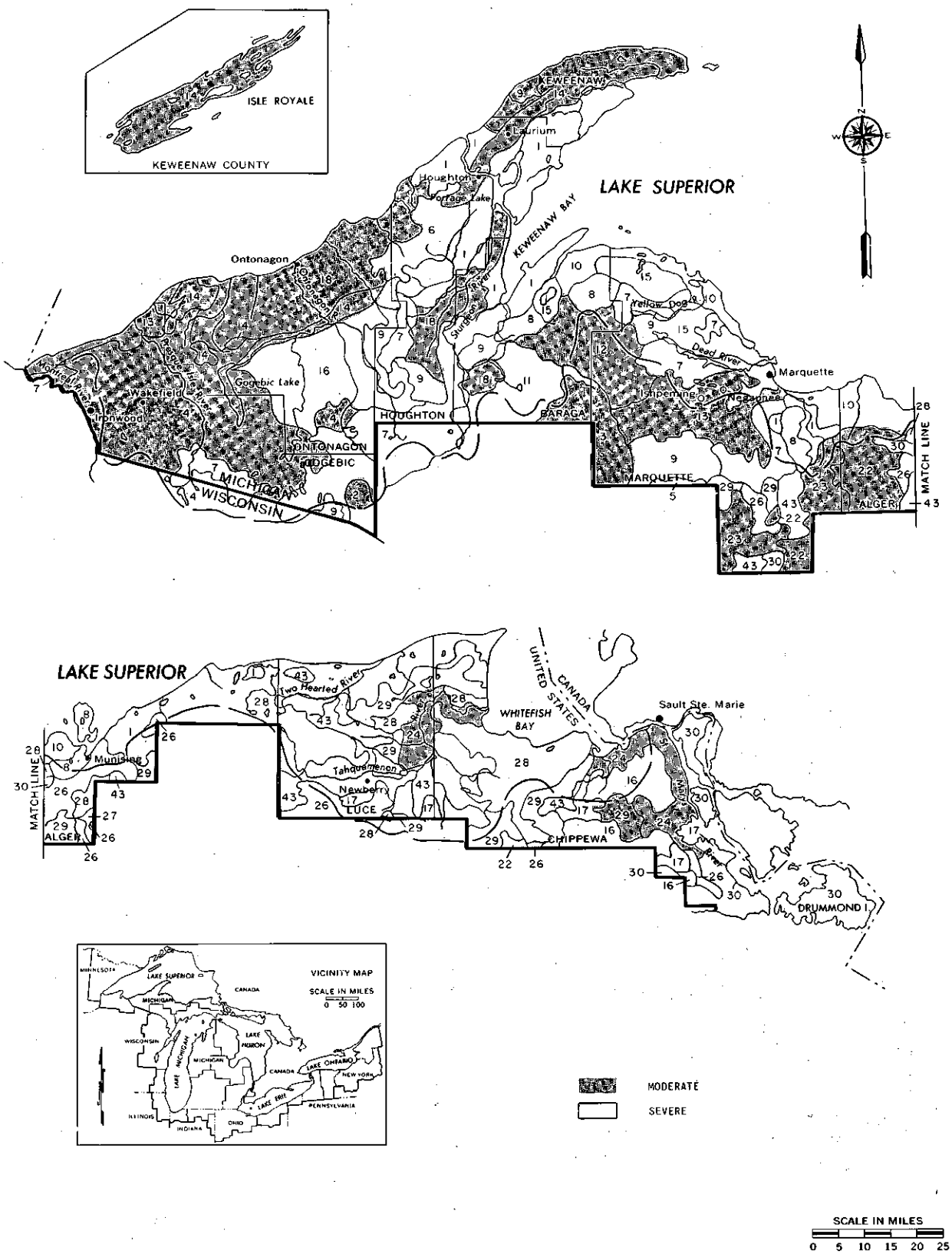


FIGURE 15–4 Soil Irrigation Limitations, Planning Subarea 1.2. Numbers are soil association codes.

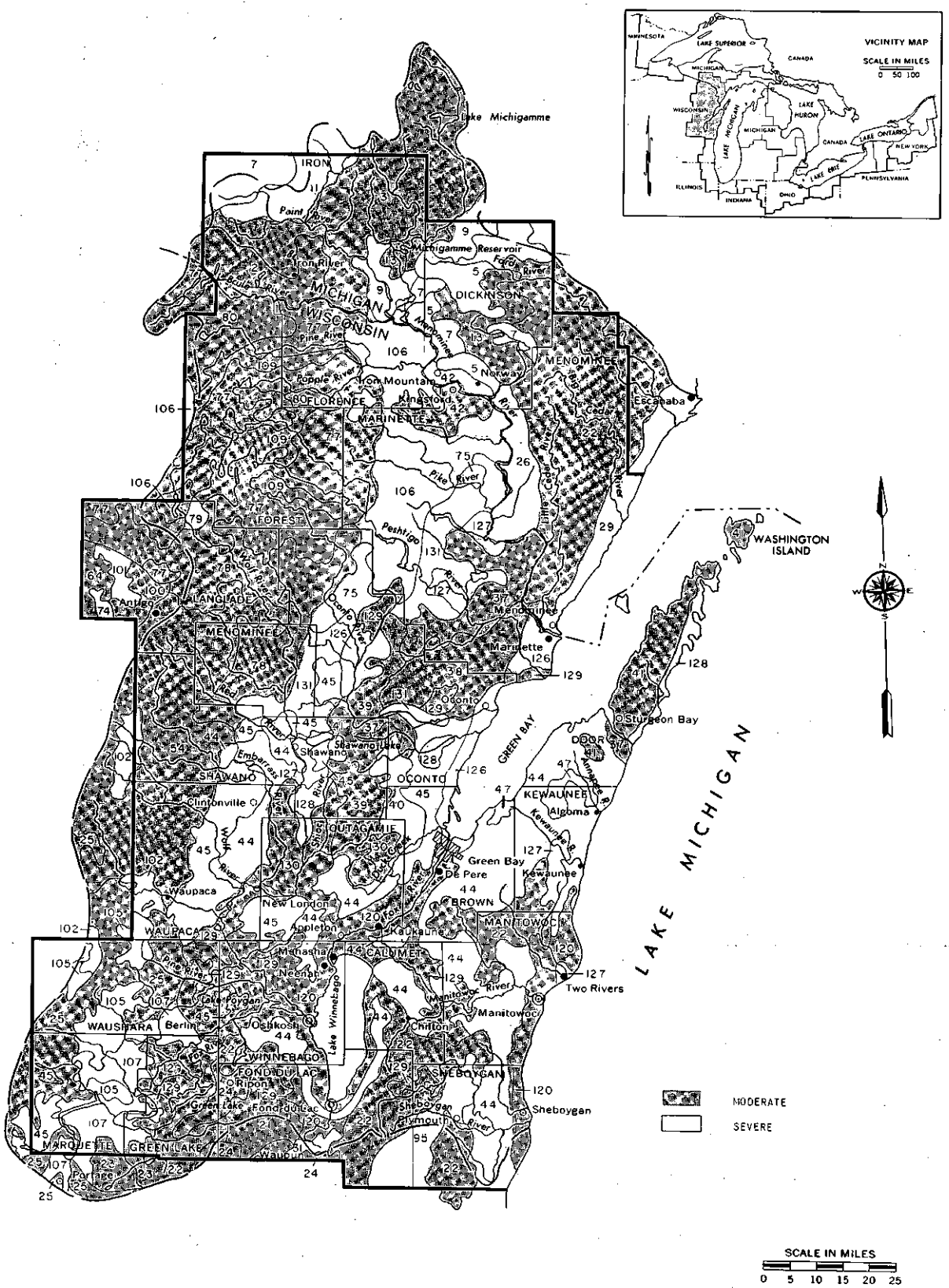


FIGURE 15–5 Soil Irrigation Limitations, Planning Subarea 2.1. Numbers are soil association codes.

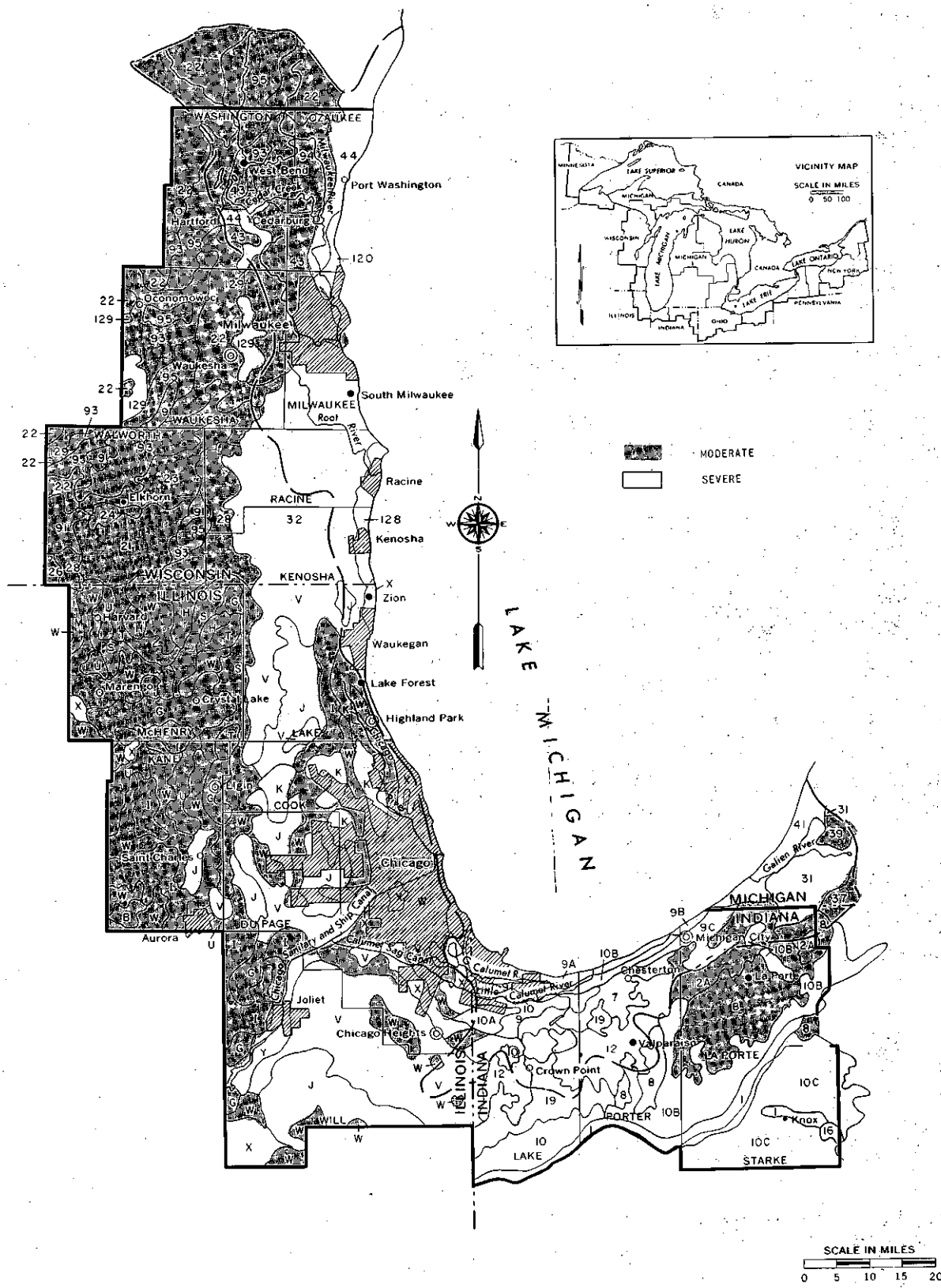


FIGURE 15–6 Soil Irrigation Limitations, Planning Subarea 2.2. Numbers and letters are soil association codes.

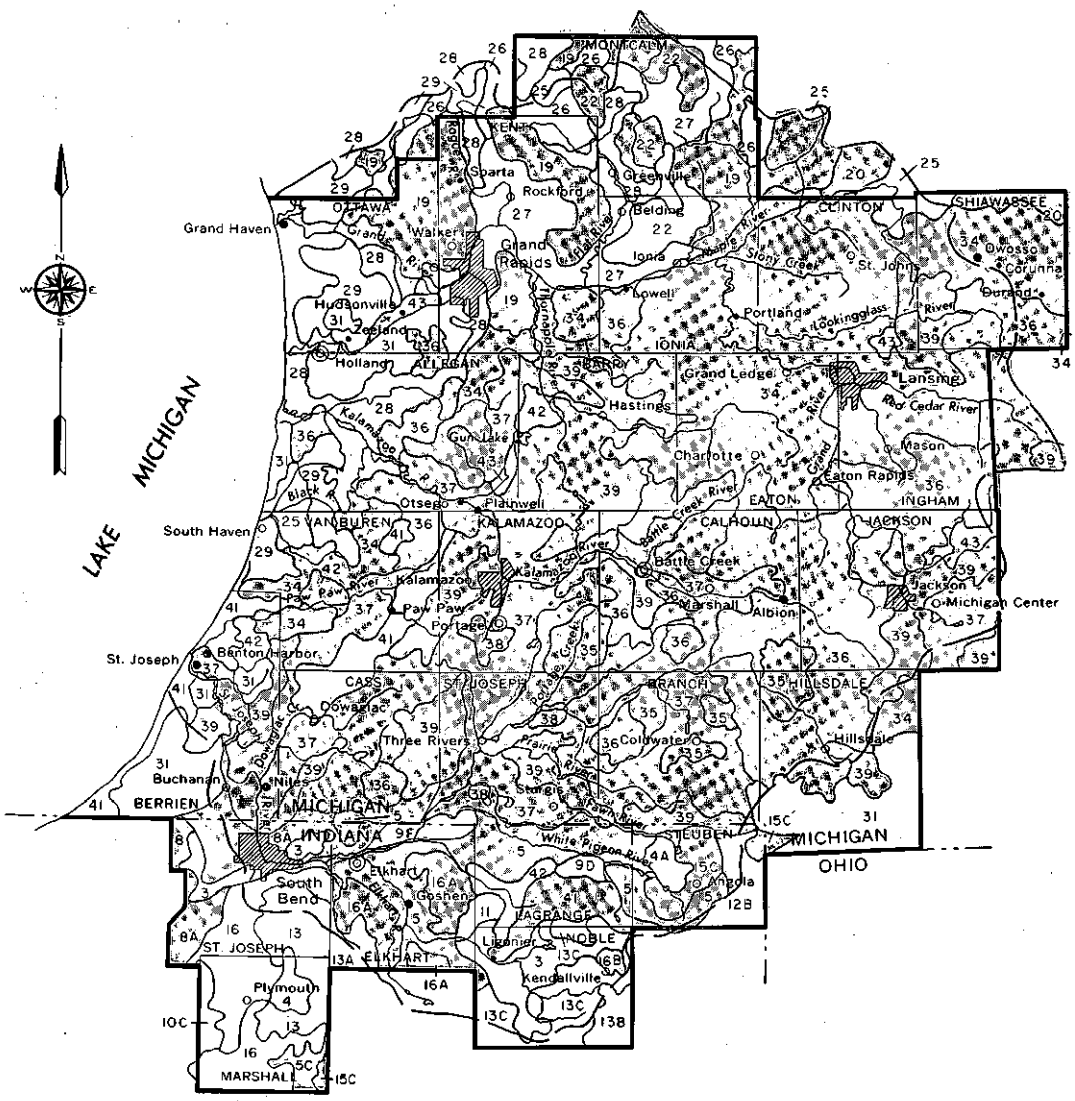


FIGURE 15–7 Soil Irrigation Limitations, Planning Subarea 2.3. Numbers and letters are soil association codes.

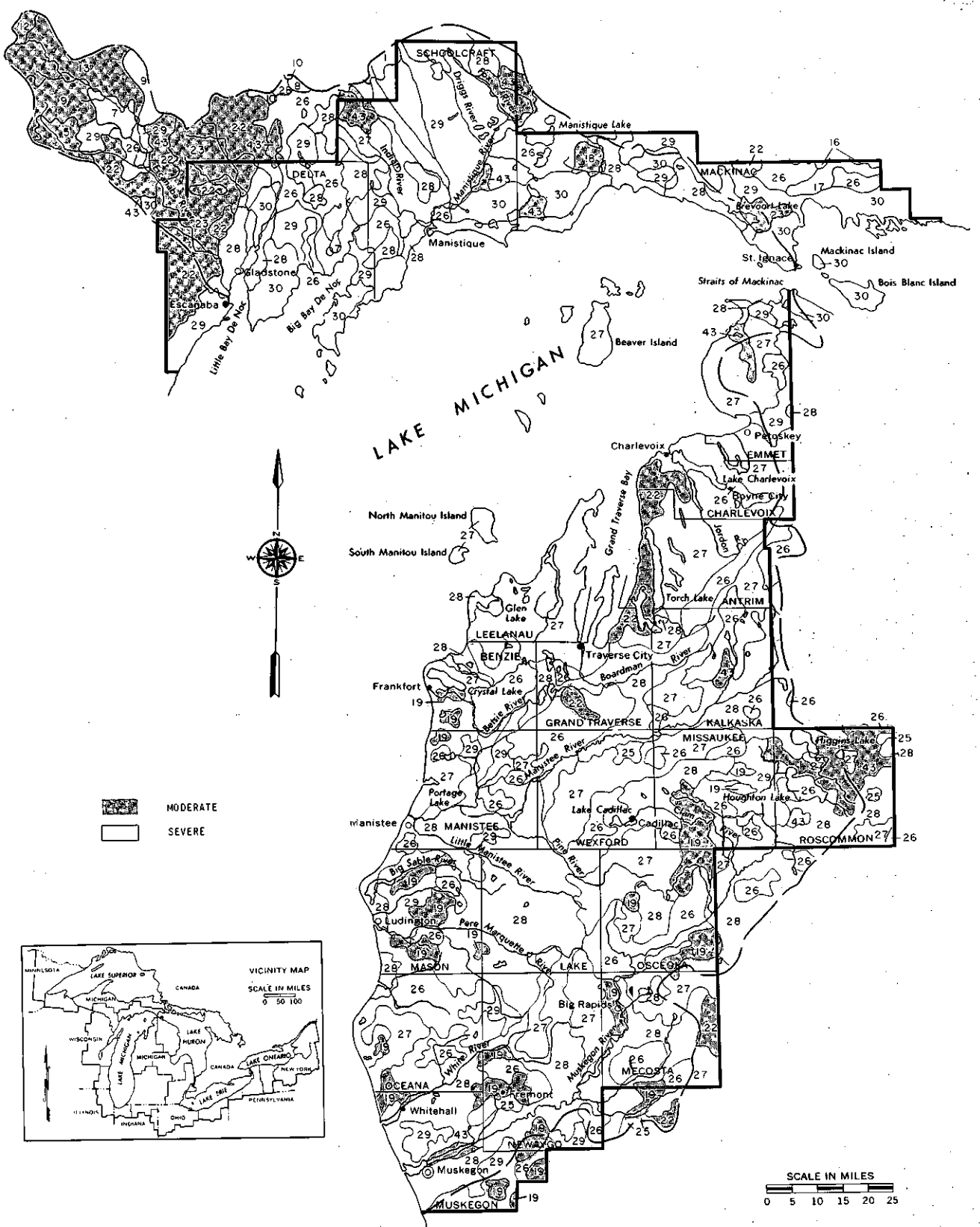
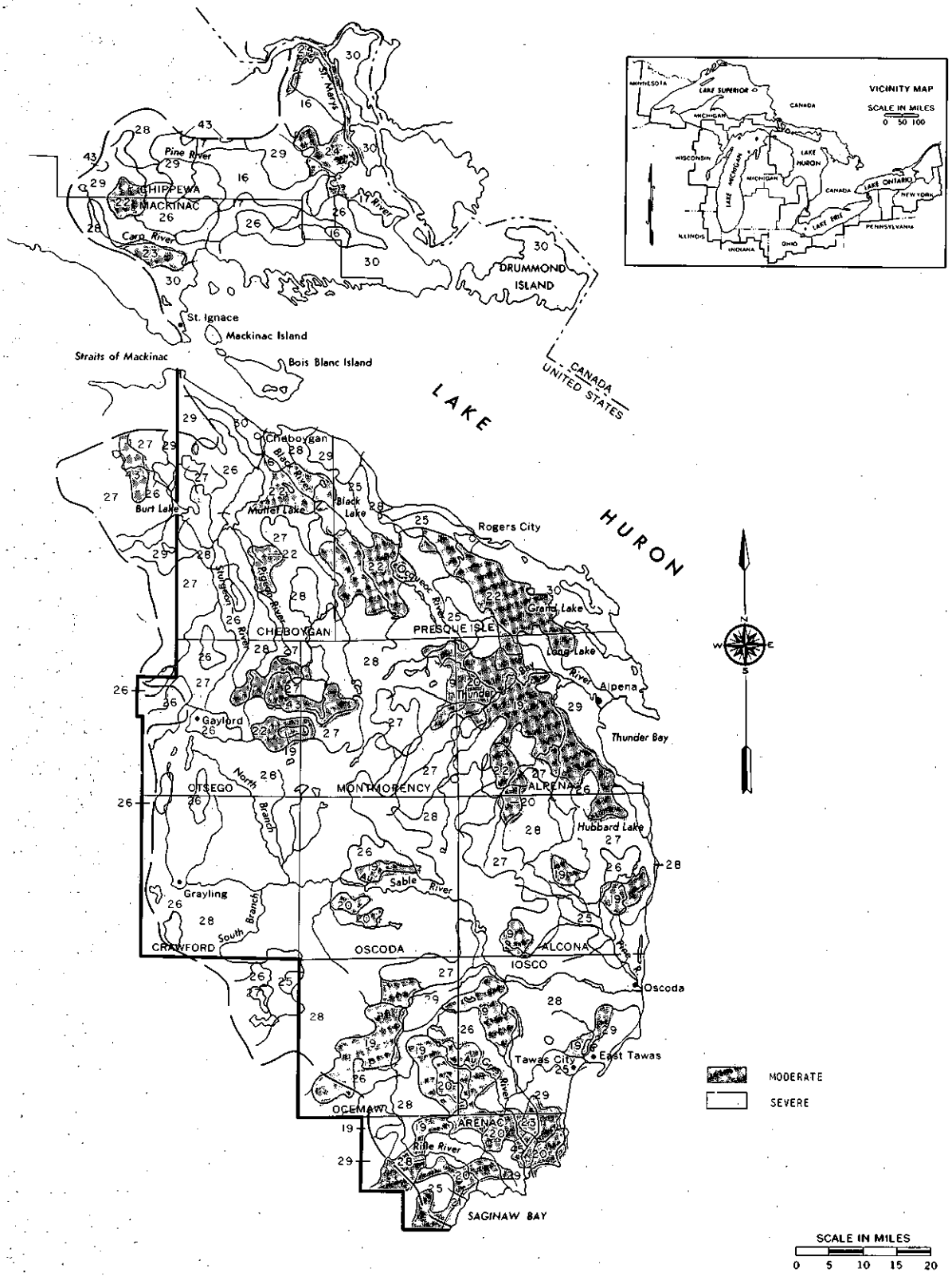


FIGURE 15–8 Soil Irrigation Limitations, Planning Subarea 2.4. Numbers are soil association codes.



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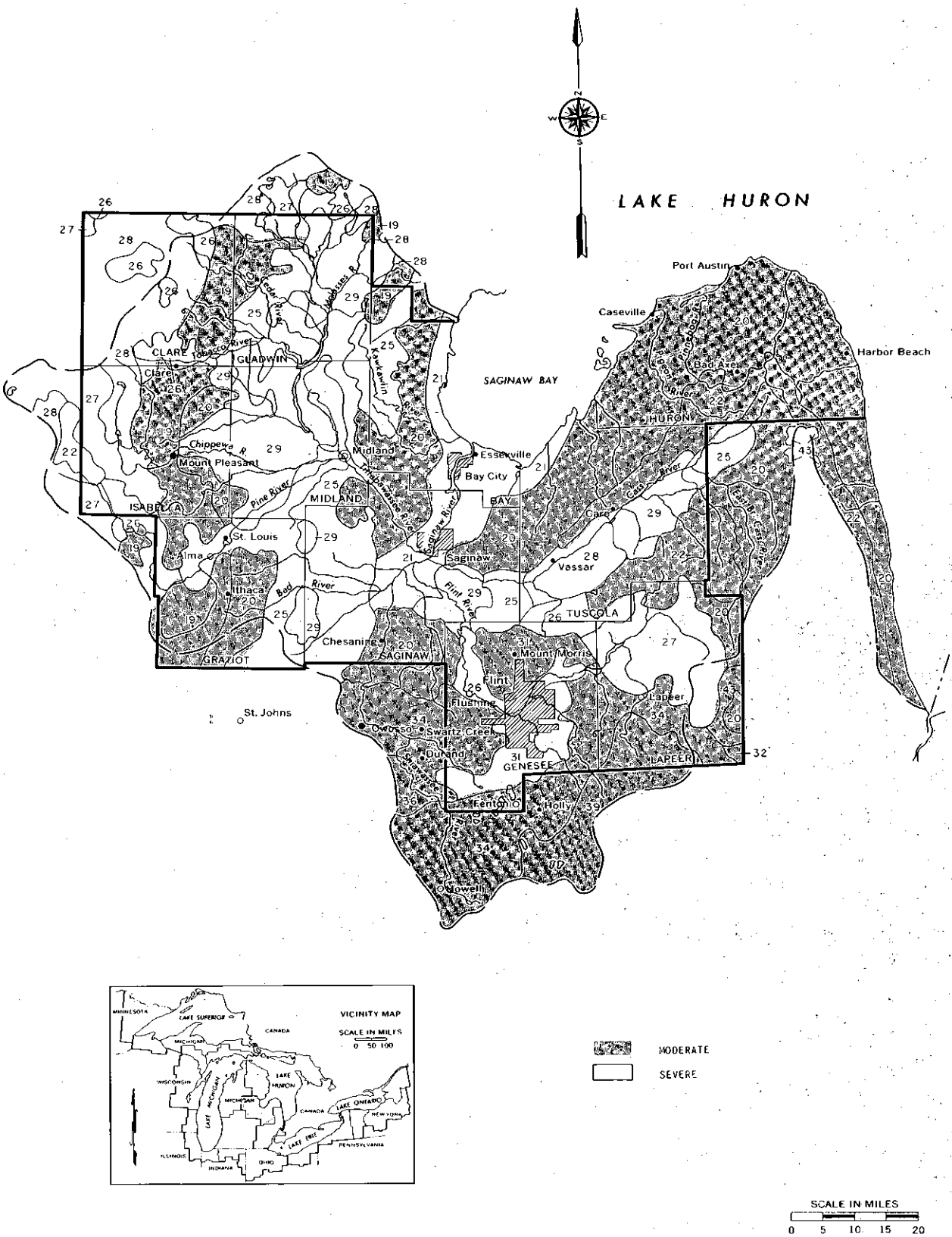
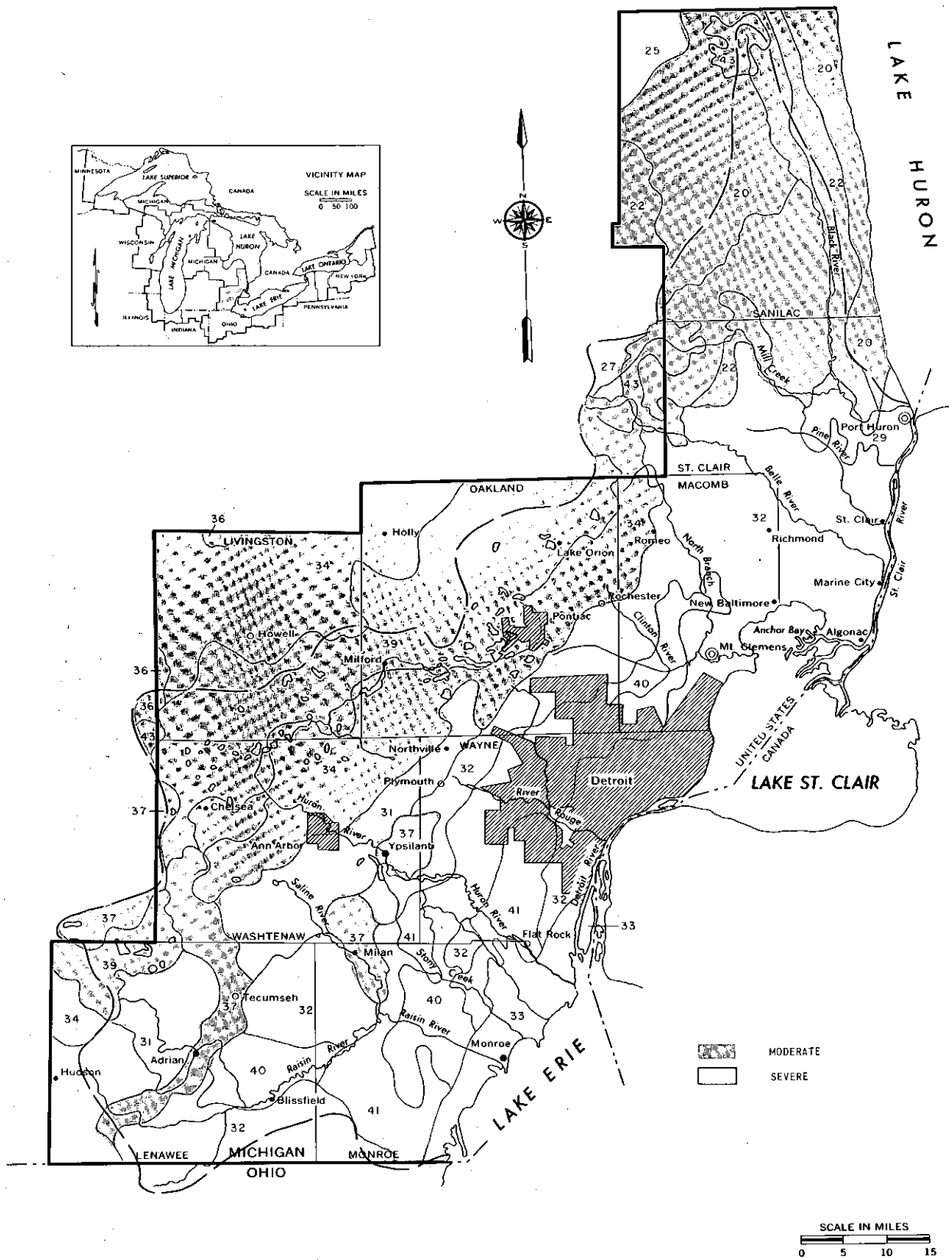


FIGURE 15–10 Soil Irrigation Limitations, Planning Subarea 3.2. Numbers are soil association codes.



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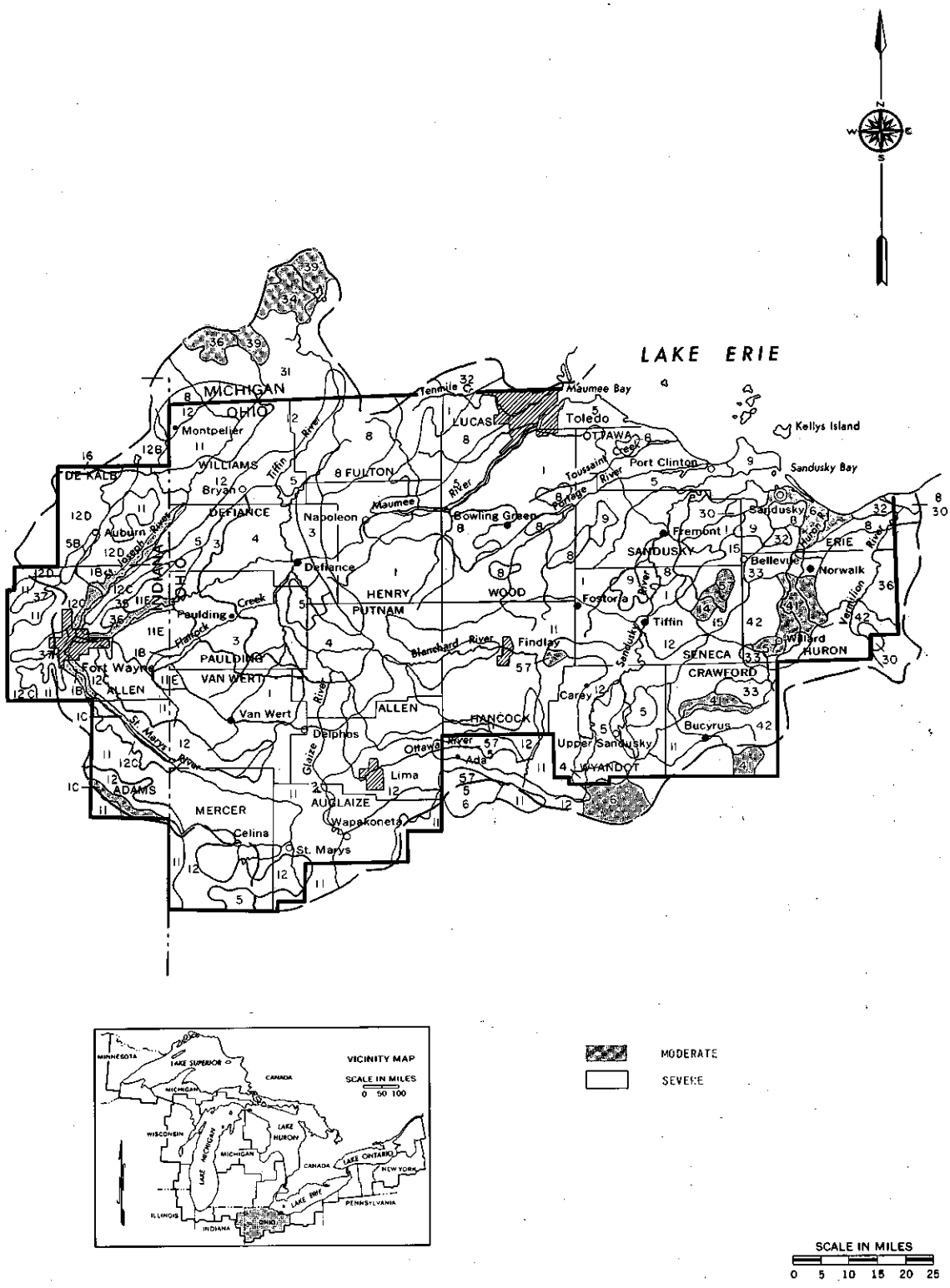


FIGURE 15–12 Soil Irrigation Limitations, Planning Subarea 4.2. Numbers and letters are soil association codes.

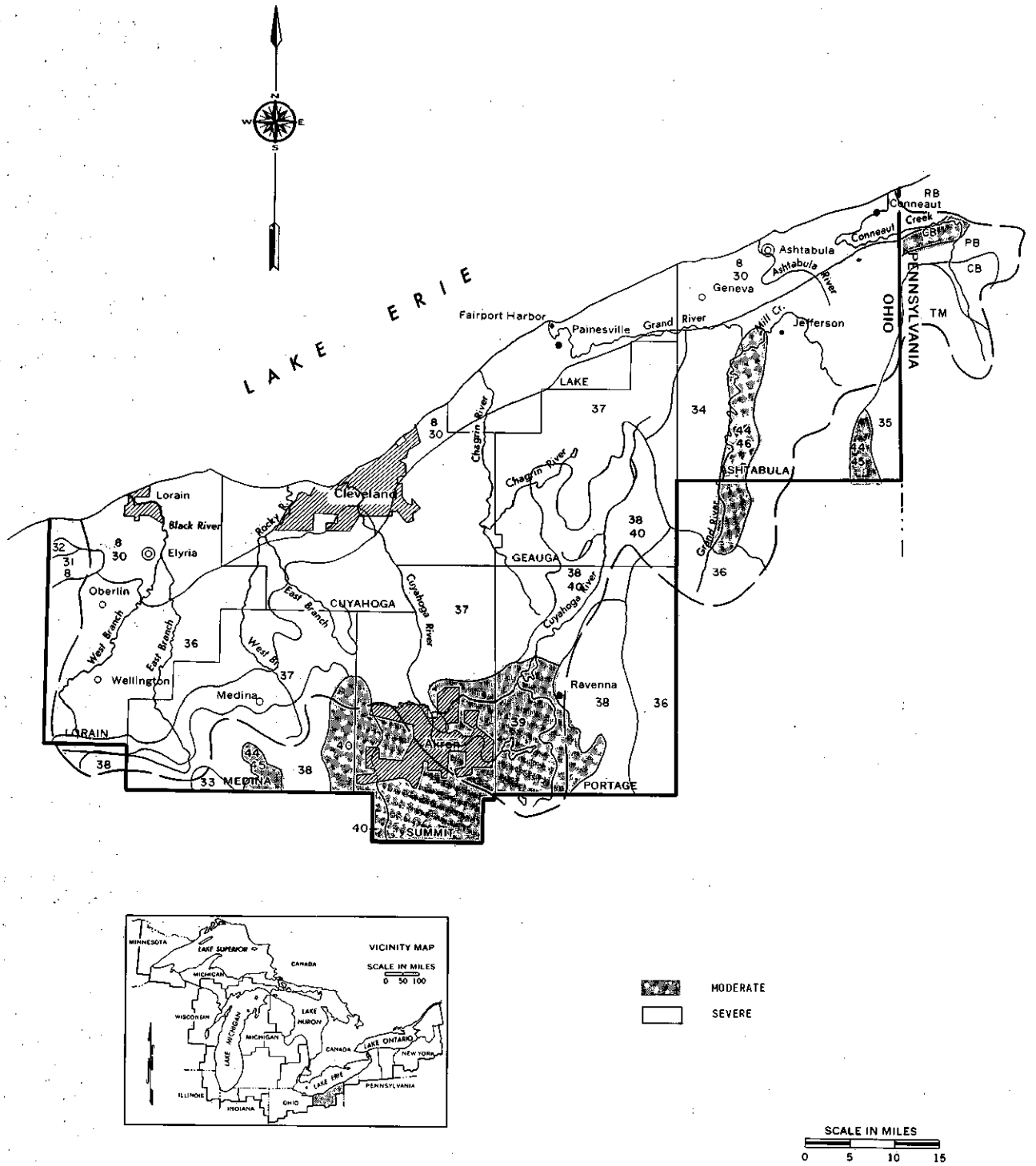


FIGURE 15–13 Soil Irrigation Limitations, Planning Subarea 4.3. Numbers and letters are soil association codes.

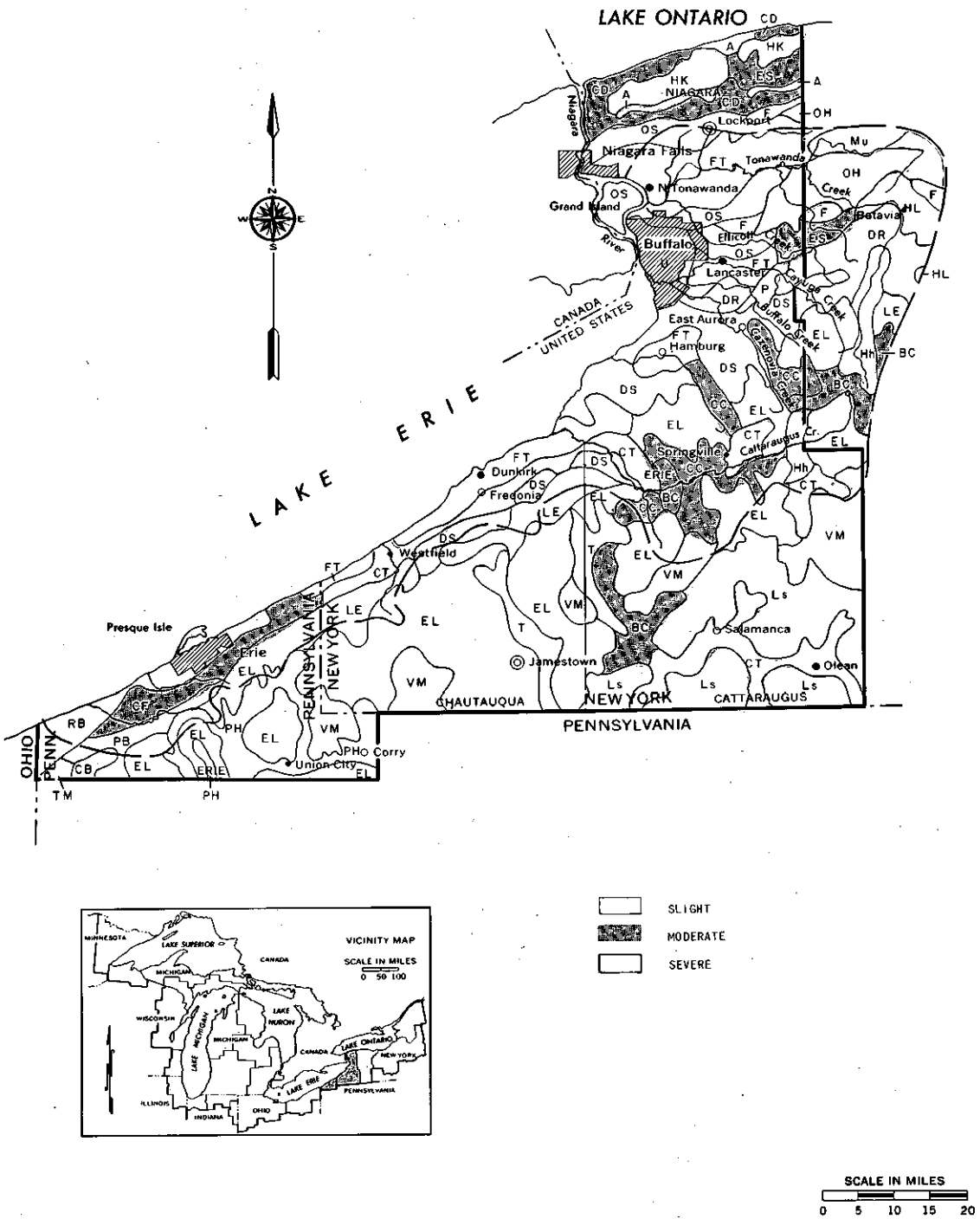


FIGURE 15–14 Soil Irrigation Limitations, Planning Subarea 4.4. Letters are soil association codes.

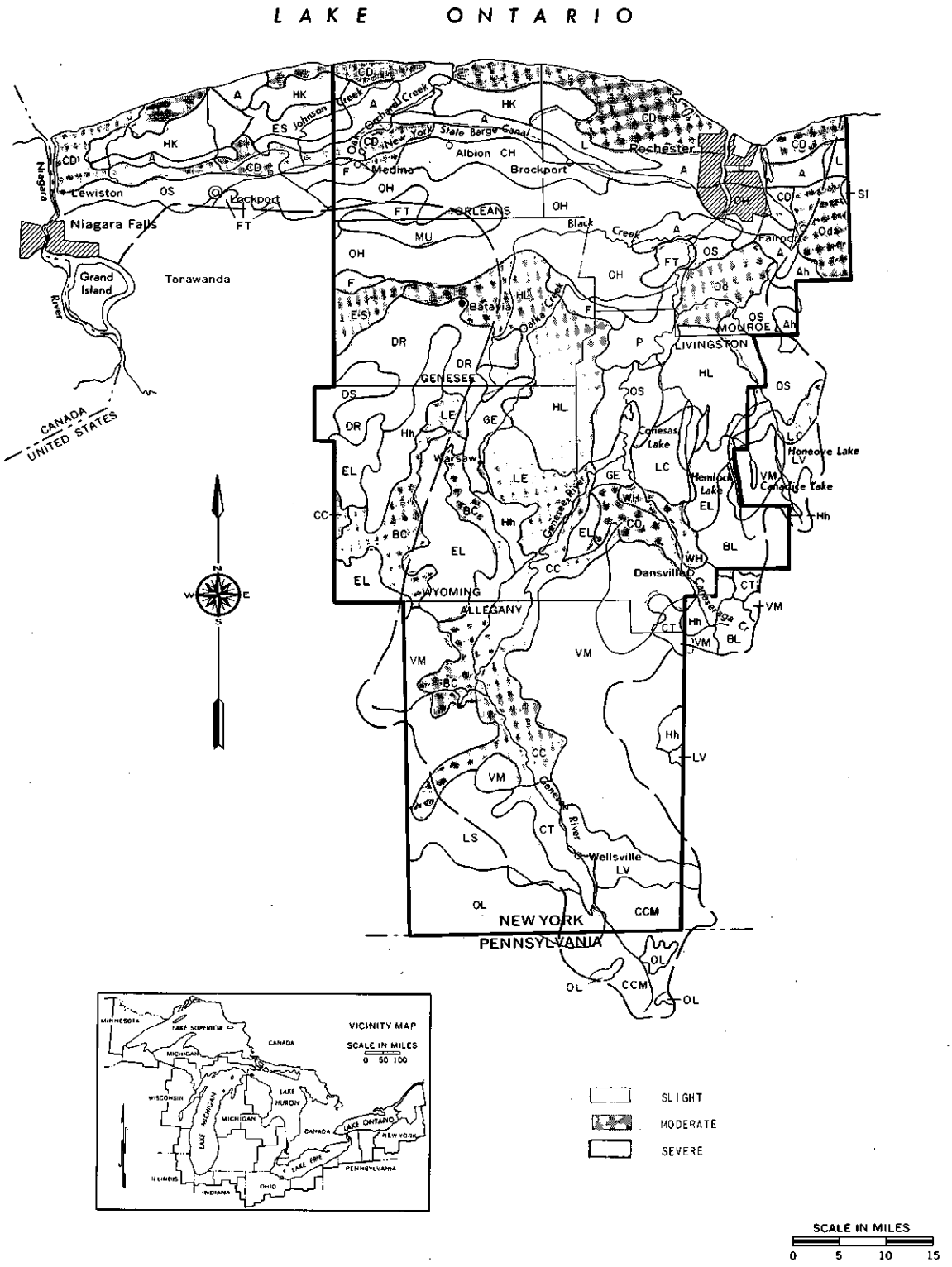
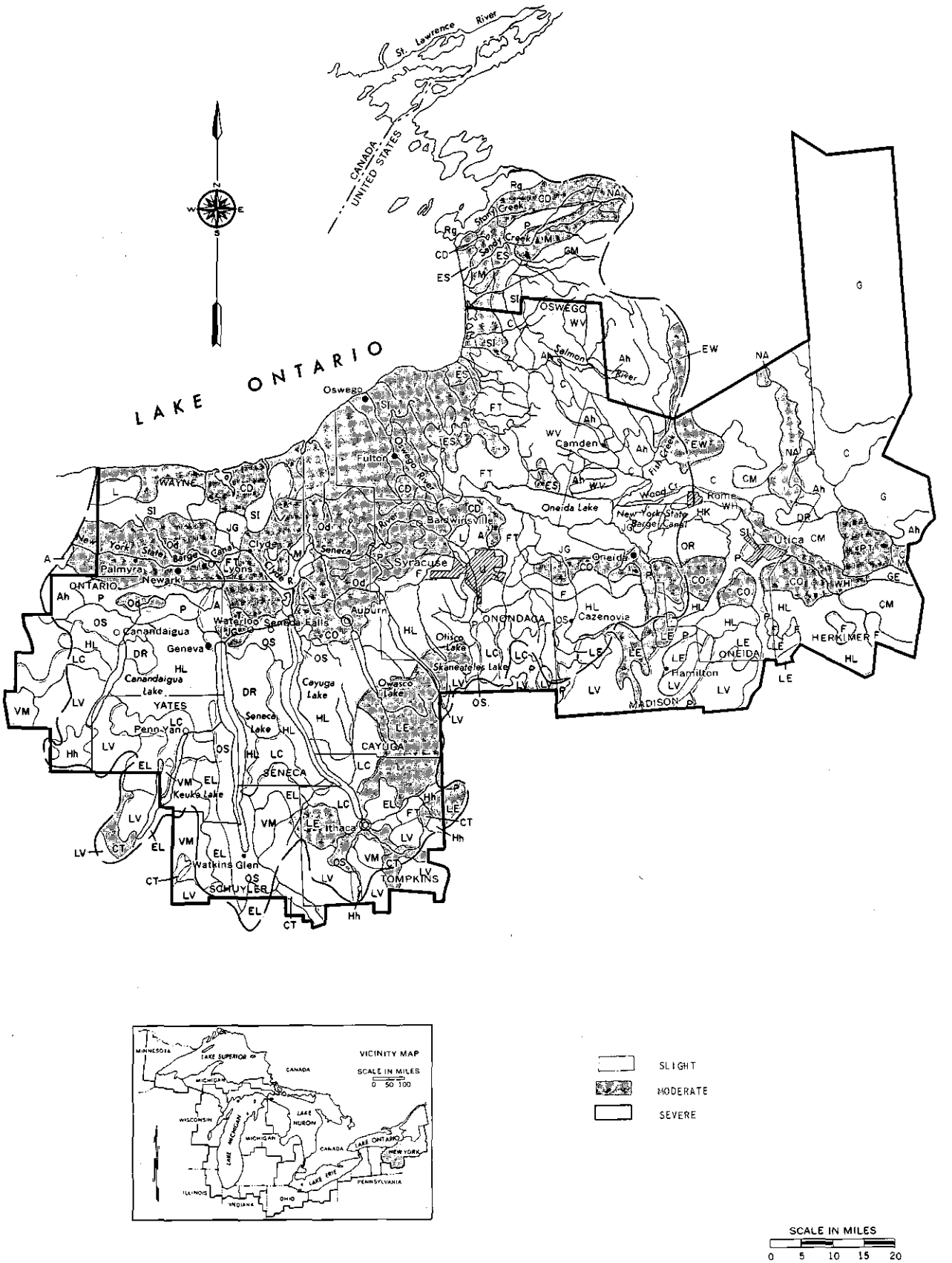


FIGURE 15–15 Soil Irrigation Limitations, Planning Subarea 5.1. Letters are soil association codes.



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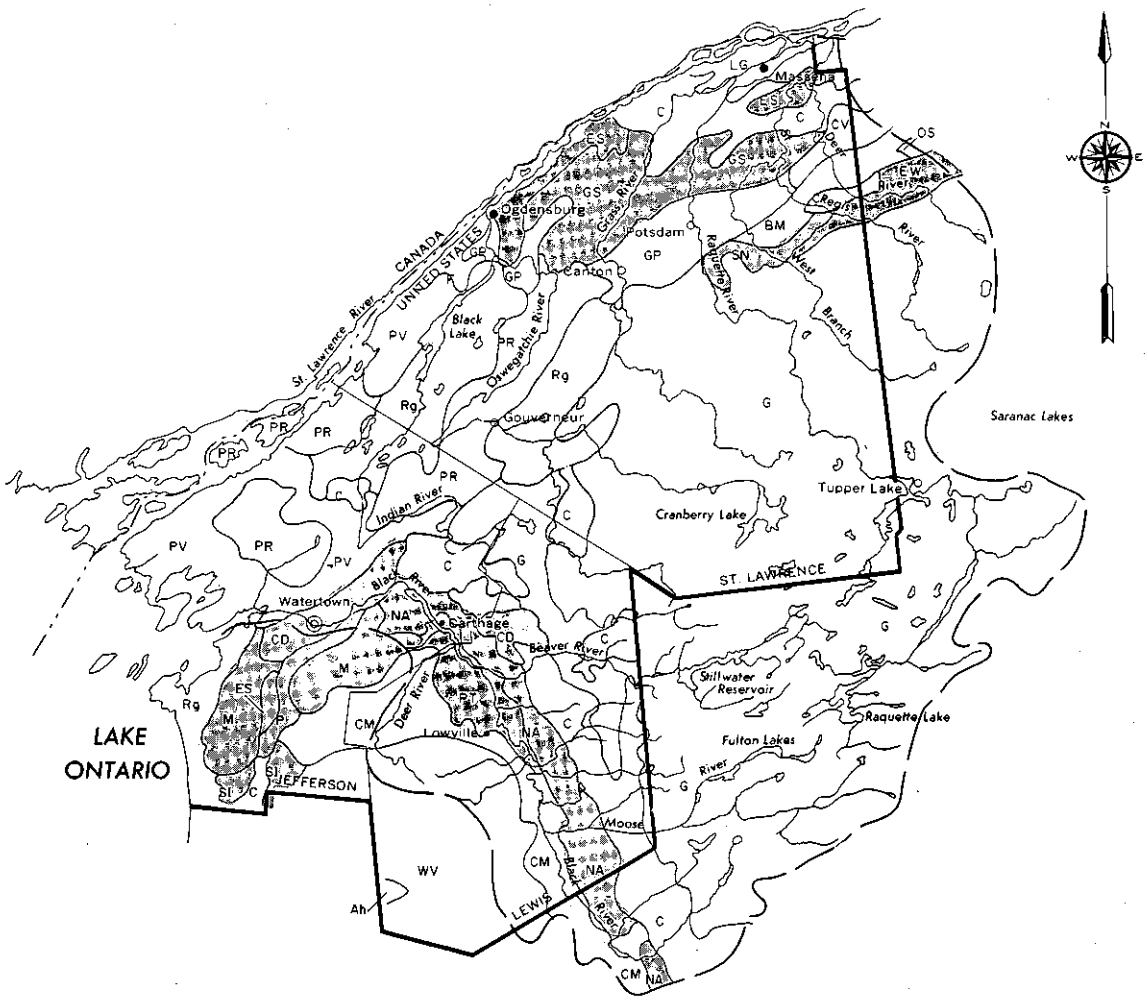
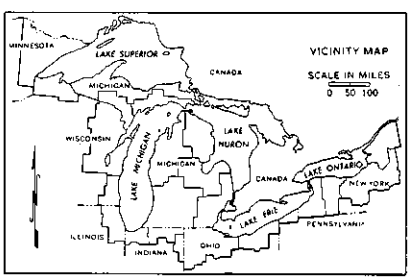




MODERATE

SEVERE

SCALE IN MILES

0 5 10 15 20

FIGURE 15–17 Soil Irrigation Limitations, Planning Subarea 5.3. Letters are soil association codes.

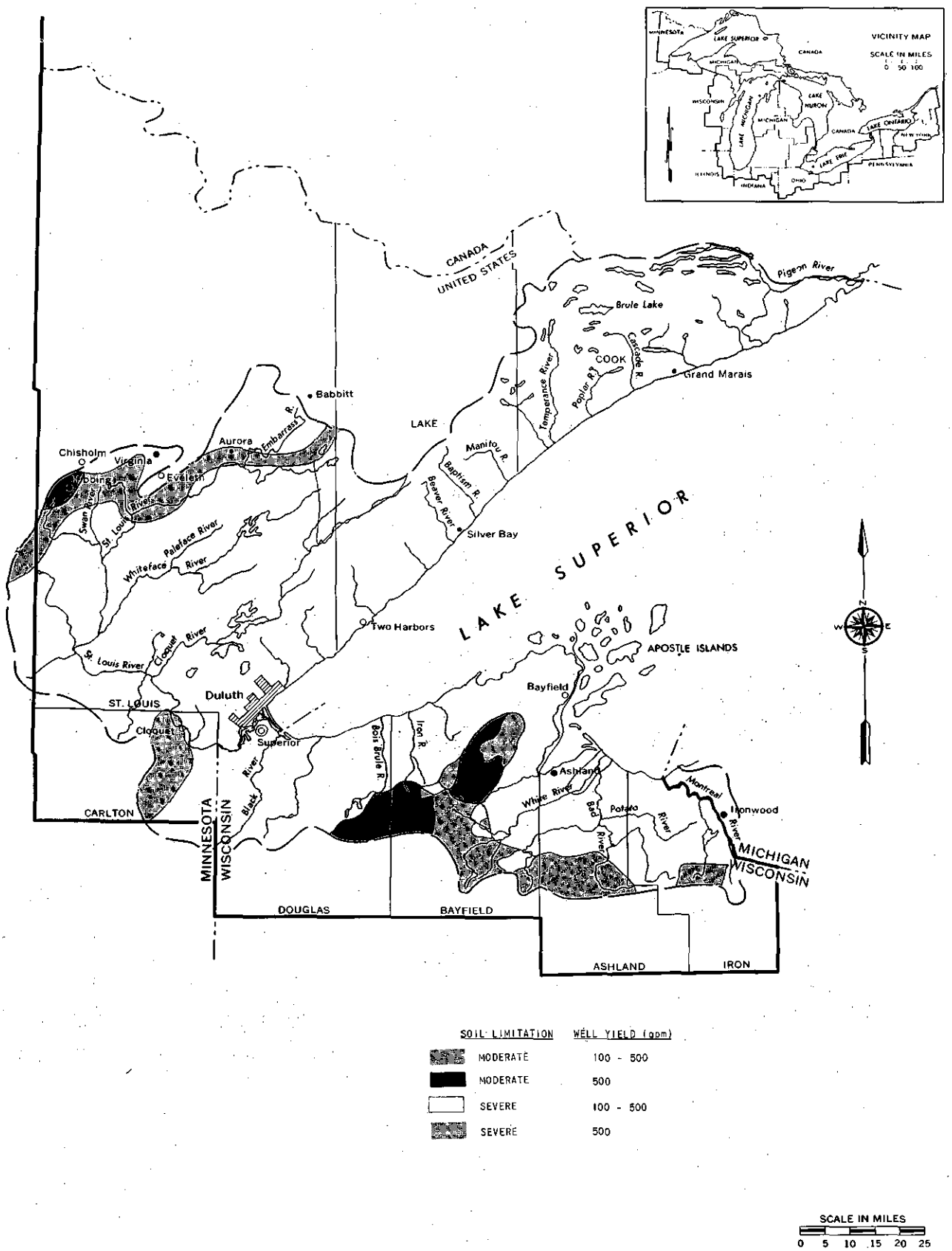


FIGURE 15–18 Soil Limitations and Well Yields, Planning Subarea 1.1

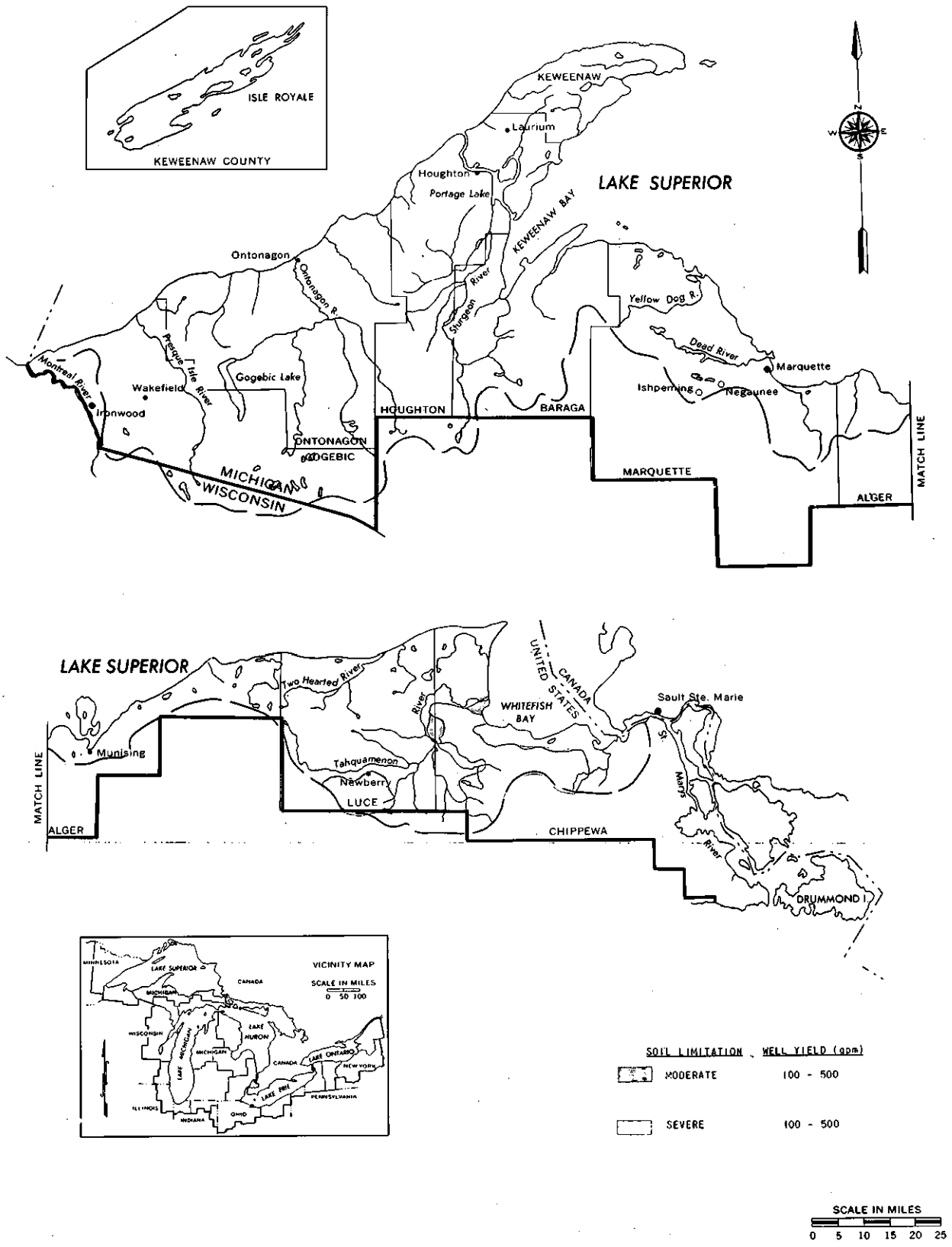


FIGURE 15–19 Soil Limitations and Well Yields, Planning Subarea 1.2

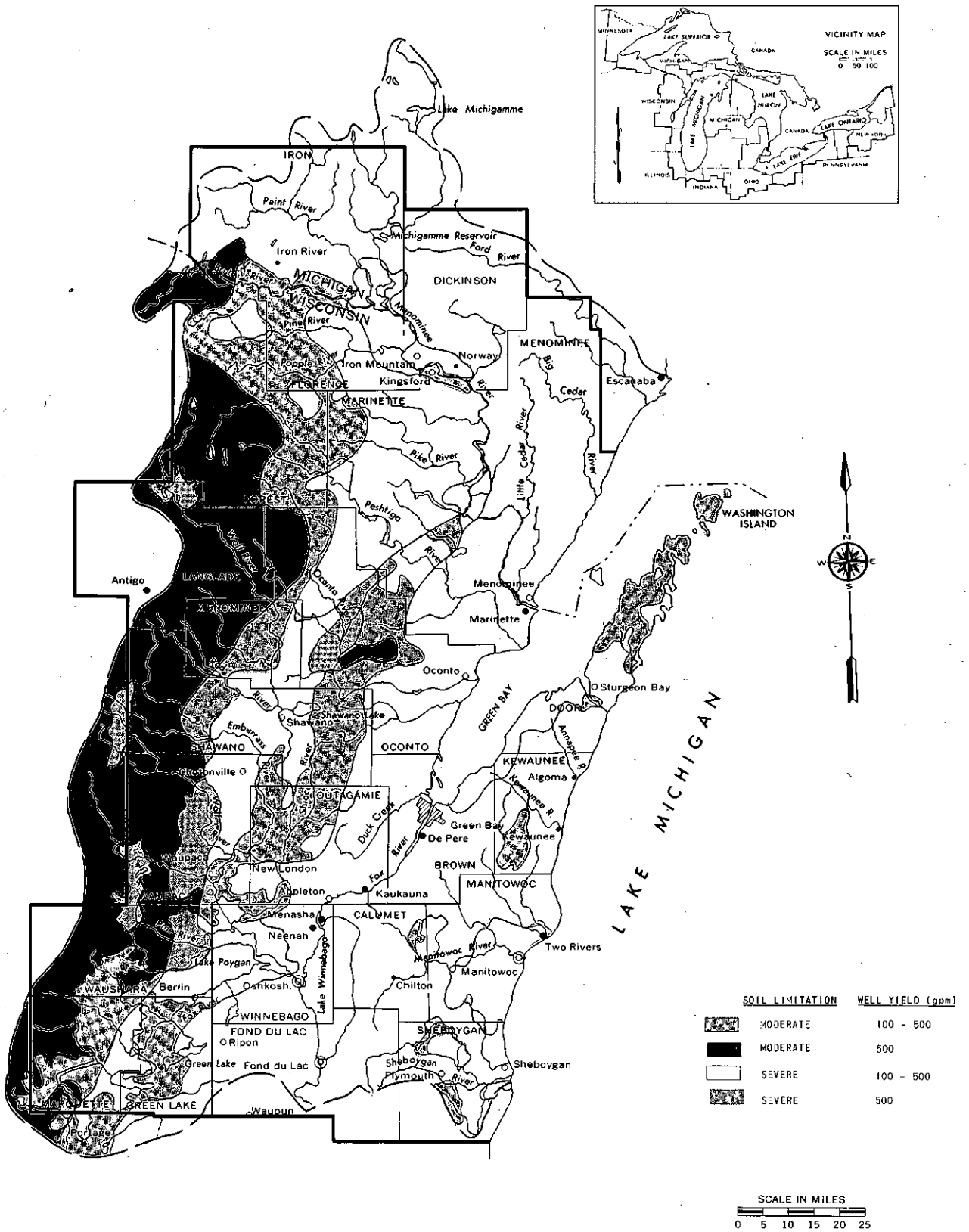


FIGURE 15–20 Soil Limitations and Well Yields, Planning Subarea 2.1

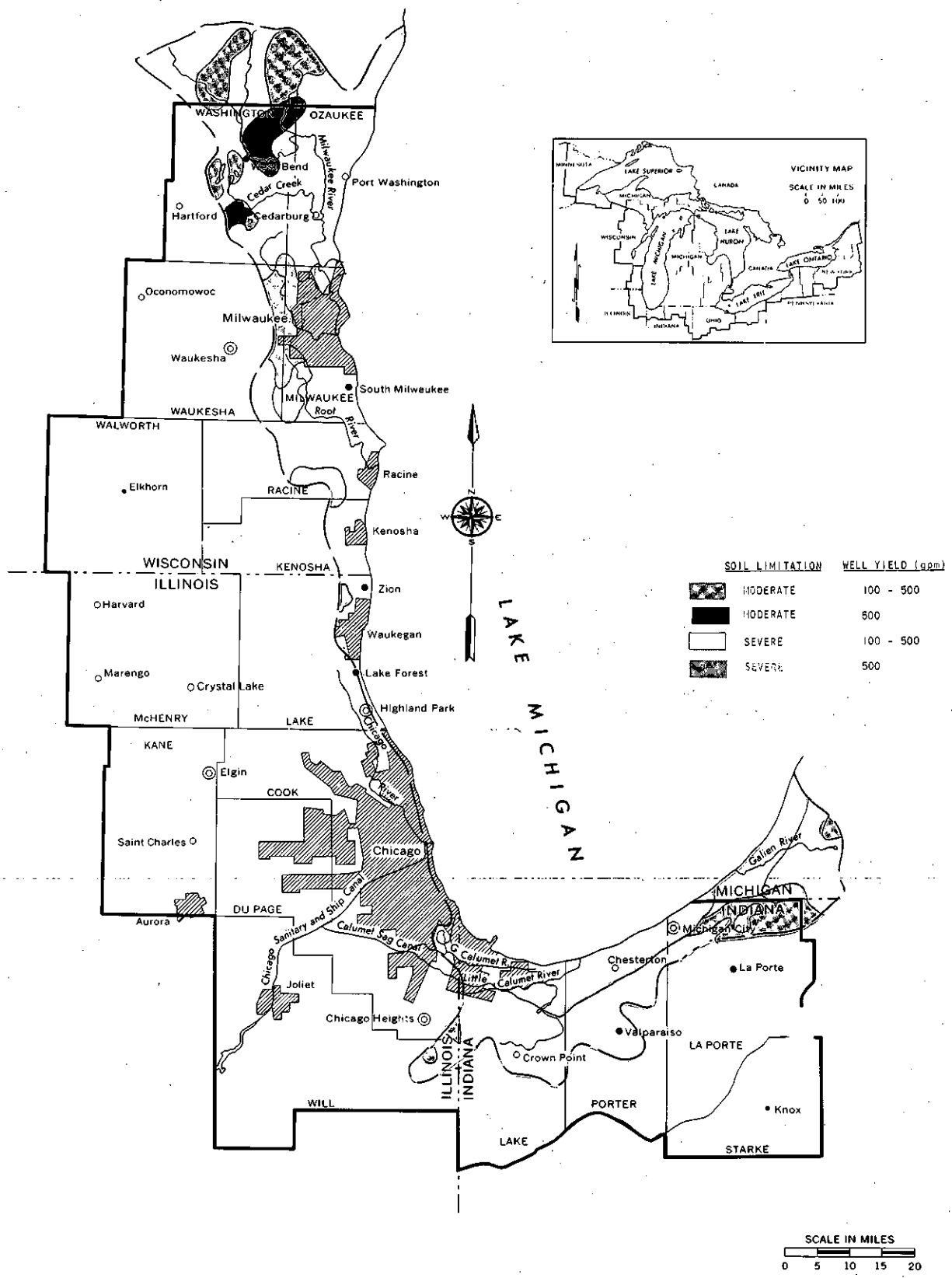


FIGURE 15–21 Soil Limitations and Well Yields, Planning Subarea 2.2

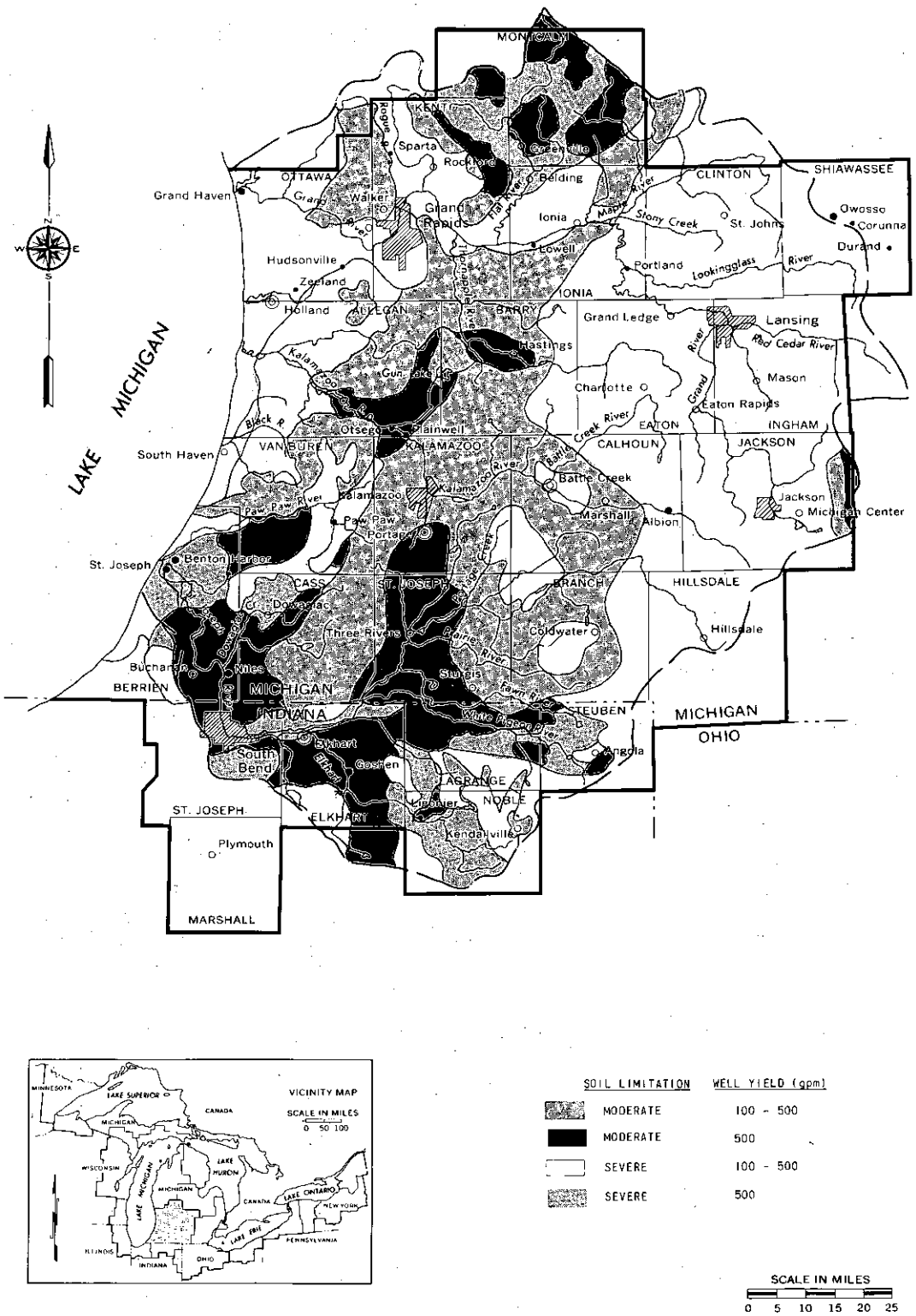


FIGURE 15–22 Soil Limitations and Well Yields, Planning Subarea 2.3

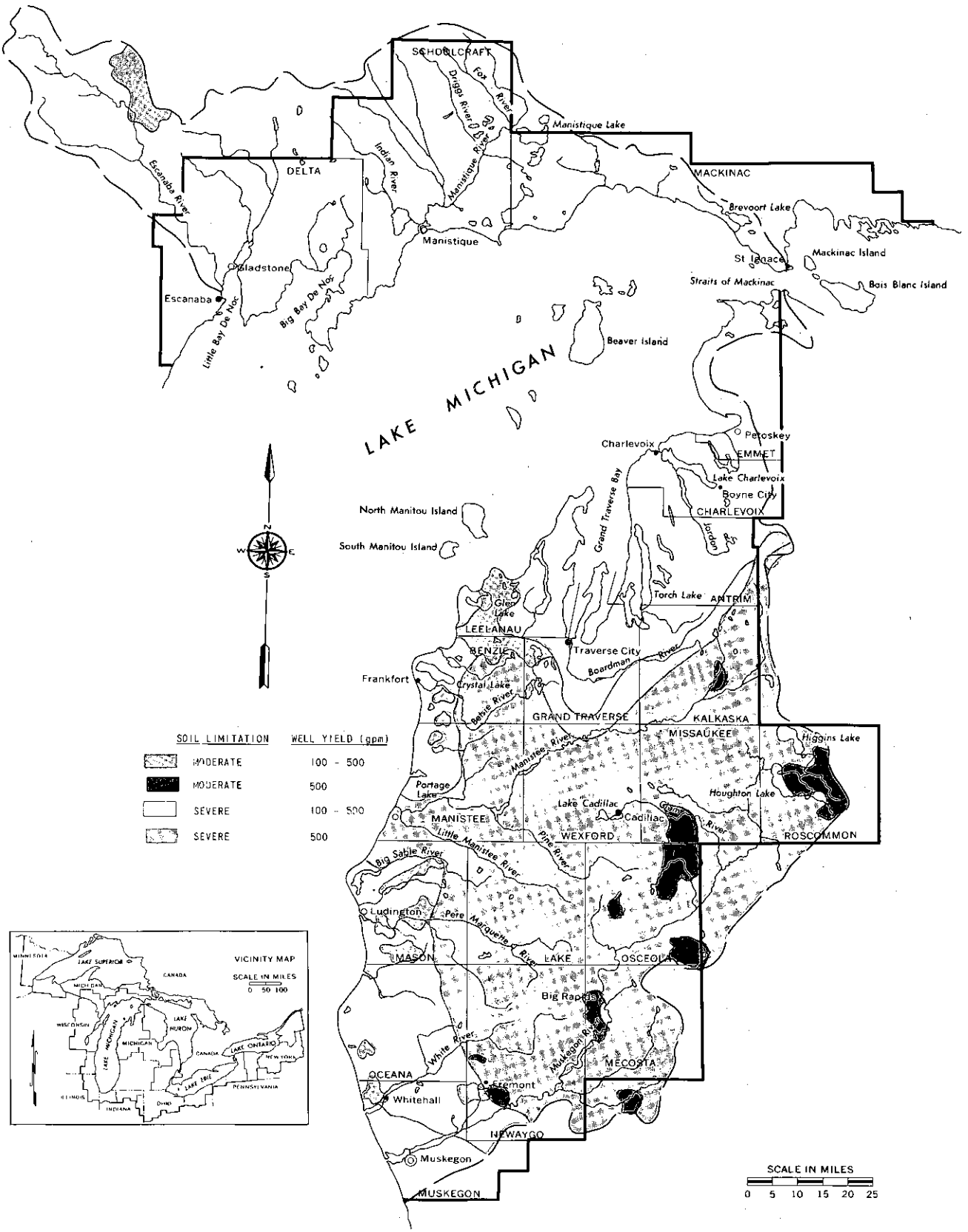


FIGURE 15–23 Soil Limitations and Well Yields, Planning Subarea 2.4

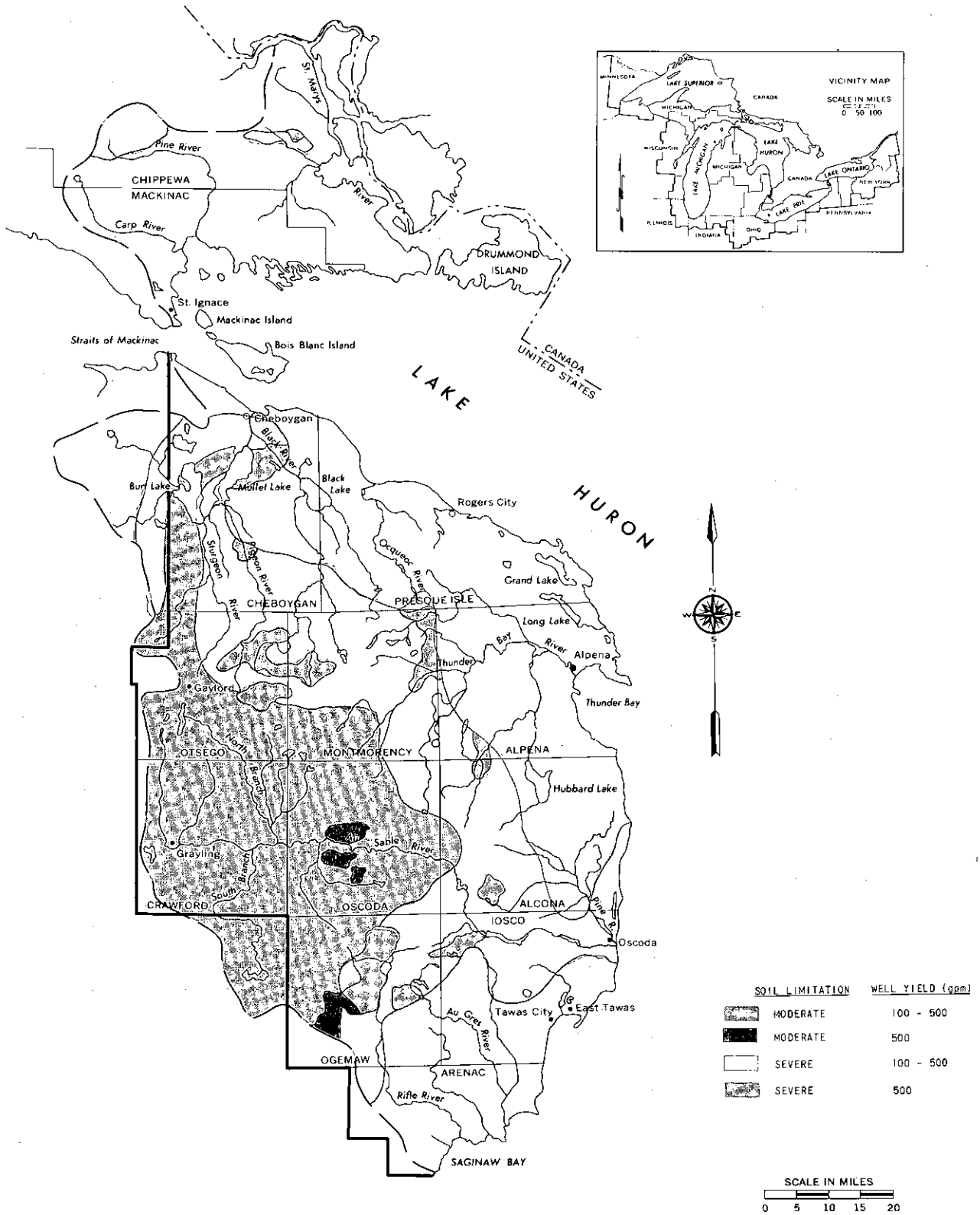


FIGURE 15–24 Soil Limitations and Well Yields, Planning Subarea 3.1

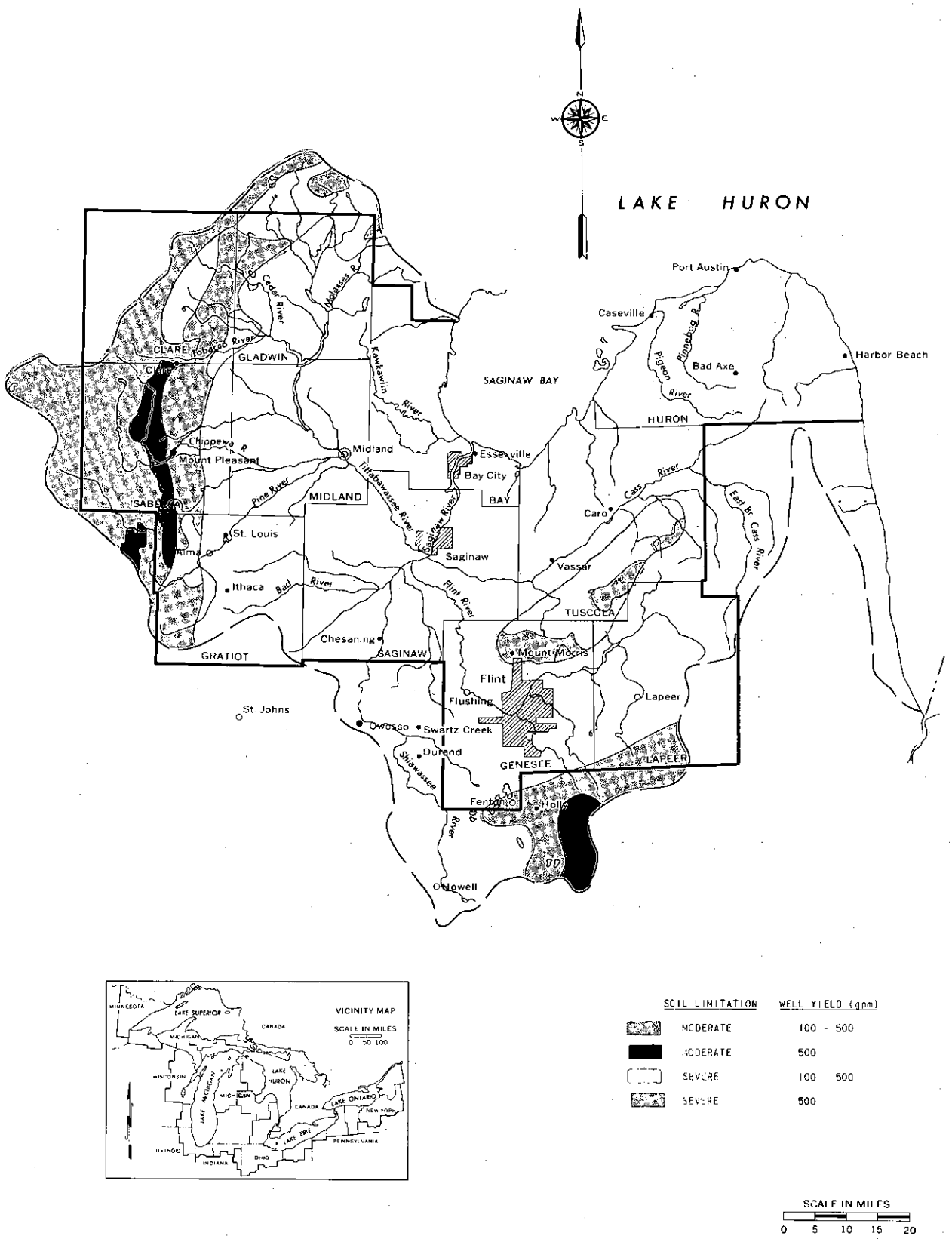


FIGURE 15–25 Soil Limitations and Well Yields, Planning Subarea 3.2

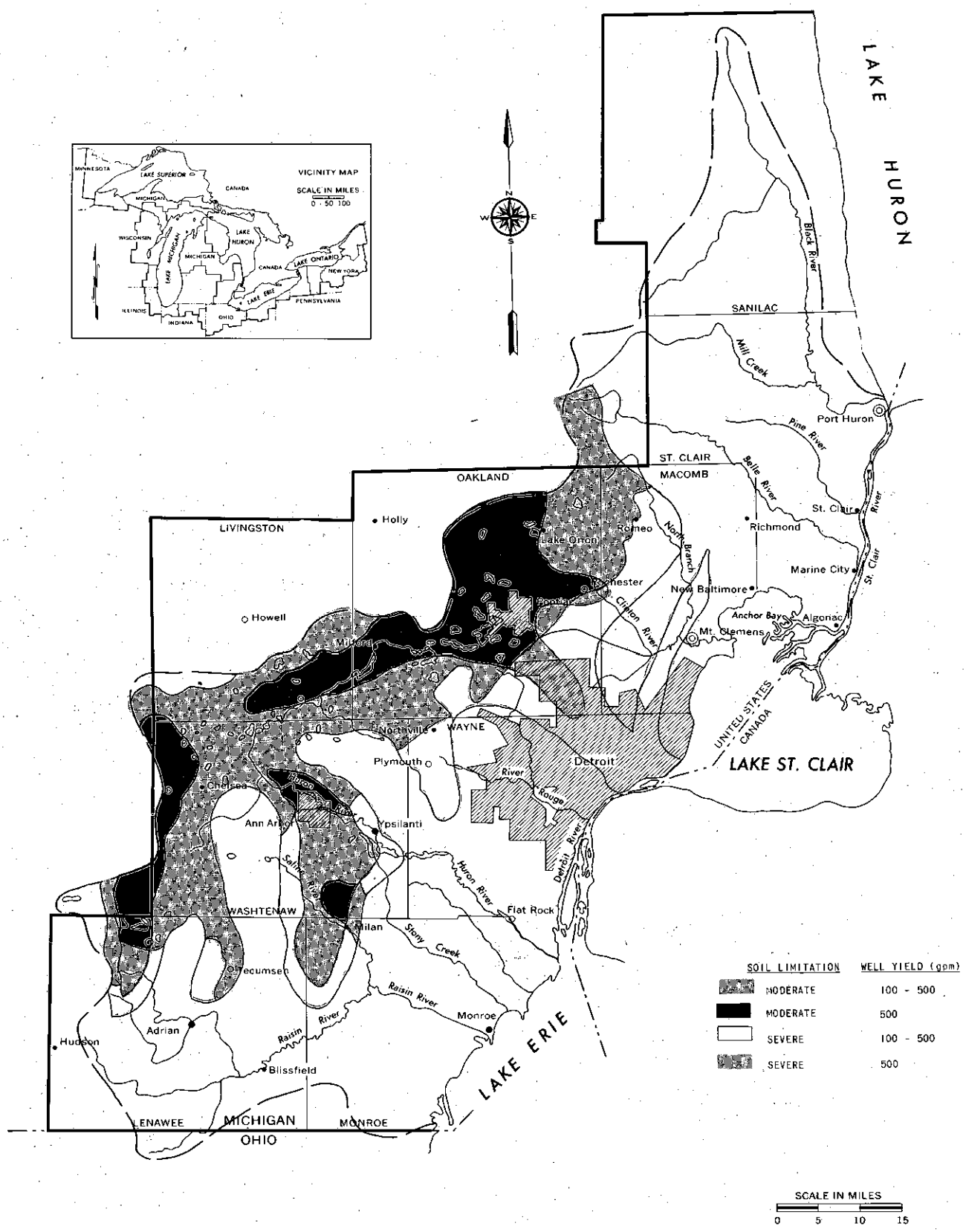
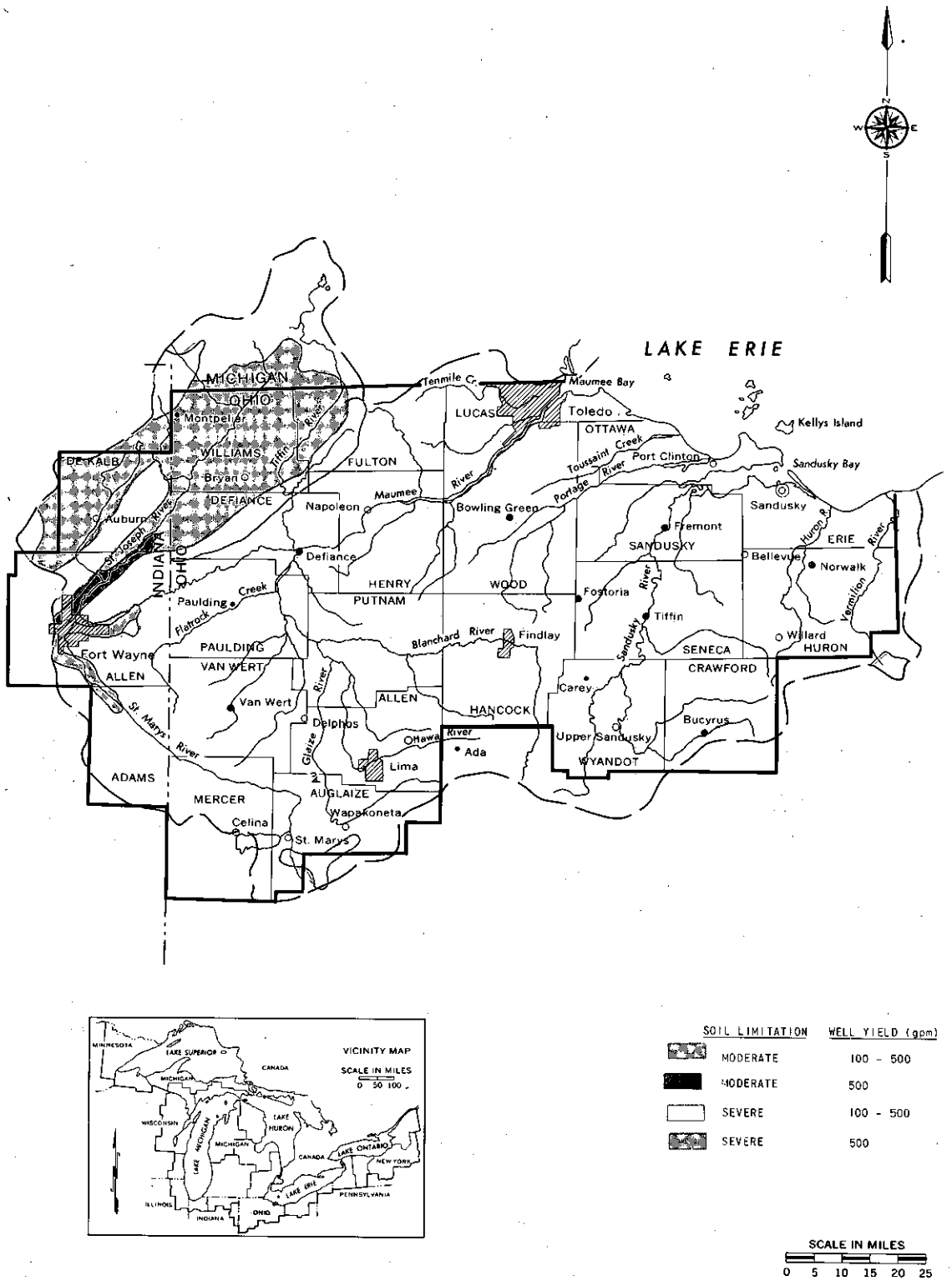


FIGURE 15–26 Soil Limitations and Well Yields, Planning Subarea 4.1



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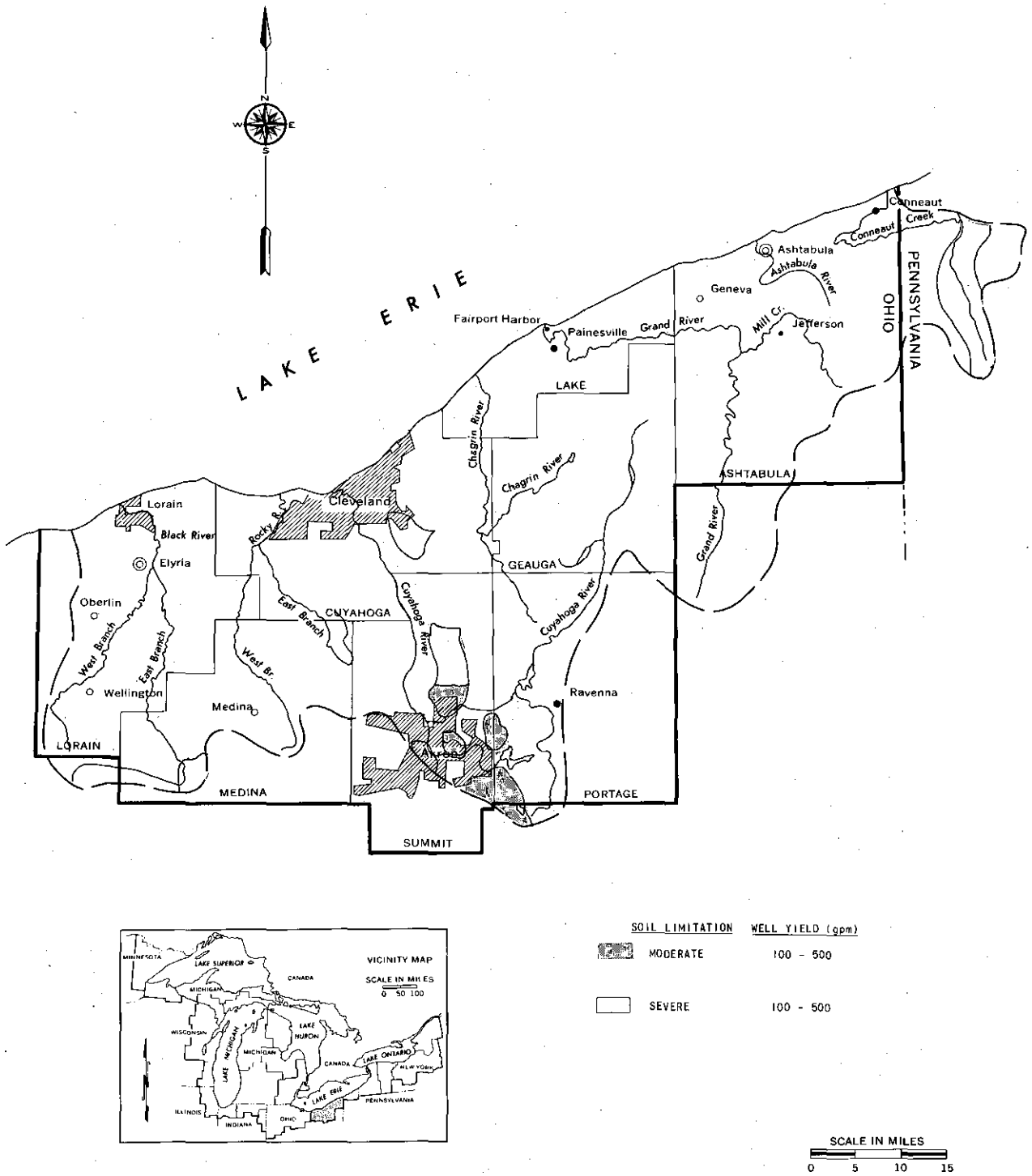


FIGURE 15–28 Soil Limitations and Well Yields, Planning Subarea 4.3

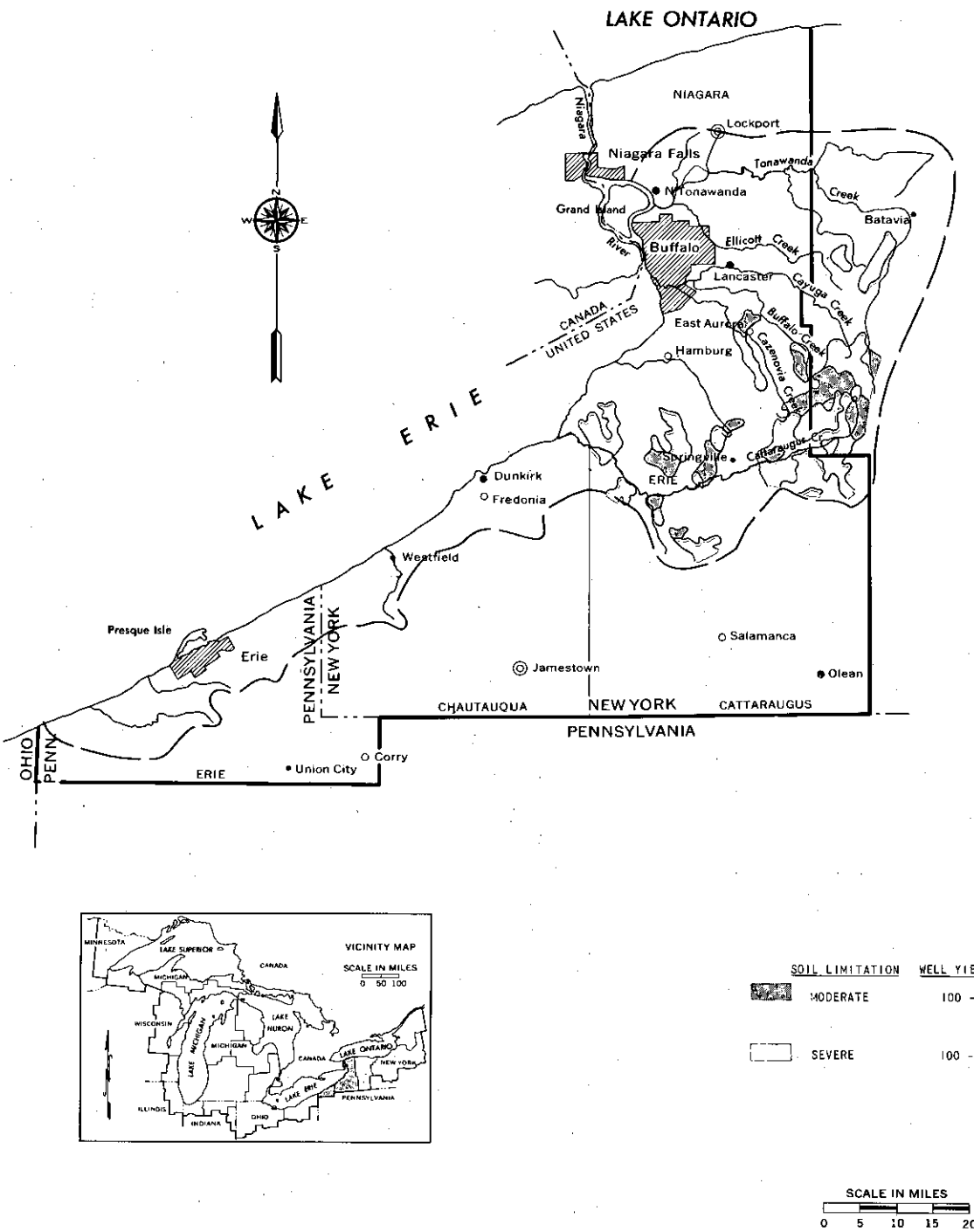


FIGURE 15–29 Soil Limitations and Well Yields, Planning Subarea 4.4

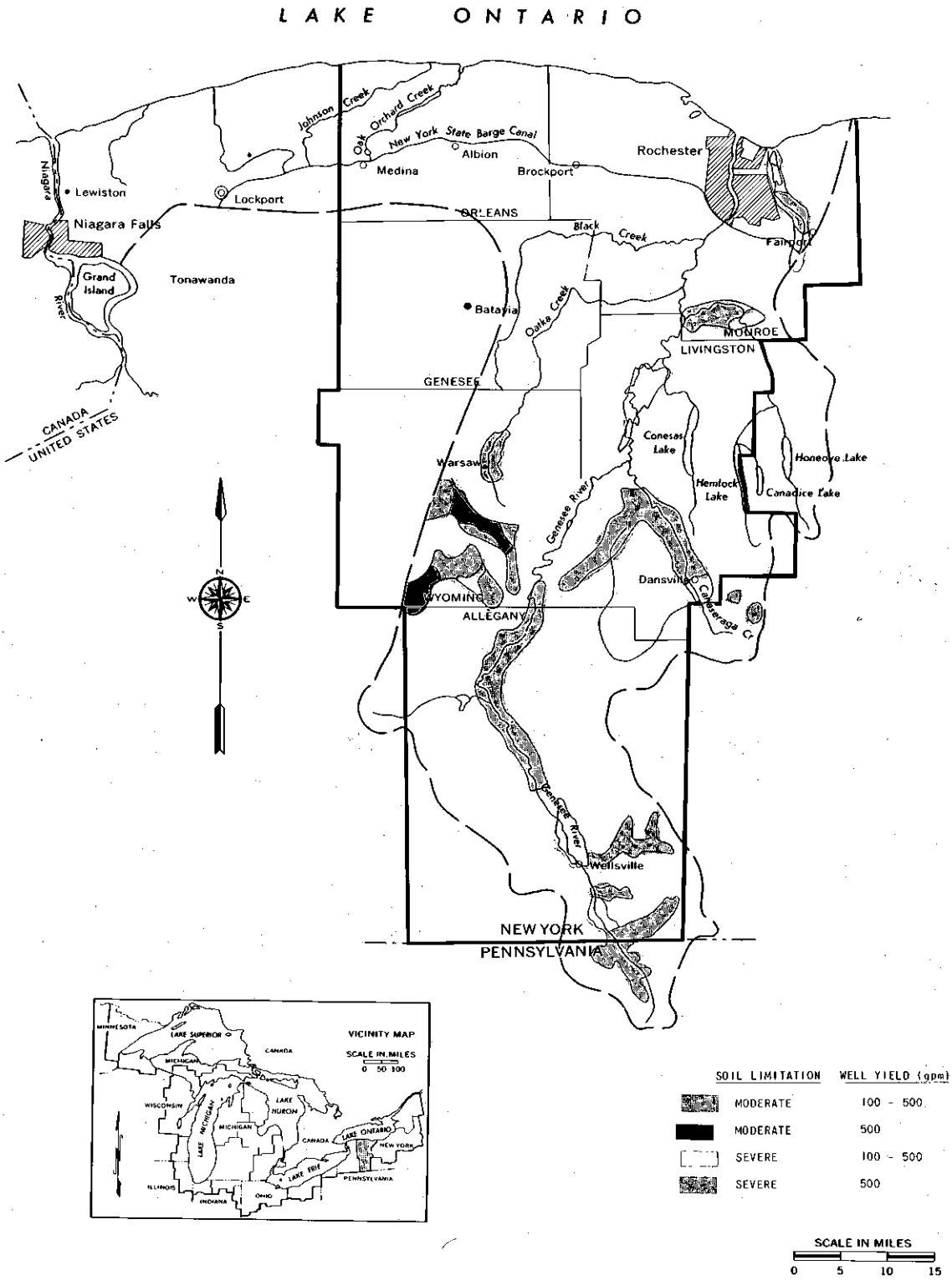


FIGURE 15–30 Soil Limitations and Well Yields, Planning Subarea 5.1

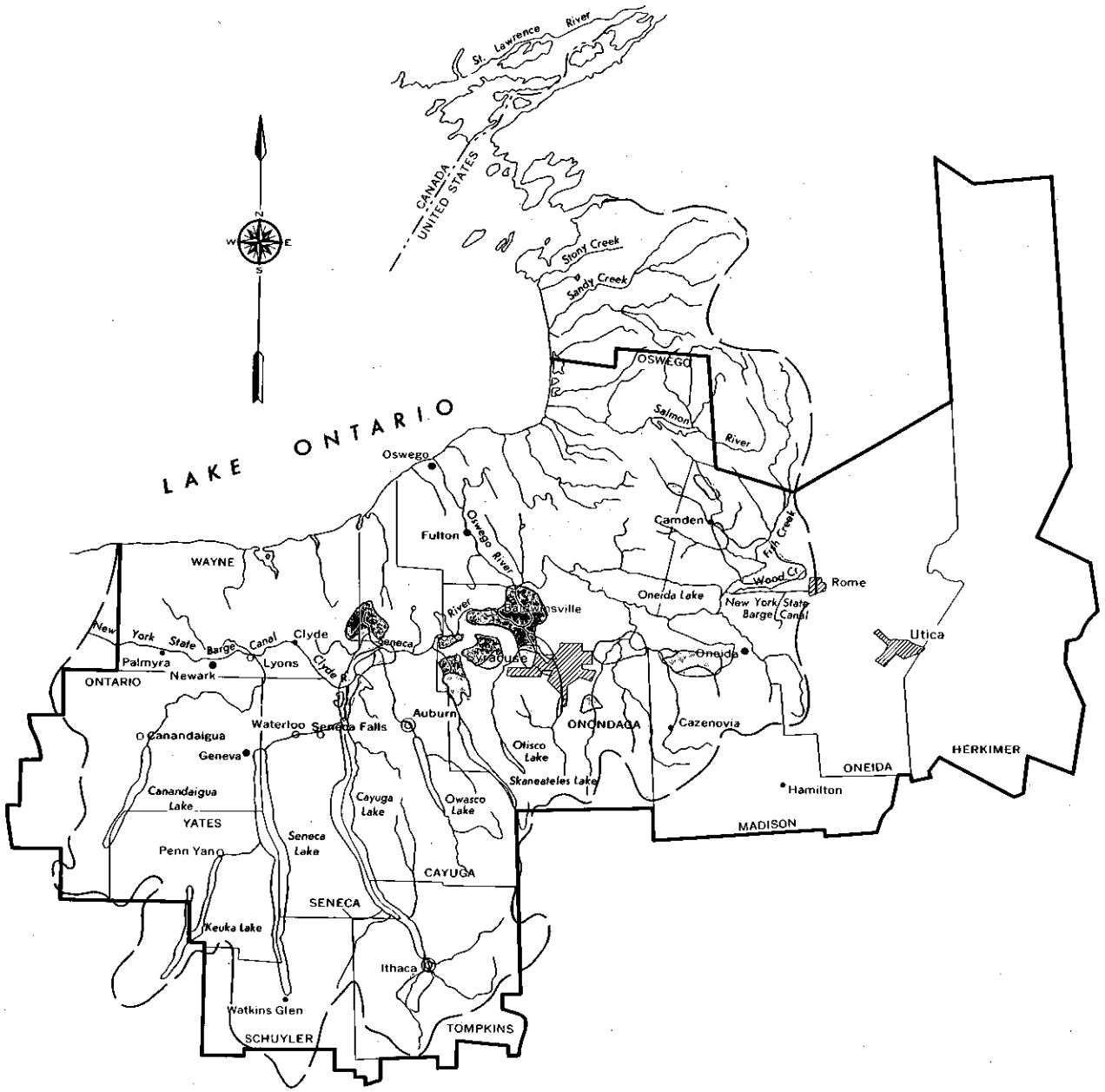


FIGURE 15–31 Soil Limitations and Well Yields, Planning Subarea 5.2

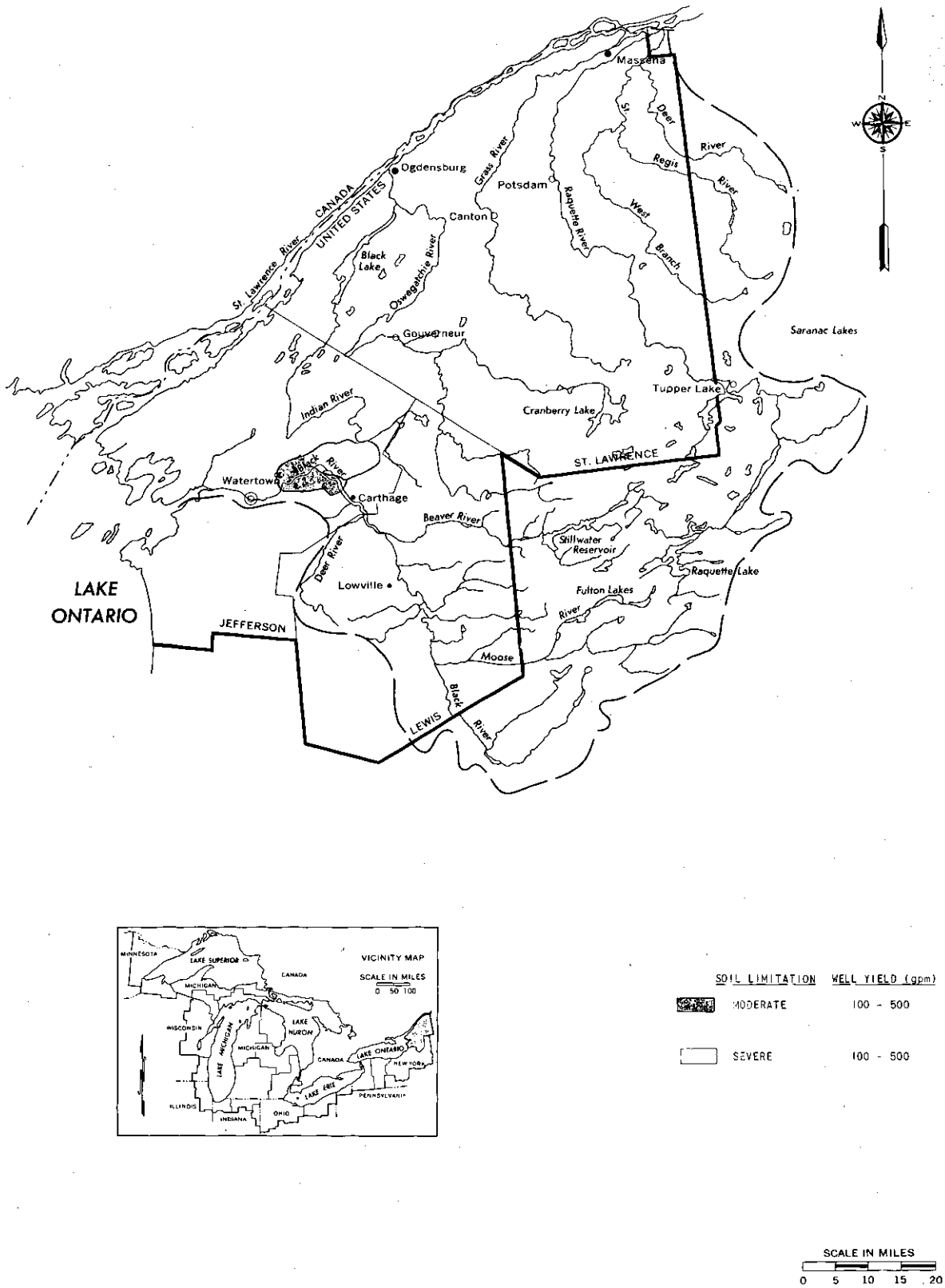
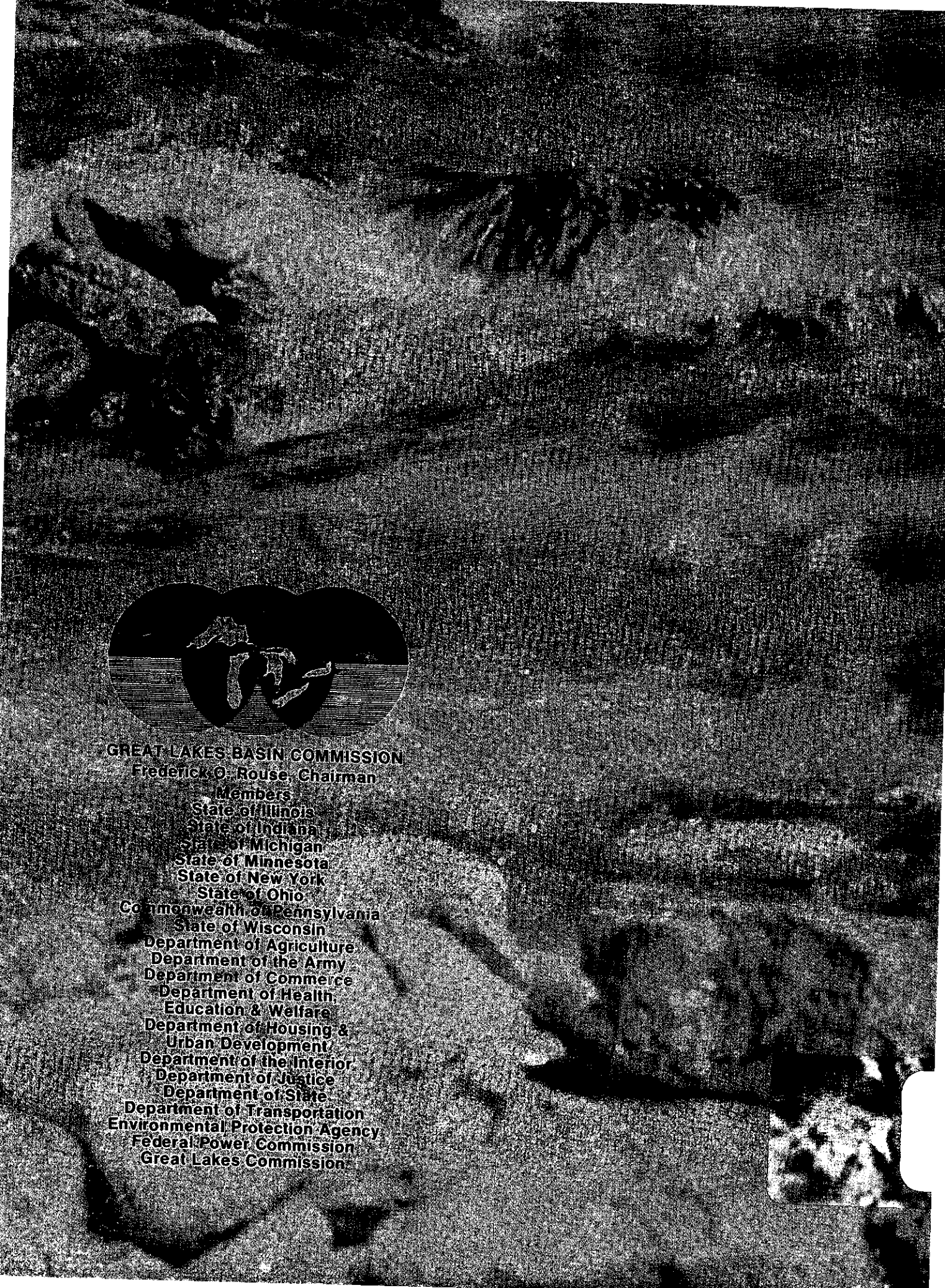


FIGURE 15–32 Soil Limitations and Well Yields, Planning Subarea 5.3

AUTHOR

TITLE GREAT LAKES BASIN FRAMEWORK STUDY - APPENDIX 15

DATE DUE	BORROWER'S NAME



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