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...IESOTA PORTION OF CRUDE OIL PIPELINE FROM PATOKA, ILLINOIS TO PINE BEND, MINNESOTA

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PREPARED BY DEPARTMENT OF NATURAL RESOURCES and NATIONAL BIOCENTRIC, INC.

DRAFT

ENVIRONMENTAL IMPACT STATEMENT
MINNESOTA PORTION OF A PROPOSED
CRUDE OIL PIPELINE ROUTE
FROM
PATOKA, ILLINOIS TO
PINE BEND, MINNESOTA

February 14, 1977

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TABLE OF CONTENTS

		PAGE
	INTRODUCTION.	1
1.	PROJECT DESCRIPTION	2
	1.1 SUMMARY STATEMENT.	2
	1.2 STATEMENT OF PURPOSE	2
	1.2.1 Uses of the Proposed Pipeline	2
	1.2.2 Need for the Proposed Project	2
	1.3 LOCATION OF PROPOSED PIPELINE	5
	1.3.1 Proposed Route.	5
	1.3.2 Proximity to Other Pipelines.	7
	1.4 LAND REQUIREMENTS.	7
	1.4.1 Right-of-Way.	7
	1.4.2 Easement Fees	7
	1.4.3 Future Facilities	8
	1.5 PROPOSED FACILITIES.	8
	1.6 CONSTRUCTION PROCEDURES.	9
	1.7 OPERATION AND MAINTENANCE.	16
	1.8 EMERGENCY PROCEDURES	16
2.	DESCRIPTION OF THE EXISTING ENVIRONMENT	17
	2.1 LAND USE	17
	2.1.1 Land Ownership Patterns	18
	2.1.2 Communities and Residential Areas	18
	2.1.3 Agriculture	23
	2.1.4 Forest Uses	23
	2.1.5 Other Land Uses	24
	2.1.6 Other Significant Resources	24
	2.1.7 Land Use of Possible Future Pump Station Site.	25
	2.2 SURFACE WATERS	26
	2.2.1 Location.	26
	2.2.2 Physical Description.	26
	2.2.3 Water Quality	39

PAGE

2.3 SOILS AND TOPOGRAPHY. 39

2.3.1 General. 39
2.3.2 Soil Descriptions (2). 43
2.3.3 Soil Capability Classes (3). 50
2.3.4 Engineering Properties of Soils. 51
2.3.5 Irrigation 51

2.4 GEOLOGY/GROUNDWATER 54

2.4.1 Bedrock Geology. 54
2.4.2 Surficial Geology. 56
2.4.3 Ground Water 56

2.5 BIOLOGICAL ENVIRONMENT. 59

2.5.1 Vegetation 59
2.5.2 Wildlife 61
2.5.3 Fishery Resources. 64
2.5.4 Rare, Unique, or Endangered Species. . . . 66

2.6 SOCIO-ECONOMIC ENVIRONMENT. 67

2.6.1 Population 67
2.6.2 Economics. 67
2.6.3 Transportation 67
2.6.4 Taxation 72
2.6.5 Services 73
2.6.6 Archaeological/Historical Sites. 77

2.7 AIR QUALITY AND NOISE 77

2.7.1 Air Quality. 77
2.7.2 Noise. 79

2.8 CLIMATE (2) 79

3. ENVIRONMENTAL IMPACTS 82

3.1 CONSTRUCTION. 82

3.1.1 Land Use 82
3.1.2 Surface Waters 83
3.1.3 Soils and Topography 83
3.1.4 Geology/Groundwater. 86
3.1.5 Biological Environment 86
3.1.6 Socio-Economic Environment 89
3.1.7 Transportation 91
3.1.8 Air Quality and Noise. 92
3.1.9 Climate 93

PAGE

3.2 OPERATION AND MAINTENANCE 93

3.2.1 Land Use 93
3.2.2 Surface Waters 93
3.2.3 Soils and Topography 94
3.2.4 Geology/Groundwater. 95
3.2.5 Biological Environment 95
3.2.6 Socio-Economic Environment 96
3.2.7 Air Qulaity and Noise. 97
3.2.8 Climate. 97

4. IMPACT MITIGATION. 98

4.1 LAND USE 98

4.2 SURFACE WATERS. 98

4.3 SOILS AND TOPOGRAHY 98

4.4 GEOLOGY/GROUNDWATER 99

4.4.1 Geology. 99
4.4.2 Groundwater. 99

4.5 BIOLOGICAL ENVIRONMENT. 99

4.6 SOCIO-ECONOMICS 100

4.6.1 Population 100
4.6.2 Economics. 100
4.6.3 Transportation 101
4.6.4 Taxation 101
4.6.5 Services 101

4.7 AIR QUALITY AND NOISE 101

4.7.1 Air Quality. 101
4.7.2 Noise. 101

5. ALTERNATIVES 102

5.1 TRANSPORTATION. 102

5.1.1 Barge, Rail or Truck 102
5.1.2 Other Pipelines. 102

5.2 SITES AND LOCATIONS 103

5.2.1 Proposed Route 103
5.2.2 Alternative Routes 105

PAGE

5.3 ALTERNATIVE STREAM CROSSING TECHNIQUES 105

5.4 NO ACTION. 106

6. UNAVOIDABLE ADVERSE IMPACTS. 107

6.1 HUMAN RESOURCES IMPACTED 107

6.2 USES PREEMPTED AND UNAVOIDABLE CHANGES 108

6.3 LOSS OF ENVIRONMENTAL QUALITY. 108

7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES 110

8. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY . . 111

9. IMPACT ON STATE GOVERNMENT OF RELEVANT FEDERAL CONTROLS 112

10. MULTI-STATE RESPONSIBILITIES 113

11. COORDINATION WITH AGENCIES AND INDIVIDUALS. . 114

REFERENCES

BIBLIOGRAPHY

APPENDICES

APPENDIX A - EMERGENCY PROCEDURES

APPENDIX B - AIR PHOTOS OF STREAM CROSSING

APPENDIX C - SOIL DATA

APPENDIX D - MAMMALS OF SOUTHEASTERN MINNESOTA

APPENDIX E - ROADWAY CROSSINGS

APPENDIX F - CAMPSITE AVAILABILITY

APPENDIX G - ROUTE MAPS

APPENDIX H - LETTER FROM HISTORICAL SOCIETY

APPENDIX I - LETTER FROM CORPS OF ENGINEERS

LIST OF TABLES

TABLE NUMBER		PAGE
1	Volumes Transported for Five Most Recent Calendar Years.	3
2	Land Use of Proposed Right-Of-Way	17
3	Land Use Along Proposed Route	20
4	Land Use By Township.	21
5	Acres of Crops Harvested in 1974 By Township. . . .	22
6	Estimated Watershed Discharge Data.	30
7	Selected Data on Proposed River and Stream Crossing.	31
8	Summary of Water Quality for MPCA Monitoring Sites in Southeastern Minnesota	40
9	Water Quality Analyses of Streams and Rivers, November 8-9, 1976.	41
10	Selected Features of Soil Landscape Units Within the Mississippi Valley Outwash (29) Geomorphic Region.	44
11	Selected Features of Soil Landscape Units Within the Cannon Valley Outwash (3) Geomorphic Region . .	44
12	Selected Features of Soil Landscape Units Within the Kenyon-Taopi Till Plain, Silty, Undulating (38) Geomorphic Region	45
13	Selected Features of Soil Landscape Units Within the Harmony-Plainview Uplands, Silty, Gently Rolling (39) Geomorphic Region	46
14	Selected Features of Soil Landscape Units Within the Red Wing-La Crescent Uplands, Steep (40) Geomorphic Region.	47
15	Selected Features of Soil Landscape Units Within the Rochester Drift Plain (41) Geomorphic Region	47

TABLE NUMBER		PAGE
16	Soil Capability Classes	52
17	Selected Engineering Properties of Soils.	53
18	Stratigraphic Column	56
19	Past, Present, and Projected Population	68
20	Rural Population Densitites	69
21	Income.	70
22	Industry of Employed Persons, 16 Years Old and Over.	71
23	Health Care Manpower and Facilities	74
24	Law Enforcement Manpower and Facilities	76
25	EPA priority Classification by Region and Pollutant	78
26	Values of EPA Air Quality Priority Classification.	78
27	Noise Standards Along the Proposed Pipeline Route (dbA).	79
28	Estimated Transportation Costs.	102

LIST OF FIGURES

FIGURE NUMBER		PAGE
1	Project Location.	6
2	Land Use.	19
3	Surface Waters	29
4	Soils	42
5	Bedrock Geology	57
6	Surficial Geology	58
7	Climate Summary	81

INTRODUCTION

INTRODUCTION

Minnesota Pipe Line Company plans to construct a 495 mile, large diameter pipeline (20 to 24 inch O.D.) approximately 99 miles of which will be in Minnesota. The pipeline will connect refineries in Pine Bend and St. Paul Park, Minnesota to other pipeline crude oil supplies available in the vicinity of Patoka, Illinois.

This document has been prepared and structured to satisfy the requirements of the Minnesota Environmental Quality Council's Rules and Regulations for Environmental Impact Statements (Minnesota Regulation MEQC 21-36) pursuant to the Environmental Policy Act of 1973.

In addition, this document will provide an information and planning document for use by Minnesota Pipe Line Company, area communities and public interest groups, regional development agencies, state and federal agencies, and concerned citizens.

PROJECT DESCRIPTION

1. PROJECT DESCRIPTION

1.1 SUMMARY STATEMENT

Minnesota Pipe Line Company plans to construct a 495 mile, large diameter pipeline (20 to 24-inch O.D.), approximately 99 miles of which will be in Minnesota, which will connect refineries in Pine Bend and St. Paul Park, Minnesota to other crude oil supplies available in the vicinity of Patoka, Illinois. Costs of the project are in the range of $110-$160 million.

This project is made necessary by planned reductions in crude oil exports from Canada that will result in a total cutoff of Canadian crude oil in 1981. Since the "northern tier" refineries in Minnesota are now almost totally dependent upon Canadian crude oil, it is mandatory that immediate steps be taken to provide supply alternatives. Such steps must provide a long-term solution that assures the availability of crude oil supplies at competitive prices, provide the most economical transportation method, and afford a high degree of operating flexibility.

Studies over the past several years, encompassing a large number of alternatives, have shown that the pipeline described herein represents the most economical transportation alternative for the nearest available crude oil supplies. These supplies are available in central Illinois by way of connections to other existing crude oil pipelines.

1.2 STATEMENT OF PURPOSE

1.2.1 Uses of the Proposed Pipeline

The new Patoka to Pine Bend pipeline, as well as the existing pipeline operated by the Minnesota Pipe Line Company, is forecasted to transport crude oil only.

1.2.2 Need for the Proposed Project

Since 1955, Minnesota Pipe Line Company has transported crude oil from Clearbrook, Minnesota to the Minneapolis/St. Paul area refiners. The volumes transported during recent years are summarized in Table 1. This crude oil was obtained principally from Canadian sources (in excess

of 85 percent) by way of the pipeline operated by Lakehead Pipeline Company, Inc. The balance of the crude oil volumes (less than 15 percent) have been received at Clearbrook by way of a pipeline operated by Portal Pipeline Company.

TABLE 1

VOLUMES TRANSPORTED FOR FIVE MOST RECENT CALENDAR YEARS

Calendar Year	Total Annual Volume (barrels)	Average Daily Volume (barrels)	Peak Day Volume (barrels)
1971	46,193,670	125,558	162,000
1972	51,747,145	141,773	167,000
1973	57,157,905	156,597	181,000
1974	48,537,335	132,979	178,000
1975	50,734,635	138,999	167,000

Source: "Application for Certificate of Need for Large Oil Pipeline Facility; Patoka, Illinois to Pine Bend, Minnesota Pipe Line Project." Minnesota Pipe Line Company, November 1, 1976.

In earlier years, the United States Government allocated the amount of Canadian crude oil that could be imported. Presidential Proclamation 3279, March 10, 1959, as amended, established the maximum levels of imports of Canadian crude oil. More recently, however, on March 1, 1973, Canada began allocating Canadian crude oil exports. Present forecasts of Canadian crude oil available to Minneapolis/St. Paul area refiners are as follows:

Year	Volume Barrels Per Day
1977	113,000
1978	72,000
1979	45,000
1980	20,000

The above schedule indicates that the Canadian crude oil supply is being drastically curtailed, and that immediate steps must be taken to provide an alternate crude oil supply beginning in 1978.

Three volume cases are presently being considered. These cases are the same as those listed in the document entitled "Patoka, Illinois to Pine Bend, Minnesota Pipe Line Project" for the new Patoka to Pine Bend pipeline. Forecasts for the existing pipeline (Clearbrook to Cottage Grove) have been prepared on a similar basis. Brief definitions of each volume case are provided as follows:

Case I - This case presumes that a pipeline will be constructed from a point near Kitimat on the west coast of British Columbia to interconnect with the pipeline operated by Trans Mountain Pipeline Company, Ltd. A segment of the Trans Mountain pipeline would be used to transport crude oil into the Interprovincial/Lakehead system near Edmonton, Alberta and thence into the Minnesota Pipe Line Company pipeline at Clearbrook in a manner similar to the present-day operation. These volumes would be supplemented by volumes transported by way of the new Patoka to Pine Bend pipeline.

Case II - This case presumes that the pipeline originating near Kitimat will not be constructed; hence, the declining Canadian volumes must be ultimately supplemented entirely by way of the Patoka to Pine Bend pipeline.

Case III - This case is an extension of Case II whereby additional volumes would be transported in a reverse direction through the existing Minnesota Pipe Line Company pipeline to refiners in other outlying areas.

Forecasts for each volume case have been prepared for both the existing Clearbrook to Cottage Grove and the Patoka to Pine Bend pipelines along with a combined forecast. This data is available in the document entitled "Application for Certificate of Need for a Large Oil Pipeline Facility; Patoka, Illinois to Pine Bend, Minnesota Pipe Line Project."

The foregoing summary clearly establishes the need to provide alternate sources of crude oil to the Minneapolis/St. Paul area refiners. Past experience has indicated that the safest and most economical means by which these supply needs can be fulfilled is to construct a pipeline from the source to the refineries. The sources are available by way of

connections to existing pipelines in central Illinois and, hence, the need is established for construction of the Patoka to Pine Bend pipeline.

Construction of the Patoka to Pine Bend pipeline will satisfy the crude oil supply needs of the Minneapolis/St. Paul area refiners, and at the same time provide a solution that eliminates their dependence upon a single source of supply. It will satisfy the basic need criteria for: 1) a long-term solution to the supply problem, thus assuring the availability of crude oil at competitive prices; 2) the most economical means of transportation; and 3) a high degree of reliability and operating flexibility. All of these factors will in turn afford assurance to the people of Minnesota that an adequate supply of petroleum products will be available for their use at competitive prices. Products from the area refineries will be distributed primarily by truck and products pipelines to much of the Minnesota area and portions of North and South Dakota, Wisconsin, and Iowa. The two refineries in the Twin Cities area currently provide approximately 50 percent of Minnesota's liquid petroleum energy needs.

1.3 LOCATION OF PROPOSED PIPELINE

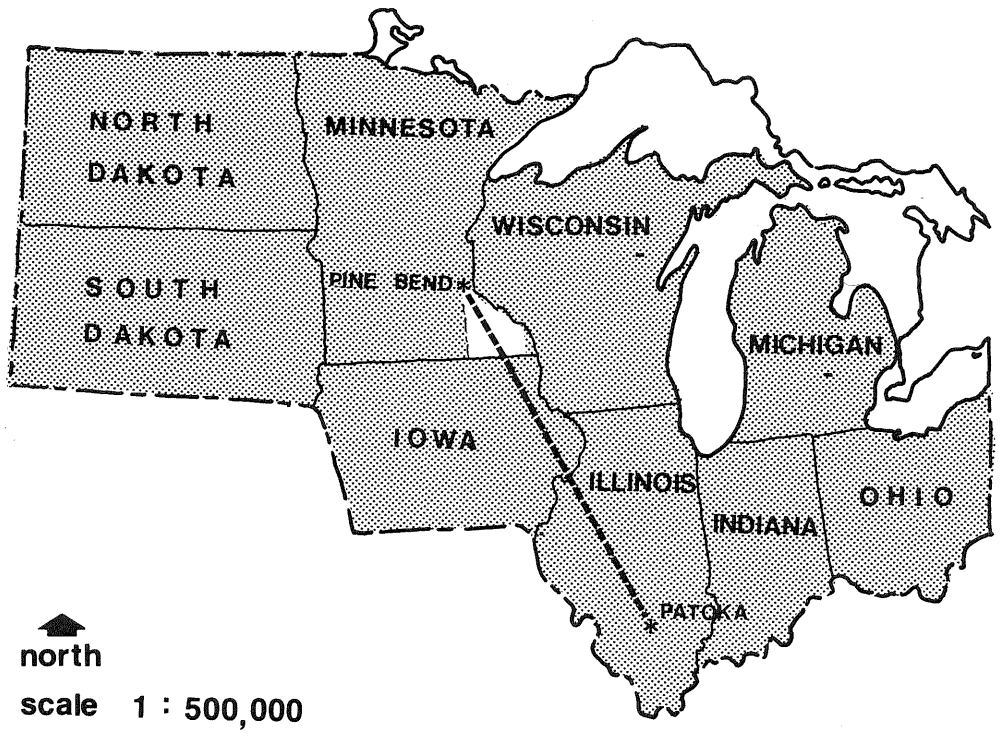
1.3.1 Proposed Route

The proposed pipeline will enter Minnesota at the southeast corner of Section 33, York Township, Fillmore County, Minnesota, and it will terminate at Minnesota Pipe Line's Pine Bend Terminal, Section 24 of T.115N., R.19W., Rosemount, Minnesota. (Figure 1 and Appendix G.) It will pass through the following townships, in order, from north to south:

Dakota County	Rosemount
	Vermillion
	Hampton
	Douglas
Goodhue County	Cannon Falls
	Leon
	Belle Creek
	Minneota
	Roscoe
Olmstead County	New Haven
	Kalmar
	Salem
	Rochester
	High Forest

FIGURE 1

PROJECT LOCATION



north

scale 1 : 500,000

5 0 10 miles

INVER GROVE
PINE BEND
ROSEMOUNT
DAKOTA
VERMILLION
FARMINGTON
EMPIRE
HAMPTON
NEW TRIER
MIESVILLE
RANDOLPH
CANNON FALLS
STANTON
WELCH
RED WING
CANNON RIVER
VASSA
WHITE ROCK
GOODHUE
SOGN
WANGS
WASTEDO
HADER
ASPELUND
WANAMINGO
BOMBAY
BELLECHESTER
WHITE WILLOW
RICE
WABASHA
ZUMBROTA
MAZEPPA
NORTH FORK
PINE ISLAND CREEK
ROSCOE
FAIRPOINT
N BRANCH MIDDLE FK
PINE ISLAND
ORONOCO
POTSDAM
CEDAR BEACH
CONCORD
MIDDLE FORK
GENOA
DOUGLAS
STEELE
DANESVILLE
WASIOJA
MANTORVILLE
SOUTH BRANCH
MIDDLE ZUMBRO
WINONA
BYRON
DODGE CENTER
ROCHESTER
KASSON
CHESTER
SALEM CORNERS
GOLDEN HILL
DODGE
OLMSTED
MARION
PREDMORE
SIMPSON
SOUTH FORK ROCK DELL
WILLOW
VERNON
OSLO
JUDGE
PLEASANT GROVE
STEWARTVILLE
NORTH
HIGH FOREST
CHATFIELD
ROOT
WASHINGTON CREEK
RACINE
BEAR CREEK
HAMILTON
FILLMORE
FOUNTAIN
FREE-
BORN
LOWER
GRAND MEADOW
SPRING VALLEY
WYKOFF
BRANCH
PRESTON
CARIMONA
AUSTIN
FILLMORE
OSTRANDER
SOUTH
ETNA
CHERRY GROVE
GREENLEAFTON
BRISTOL
YORK

MINNESOTA PIPE LINE CO.

prepared by: NATIONAL BIOCENTRIC, INC.
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Mower County	Racine
Fillmore County	Sumner
	Spring Valley
	Bloomfield
	Forestville
	York

1.3.2 Proximity to Other Pipelines

The proposed route closely parallels the existing American Oil Company products pipeline from the Iowa border to Pine Island, Minnesota, where the American line veers northward and the proposed Minnesota Pipe Line Company route continues north-northwestward. The Minnesota Pipe Line route may have to cross the American Oil pipeline up to three times in order to gain a desirable alignment with respect to terrain, rivers, residential areas, etc.

The proposed route crosses the Williams Brothers pipeline (a products pipeline) in Section 13, T.111N., R.17W., in Goodhue County, Minnesota. The route also crosses nine branches of the Northern Natural Gas Company's network of lines in Minnesota. The Koch Refining Company pipeline will be crossed near Pine Bend. (Appendix G.)

1.4 LAND REQUIREMENTS

1.4.1 Right-of-Way

The proposed right-of-way width for this project is 50 feet, representing approximately 6 acres per mile of pipeline. The entire right-of-way acreage in Minnesota would be about 660 acres.

1.4.2 Easement Fees

Generally, the easement fee and any compensation for damages will be paid to individual landowners in a lump sum, to be negotiated between the Minnesota Pipe Line Company and the landowner. Every possible effort will be made to reach an equitable settlement with each landowner; however, in those extreme cases where no agreement can be reached, the pipeline company will take the matter to an independent board of arbitrators, in accordance with proper eminent domain proceedings.

1.4.3 Future Facilities

A future, related facility that might be developed is a pump station in southern Minnesota. The required total number of pump stations for Case I does not include a pump station in Minnesota; however if the volume demands increase as projected around 1980 (Cases II and III), a pump station in Minnesota would be required. This station would utilize approximately five acres and would be located so as to have road access and adequate electric power. The most probable location is along the proposed route where it crosses Highway 14, west of Rochester, in Olmstead County. The pump station would occupy a space of about 500 feet by 400 feet, and would be surrounded by a chain-link fence. On the grounds there would probably be three, unmanned, remote control, electrically driven centrifugal pumps; several above ground valves, an electric substation, a small structure to house controls and switch gears, and a parking lot. Since a pump station is not a part of the present proposed project, and no formal design has been created, it is difficult to go into greater detail.

No additional land requirements are projected for the Cottage Grove or Pine Bend Terminals.

1.5 PROPOSED FACILITIES

Two pipe sizes are being considered at this time in relation to the three volume cases, and the design considerations are shown as follows:

Volume Case	Length (miles)	Outside Diameter (inches)	Wall Thickness (inches)	Grade
I	98.75	20	0.250	5LX-60
II and III	98.75	24	0.281	5LX-60

Cost estimates have been developed individually for each of the three volume cases (Cases I, II, and III). The economic life for all cases is 20 years. Individual cost estimates are as follows:

Volume Case	Initial Investment ($)	1979 Investment ($)	Total Investment ($)
I	107,943,000	--	107,942,000
II	135,447,000	7,101,000	143,548,000
III	147,270,000	10,251,000	157,521,000

As of this filing, it is most likely that either Case I or II will be initially built. Since it is not known whether the Kitimat line will be built, there is no basis upon which to determine the likelihood of Case I or II.

In any event, shutoff valves will be located every 10 to 15 miles on the pipeline.

1.6 CONSTRUCTION PROCEDURES

Manpower Requirements

Construction of the entire pipeline, scheduled to begin June 1, 1977, will be divided into two or three sections called "spreads", each composed of a full work force having the responsibility to complete the pipeline construction within its respective spread. It is possible that the Minnesota portion of the pipeline will be constructed as a single spread. Up to 250 workers comprise a spread, which is organized into some 10 crews, each responsible for a certain phase of construction. These include a fence and right-of-way crew, a stringing crew, a ditching crew, a lowering and tie-in crew, a backfill crew, a cleanup crew, and a testing crew.

Preliminary Procedures

Before construction can begin, the exact route must be determined. Negotiations with individual landowners may result in small variations in the proposed route. Once the route is established, it is surveyed and marked. Surveyors will not enter any property until having first received permission from the landowner. The fencing crews provide access for the construction crews by installing temporary gates as required in all the existing fences crossing the pipeline route.

Stockpiling Site Requirements

There will be a need for temporary storage sites at strategic points along the pipeline route. Rochester has been selected for the pipe unloading point for pipe to be used in the State of Minnesota. The pipeline contractor will have the responsibility of providing the storage space and securing any necessary permits. Storage for valves, fittings, tape, etc., will be provided by the company at strategic points along the route. Existing storage will be rented for this purpose.

Clearing and Grading

The pipeline construction will require the removal of trees, brush, and other vegetation within the right-of-way. The residual debris will be disposed of to the satisfaction of the landowner or tenant, local regulations, and the Minnesota PCA. The right-of-way will then be graded by appropriate earth moving equipment. Since a very large percentage of the route is through cultivated land or meadows of a relatively flat or rolling nature, very little grading will be required.

Ditching and Trenching

The pipeline trench will be sufficiently deep to allow a minimum of 36 inches of earth cover over the pipe, (with at least 48 inches of cover at all stream and road crossings) and wide enough to easily accommodate placement of the pipe; e.g., a 24 inch pipe would require a trench five feet deep and three feet wide. Trenching is accomplished wherever possible by crawler-mounted, wheel-type ditch digging machines. In rocky soils, a crawler-mounted backhoe is commonly used to excavate the trench. At any draw, creek, gulley, drainage ditch, canal crossing or other place where the prevailing terrain requires bends, the right-of-way will be graded to minimize the degree of difficulty encountered by construction equipment and to insure that the ditch will have a uniform profile. In those relatively few instances where solid rock may be encountered, requiring the use of explosives, the safest and most effective techniques will be employed. Such blasting will be conducted in full compliance with regulations imposed by the local authorities having jurisdiction.

River and Stream Crossings

Where the waterway is shallow or of limited extent, the trenching operation may be performed by conventional trenching equipment. Where necessary, draglines or clamshell buckets will be used to perform the trenching operation. No dewatering is planned. Excavation will be carried out so as to minimize the turbidity of the water resulting from any suspension of soils. The work of clearing, grading, slope protection, trenching, backfilling, final cleanup, and revegetation within at least 50 feet (further, if the banks extend beyond 50 feet) of rivers and streams will be completed within as short a time as possible to minimize erosion. The stream bed will be restored to grade with the same material as that which was excavated to minimize erosion and sedimentation after construction is complete. If the river bottom is armored with cobbles, these will be separated and replaced on the river bed.

All pipe used at river crossings will be 0.5 inch wall thickness. The pipe will be coated with a suitable insulating material to prevent corrosion. Concrete weighting will be used as required to give the pipe a negative bouyancy. All field welds at river/stream crossings will be X-rayed 100%. Permits from the Minnesota DNR will be required for all crossings.

Locations of all river and stream crossings are included in "Surface Waters" (Section 2.2).

Highway and Railroad Crossings

All highway and railroad crossings will be carried out in strict accordance with the specifications required by the railroad companies, state highway engineers, or any other authority having jurisdiction over such installation. All paved roads, most gravel roads, and all railroads will be bored by an approved method. The pipe will be cased and will have at least four feet of cover below the road surface.

Where the pipeline crosses other public and private highways or roads, or where boring is not practical due to rock strata or other obstructions, permission will be obtained from the proper authority to cut such crossings. The pipeline ditch will be backfilled immediately after the

installation of the pipe and the top six (6) inches of the backfill will be of the same materials as were cut and removed from the roads. All possible measures will be taken to avoid delays when cutting through roads.

Drain Tile

Any drain tile that is cut by the trenching machine will be clearly marked and the ends of the cut tile will be plugged to prevent clogging with dirt or rock. If necessary, temporary repairs will be made so that the system can continue to function until permanent repairs can be made. The pipeline will be emplaced far enough below the tile repair (at least 4 inches of clearance) so as to ensure that the pipeline will not interfere with normal drain tile operation. Care will be exercised so that all drainage ditches be maintained and left unobstructed to prevent the backing up of water.

Bending, Lining Up, and Welding Pipe

After the pipe is strung along the right-of-way, a bending machine will be used to bend individual pieces of pipe by the cold smooth bending process in such a way that, when the pipe is joined and lowered in, it will conform to the bottom of the ditch. Bending machines are hydraulically powered, crawler mounted and are towed along the right-of-way by a crawler tractor which also handles the pipe into and out of the bending machine. Following the bending, the individual pieces of pipe are welded together using a line-up clamp. While the pipe is held in alignment by the clamp, the first pass of the welding operation is completed. This pass is known as the "stringer bead". Immediately following the stringer bead, the second pass, known as the "hot pass", is applied. Next, the pipe is placed on wooden skids alongside the trench and the remainder of the welding is completed. All of the equipment is mounted on crawlers except for the skid truck which is usually a conventional rubber-tired truck, and the welding equipment, which consists of trailer-mounted or truck-mounted welding machines.

Coating and Lowering In

In some cases the pipe can be factory coated. In other cases, pipe may be coated in the field, which operation consists of cleaning and

priming, and coating or wrapping. In any event, the pipe will be coated with a high quality insulating material whose application is designed to prevent corrosion of the pipe. Construction contractors will not be allowed to dump any waste materials onto the ground or into the waters.

Prior to lowering the pipe into the ditch, an electronic detector is used to inspect the surface for defects in the coating. Any defects are promptly repaired. The pipe is usually lowered immediately into the trench, with care being exercised to protect the pipe coating. The equipment used in the lowering operation usually consists of two or more side boom crawler tractors equipped with special belt slings adapted for handling the coated pipe. Near river crossings the pipe is welded and coated on the upland, thus insuring that no debris or priming material gets into the water. The pipe is subsequently lifted out over the river and put in place.

Backfilling

The backfilling operation immediately follows the lowering in operation. This operation is performed by a dozer or by a backfiller, which is a crawler mounted machine adapted with a drag backfill bucket which drags the loose soil back into the trench. Care is taken to insure that the pipe coating is not damaged during the backfilling operation. Boulders and large rocks are removed from the material that will be placed directly on and around the pipe. Normal soil compaction techniques are employed in the backfilling operation to prevent against erosion and settling. On slopes, small diversion dikes will be used when necessary to keep water runoff from running down the ditch area. Excess excavation material will be evenly spread over adjacent areas so as not to disturb normal drainage patterns.

Cleanup

The cleanup operation consists of removing any construction debris such as rock, roots, stumps, etc.; disking, harrowing, or raking the the surface as required; replacing the fences and seeding the soil where appropriate; and restoring all disturbed surfaces. The cleanup equipment may consist of bulldozers, drag lines, backhoes, road maintainers, wheel

type tractors and other agricultural type equipment such as disks, harrows and rakes.

Pressure Testing

After a pipeline segment is completed, it is filled with water and hydrostatically tested to the appropriate Department of Transportation (DOT) standards. To assure an air-free fill, a pipeline sphere or scraper of appropriate size is inserted in the line ahead of the fill water. After filling, the line segment is brought up to the specified pressure and held for the required time. If no leaks occur, the line segment is then depressured. Should the next line segment be ready for testing, the water can be pumped from the tested segment and the testing can begin. This operation is repeated as many times as necessary to test the whole pipeline. When the testing is complete, the pipeline may then be tied into existing facilities and placed in service.

Hydrostatic testing water will be the only water required. To fill the Minnesota part of the pipeline will require about 275,000 barrels of water (less may be used, depending upon the legth of the segments tested). Sites for appropriation and disposal of this water have not yet been determined; however, permits will be required to appropriate and discharge this water.

Cathodic Protection

Cathodic protection is a method of reducing or preventing corrosion of underground metallic structures by impressing electrical potentials on them which make them cathodic throughout with respect to surrounding soil (electrolyte). The current source may be a rectifier or galvanic anodes.

On new rights-of-way, cathodic protection equipment is installed within 12 months of final construction to assist the pipeline coating in preventing corrosion. Periodic monitoring of the induced electrical potential will assure that the system is functioning properly.

All corrosion control measures are installed and maintained in accordance with Subpart I, Requirements for Corrosion Control, Part 192, Title 49, Federal Safety Standards (Department of Transportation).

Fugitive Dust Control

Some dust is produced in normal pipeline construction, mostly in hot, very dry weather. Vehicle traffic causes most of the dust; however, it results in very short-term minor impacts with conditions returning to normal in very short order. Appropriate measures will be taken to safeguard adjacent inhabited areas from excessive dust in those instances where it should be necessary.

Access Roads

No new access roads will be necessary for the operation and maintenance of the proposed facilities. Most of the area is pasture or cultivated and there are numerous local roads.

Irrigated Fields

Where the pipeline construction crosses fields that are currently being center pivot irrigated (this will occur only in Dakota County), the contractor will be instructed to take all reasonable measures to minimize the distrubance to such irrigation. The pipe will be initially lined up on the edge of the field, instead of being strung out along the right-of-way, where it might interfere with the irrigation process. The contractor will complete the construction operation over irrigated fields as soon as possible after the trenching has been carried out.

Duration of Construction

Construction of the pipeline in Minnesota will be carried out over a two to three month period. At any given point on the line, the construction process, from the actual digging of the trench to the cleanup operation, should take one week or less. Some of the crews such as the fencing crew and right-of-way crew will probably move ahead of the other crews as construction proceeds southward, so that there will be a longer period of time for construction at any given point in the southern part of the state.

Safety Considerations

All due consideration will be taken for the safety of animals in the vicinity of the construction activity. Each landowner or tenant

will be consulted concerning any special precautions that might be required, such as erecting temporary fences, putting covers over the ditch, etc.

1.7 OPERATION AND MAINTENANCE

Vegetative Manipulation

Since 95 percent of the proposed pipeline route is managed land, either as cultivated fields or as pasture, there will be no need for long-term vegetative manipulations along the right-of-way, except for keeping large trees from growing in the right-of-way. Disruption of shelterbelts and windbreaks will be kept to a minimum.

Line Inspection

In accordance with the Department of Transportation Regulations, the pipeline route will be aerially inspected at least once every 2 weeks for leaks, encroachments near the pipeline, erosion, and other potential problems.

1.8 EMERGENCY PROCEDURES

Information derived from the "Minnesota Pipe Line Company Oil Conservation Alert Procedure" is attached as Appendix A.

2. DESCRIPTION OF THE EXISTING ENVIRONMENT

2. DESCRIPTION OF THE EXISTING ENVIRONMENT

2.1 LAND USE

The crude oil pipeline proposed for construction from York Township, Fillmore County, Minnesota (T.101N. - R.12W. S.33) to the Pine Bend Terminal in Rosemount, Minnesota is located in five counties (Fillmore, Mower, Olmsted, Goodhue, and Dakota).

In summary, the overwhelmingly predominant land use along the proposed pipeline is agricultural (Figure 2). Approximately 80 percent of the proposed route is cropland, 17 percent is considered pasture and open (includes pastures, unmanaged weedy areas, open brush, farm yards, etc.; but does not include developed areas, transportation corridors, aquatic habitat, etc.) and 3.4 percent is forested (includes areas in which the dominant growth consists of trees whose crowns cover at least 10% of the land area), most of which occurs near streams and rivers, and on slopes not suitable for cultivation. Table 2 gives a summary of this breakdown, including the total acreages for the proposed 50 feet right-of-way and the acreage actually excavated for the trench. Table 3 breaks down the land use by townships.

TABLE 2

LAND USE OF PROPOSED RIGHT-OF-WAY

	Miles	Acreage	
		50' R.O.W	3' Trench
Cultivated	77.4	469	28
Pasture & Open	16.8	102	6
Forest	3.3	20	Does not Apply
Total	97.5	591	34

Source: Minnesota State Planning Agency. Minnesota Land Use - The M.L.M.I.S. (Map) 1968.

2.1.1 Land Ownership Patterns

The land ownership patterns of the proposed pipeline route are relatively simple. Since the route passes through prime agricultural land, the entire route is privately owned. No public lands of any kind are crossed, and no state or federally owned lands lie within two miles of the proposed right-of-way.

The estimated number of farms crossed by the proposed pipeline are displayed in Table 3. Since very few parcels are less than 40 acres, most of the land ownership represents farmsteads of one sort or another.

2.1.2 Communities and Residential Areas

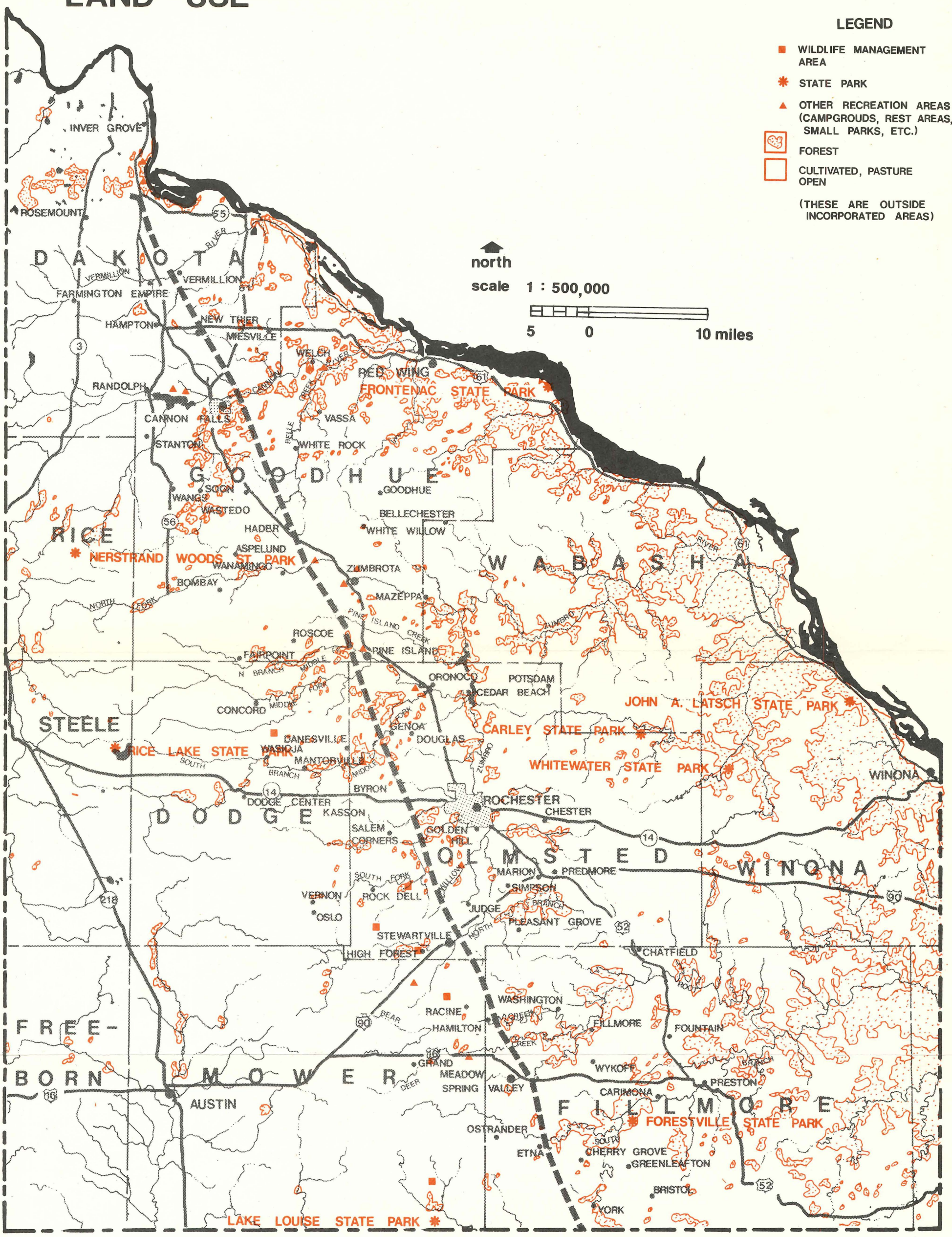
The proposed pipeline does not traverse any incorporated areas or population centers along its route until it reaches the terminus at Pine Bend, which is in the incorporated City of Rosemount, Minnesota. The proposed pipeline will, however, be routed near several communities. The following is a list of incorporated areas within 3 miles of the proposed route.

		Population
Dakota County	Rosemount	4,047
	Coates	212
	New Trier	153
	Vermillion	359
Goodhue County	Cannon Falls	2,072
	Wanamingo	574
	Zumbrota	1,929
	Pine Island	1,640
Olmsted County	Rochester	53,983
	Stewartville	2,802
Mower County	None	
Fillmore County	Spring Valley	2,572

The entire proposed pipeline route is zoned for agricultural use, except for the floodplain of Belle Creek, Goodhue County, which is zoned as a flood way. In Dakota County, each township is individually zoned,

FIGURE 2

LAND USE



MINNESOTA PIPE LINE CO.

prepared by: NATIONAL BIOCENTRIC, INC.
2233 Hamline Avenue North, St Paul, Minnesota 55113

TABLE 3

LAND USE ALONG PROPOSED ROUTE

	MILES			APPROXIMATE	
	Cult.[1]	Past.[1] & Open	Forest[1]	No. Farms[2]	No. Fields[3]
Dakota					
Rosemount	2.40	0.25	.0	5	12
Vermillion	6.60	0.25	.0	21	33
Hampton	3.30	0	.0	10	19
Douglas	3.20	0.55	.0	8	18
Goodhue					
Cannon Falls	4.0	1.75	.60	18	30
Leon	3.05	1.20	.20	8	26
Belle Creek	1.85	.25	.0	5	11
Minneola	5.60	1.70	.10	16	32
Roscoe	5.15	1.05	.25	18	26
Olmsted					
New Haven	3.10	2.70	.65	18	35
Kalmar	4.80	1.05	.45	14	32
Salem	3.0	0.30	.10	12	17
Rochester	2.50	0.45	.35	9	13
High Forest	6.55	1.65	.05	24	32
Mower					
Racine	.50	0	.0	2	3
Fillmore					
Sumner	4.65	.15	.0	13	16
Spring Valley	6.80	0.15	.30	33	32
Bloomfield	4.50	1.25	.20	12	22
Forestville	1.05	.30	.0	4	5
York	4.75	1.80	.05	20	27
TOTAL	77.35	16.80	3.30	270	441
PERCENT	79.4%	17.2%	3.4%		

Sources: [1]Minnesota Land Mangement Information System

[2]County Plat Books

[3]Aerial Photos

TABLE 4

LAND USE BY TOWNSHIP

County/Township	FARM ACREAGE			PERCENT OF TOWNSHIP LAND			
	Total Farm Acres	Number of Farms	Average Acres Per Farm	In Farms Harvested	In Farms Total	Non Farm	Forested
Dakota							
Rosemount	11,231	60	187	32	51	49	8
Vermillion	24,837	86	289	~87	(Sic)113	(Sic) -	2
Hampton	19,359	75	258	69	87	13	4
Douglas	19,338	57	340	69	84	16	6
Goodhue							
Cannon Falls	17,132	85	202	43	74	26	21
Leon	19,921	87	229	58	82	18	15
Belle Creek	22,332	79	283	70	97	3	3
Minneola	16,779	84	200	59	76	24	2
Roscoe	20,846	102	204	61	90	10	5
Olmsted							
New Haven	17,471	78	224	9	76	24	14
Kalmar	14,265	73	195	38	62	38	12
Salem	19,598	92	217	51	85	15	8
Rochester	6,877	28	245	21	34	66	14
High Forest	24,098	107	213	73	93	7	3
Mower							
Racine	17,763	82	217	64	84	16	0
Fillmore							
Sumner	23,025	84	274	66	96	4	3
Spring Valley	18,993	82	232	56	93	7	10
Broomfield	16,297	69	236	55	71	29	3
Forestville	21,073	83	254	59	91	9	22
York	18,097	70	259	51	79	21	2

Source: Minnesota State Planning Agnecy. Minnesota Land Management Information System (Map). 1968.
Crop Data: Minnesota Crop and Livestock Reporting Service.

TABLE 5

ACRES OF CROPS HARVESTED IN 1974 BY TOWNSHIP

County/Township	Corn Grain or Silage	Soy Beans	Oats	Barley	Rye	Wheat	Vegetables			Hay	Others	Total Acres In Crops
							Potatoes	Peas	Sweet Corn			
Dakota County												
Rosemount	2,388	1,614	880	0	0	209	7	196	193	1,445	21-Cabbage 49-Beans	7,032
Vermillion	8,120	4,062	2,947	89	18	2,231	0	1,209	490	2,177	342-Sunflowers	21,685
Hampton	6,286	2,753	2,022	0	55	1,198	0	529	217	1,959	14-Red Clover 304-Beans	15,337
Douglas	6,273	3,061	1,530	0	120	1,980	0	683	110	2,065	50-Sunflowers 6-Clover	15,878
Goodhue County												
Cannon Falls	3,501	1,745	963	51	50	788	0	711	0	2,086		9,895
Leon	5,274	2,800	1,550	13	0	756	0	83	175	3,410		14,061
Belle Creek	7,886	2,324	1,643	13	0	444	0	209	324	3,327		16,170
Minneola	5,110	2,340	1,898	122	0	285	0	76	154	3,009	20-Flax	13,014
Roscoe	5,578	2,639	1,958	49	0	148	0	75	145	3,541		14,133
Olmstead County												
New Haven	1,058	167	322	0	0	20	0	0	0	490		2,057
Kalmar	3,486	1,709	1,546	30	0	15	0	35	55	1,786		8,662
Salem	6,745	2,806	1,321	0	0	35	0	74	88	602		11,671
Rochester	1,851	849	479	20	0	69	0	0	0	850		4,118
High Forest	9,693	4,722	1,123	29	0	263	0	121	19	2,858	3-Flax	18,831
Mower County												
Racine	5,738	4,453	1,168	25	0	180	0	124	219	1,551		13,458
Fillmore County												
Sumner	6,809	3,604	1,671	0	0	510	0	0	0	3,190		15,784
Spring Valley	5,179	2,104	1,350	0	0	69	0	0	0	2,721		11,427
Bloomfield	5,795	4,141	1,161	117	0	71	0	0	0	1,476		12,761
Forestville	6,021	2,049	1,962	40	0	60	0	0	0	3,540		13,672
York	5,543	2,233	1,677	0	0	36	0	0	0	2,231		11,720

Source: Minnesota Crop and Livestock Reporting Service.

whereas all the other counties traversed by the proposed pipeline have county-wide, comprehensive zoning ordinances. Most ordinances do not have specific references to underground pipelines; such a project would be considered a special use similar to a public utility.

In the vicinity of Rochester, the proposed route passes within 1/8 mile of the Cairnbrae Farms sub-division (T.106N. - R.14W. S.18), which occupies an area of about 160 acres and has 15 homes. In Stewartville, the proposed route will pass around a trailer court of approximately 175 units, whereas the existing 28-year old American Oil products line runs directly under the development.

2.1.3 Agriculture

The dominant land use in southeastern Minnesota is agriculture (Figure 2). Along the route (approximately 100 miles), 80% of the land is cultivated and 17 percent is considered pasture or open (1). Table 4 shows the farm versus non-farm uses of the land on a township basis. Several townships have less than 10 percent non-farmland, and the average is about 20%.

Table 4 also gives the total farm acreage in each township, the number of farms and the average farm size, which ranges from 187 to 340 acres.

Table 5 shows the acreage of various crops harvested in 1974, by township. Corn is the most important crop (by acreage) in all the townships. Soybeans and hay are also predominant, with wheat being important in portions of Dakota County. Other significant crops include oats, barley, and various vegetables (potatoes, peas, and sweet corn). One turkey farm is known to be within one mile of the proposed route. (T.110N. - R.16W. S20, Goodhue County, near Wanamingo). No fur farms are known to exist within one mile of the proposed route.

2.1.4 Forest Uses

Approximately 3.3 miles (20 acres of right-of-way) of the proposed pipeline route are forested. Table 3 shows the amount of forested land

in each township traversed by the proposed route. Approximately 2.75 of the 3.3 miles are in Goodhue and Olmsted Counties, the rest being in Fillmore County. In Dakota County, the proposed route does not traverse any forested land. Table 4 shows the percentage of forested land in each township considered.

Approximately 21 miles of the proposed route lie within the boundaries of the Richard I. Dorer Memorial Hardwood State Forest, but no state owned lands are crossed by the route. Of the 21 miles within the boundaries, only 10 miles are within what is known as "aquisition compartments", areas in which the state would be interested in purchasing forested tracts of land, if available. However, only 1.5 miles of this land is actually forested. The proposed route lies near the western boundaries of the forest, and most of the wooded areas and actively managed areas lie to the east, closer to the Mississippi River. No forestry management areas are crossed by the proposed pipeline route.

2.1.5 Other Land Uses

The proposed pipeline route closely follows that of the American Oil Company's pipeline from the Iowa border to Pine Island. The land use on the right-of-way of the Amoco pipeline is no different from the surrounding areas except that no permanent structures may be built on the right-of-way.

2.1.6 Other Significant Resources

The region of the proposed pipeline has been subjected to intensive cultivation and other forms of land use, so there are not many natural undisturbed areas remaining. The proposed route does not encroach upon, nor come within 2 miles of any wildlife management areas (Figure 2). The only wetlands crossed by the pipeline are the narrow bars and islands along the rivers and streams. The floodplains of most of the rivers are pastures and cultivated fields which come right to the river banks. The areas are not necessarily seasonally flooded and would not represent actual wetland areas. The southwest corner of the Rochester State Game Refuge, a restricted hunting area which is not state owned, is crossed

by the proposed route. This segment within the game refuge is in agricultural production, so that no wildlife habitat is actually encroached upon.

No state parks are either traversed by or lie within 2 miles of the proposed route. No other recreational facilities, public or private, are crossed by the proposed route. Figure 2 shows recreational facilities such as public and privately owned campgrounds, wayside rest areas, marinas, etc., which are within eight miles of the proposed route. Figure 3 includes rivers which the Minnesota Department of Natural Resources has designated as canoe and boating rivers. These are the Cannon, South Fork of the Zumbro, and North Branch of the Root Rivers. These rivers are crossed by the proposed route within the designated reaches.

Spring Valley Creek, in Fillmore County, is officially designated as a trout stream at the proposed crossing. However, upon inspection of the stream and discussion with Minnesota Department of Natural Resources Fishery Managers, it has been concluded that this stretch does not provide suitable trout habitat at the present time, is not managed for trout, and no natural trout reproduction is known to occur in the area of the proposed crossing. The wastewater treatment plant in Spring Valley discharges into Spring Valley Creek, resulting in waters which are too fertile to provide trout habitat. The proposed crossing is about 1/2 mile downstream from a private, commercial trout farm. The South Branch of the Root River is designated as a trout stream about 5 miles downstream from the proposed crossing.

2.1.7 Land Use of Possible Future Pump Station Site

The most probable location of the pump station is along the proposed route where it crosses Highway 14 west of Rochester, Olmsted County. This station will utilize approximately five to six acres of land which are presently utilized primarily as cropland, with some pasture. No forested land would be needed for the pump station site.

2.2 SURFACE WATERS

2.2.1 Location

Sixteen rivers and streams are crossed by the proposed pipeline route (Figure 3). These are:

Dakota County			
Vermillion River	T.114N.	R.18W.	Sec. 21
Goodhue County			
Cannon River	T.112N.	R.17W.	Sec. 9
Tributary to Belle Creek	T.111N.	R.17W.	Sec. 13
Belle Creek	T.111N.	R.16W.	Sec. 30
Zumbro River, North Fork	T.110N.	R.16W.	Sec. 29
Pine Island Creek	T.109N.	R.16W.	Sec. 14
Zumbro River, North Branch of Middle Fork	T.109N.	R.16W.	Sec. 25
Olmsted County			
Zumbro River, Middle Fork	T.108N.	R.15W.	Sec. 6
Zumbro River, South Branch of Middle Fork	T.107N.	R.15W.	Sec. 9
Zumbro River, South Fork	T.106N.	R.15W.	Sec. 13
Willow Creek	T.105N.	R.14W.	SEc. 8
Root River, North Branch	T.105N.	R.14W.	Sec. 26
Mower County			
None			
Fillmore County			
Bear Creek	T.104N.	R.13W.	Sec. 32
Deer Creek	T.103N.	R.13W.	Sec. 9
Spring Valley Creek	T.103N.	R.13W.	Sec. 26
Root River, South Branch	T.102N.	R.13W.	Sec. 25

No lakes, marshes, or wetlands are crossed by the proposed route.

2.2.2 Physical Description

Vermillion River

The Vermillion River has its origins in eastern Scott County (T.113N., R.21W.) and it flows directly into the Mississippi River near Hastings.

At the proposed point of crossing, during November, 1976, the Vermillion River was about 25 feet wide and 18 inches deep. The average discharge is about 72 cfs (Table 6). The bottom is sand and gravel and the banks are 2-3 feet high with some erosion along the outsides of meanders. The soil is exposed in places and consists of loess over sand with only sand appearing on the low, gradually sloping banks on the insides of meanders.

Along the stream, the vegetation consists of various grasses, and a few small islands exist with rushes, sedges, etc. The approaches to the river are flat, consisting of corn fields, with pasture extending 100-200 feet away from the river on both sides. There are few trees (greater than 100 feet apart), mostly oaks and small willows. The 100-year floodplain (hereafter referred to as the floodplain) is approximately 2,200 feet wide.

The Vermillion has no distinctive uses such as fishing or boating. The land use consists of well grazed pasture up to the banks. An air photo of the proposed crossing is included in Appendix B. A summary of river characteristics is included in Table 7.

Cannon River

The Cannon River begins east of St. Peter, Minnesota and flows through many lakes towards Faribault, Minnesota, where it gains in size as it joins with the Straight River. The proposed crossing is 2 miles east of Cannon Falls (Appendix B). From here, the Cannon flows in an easterly direction and drains into the Mississippi, north of Red Wing, Minnesota.

At the proposed crossing, the Cannon River is about 110-130 feet wide, and at the time of inspection (November, 1976), was approximately 3 feet deep. The average discharge of the Cannon River is approximately 643 cfs (See Table 6). The bottom of the river consists of sand, gravel and cobble, and appears to be well armored with cobble at the point of crossing. The banks are 3-4 feet high, nearly vertical, and there is considerable erosion along the river, exposing soils consisting of fine alluvium, overlying sand.

The floodplain of the Cannon River is approximately 600 feet wide. On the south side of the river, above the 3 foot bank, is a 45° slope which extends up to a terrace approximately 8-10 feet above the river level. This terrace is only about 15 feet wide. A 10-12 foot high slope (about 45°) extends to a higher terrace, which is approximately 450 feet wide and runs back to the bedrock embankment. On the north side of the river is a 150 foot floodplain which extends back to the vertical limestone cliffs (30-40 feet high). These cliffs are eroded in places and the proposed route follows a 45° slope.

On the south side of the river, there are thickly wooded slopes with oak, elm, aspen, birch, and some ash leading down to terraces consisting of mixed pasture and juniper thickets growing on sandy, alluvial soil. Large cottonwoods and some aspens also grow on the banks. The north floodplain is vegetated with dense thickets of small elms, juniper and ironwood, with aspen, birch and oaks being more predominant on the slopes.

At the proposed point of crossing, the Cannon River is designated by the Minnesota Department of Natural Resources as a canoe and boating route and is considered a fairly good bass fishing stream.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

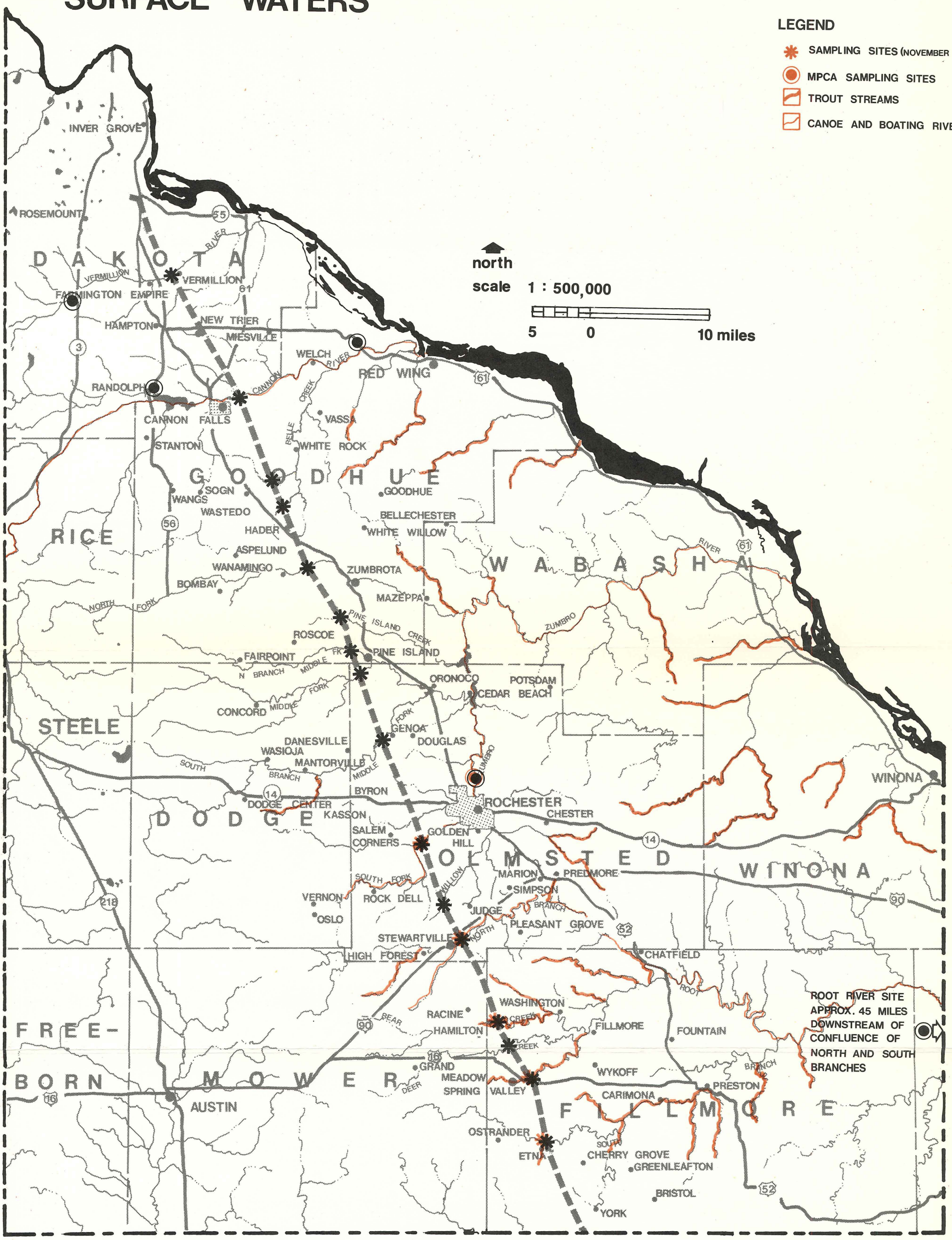
Tributary to Belle Creek

This tributary arises about one mile south of Wastedo, and flows into Belle Creek. At the proposed crossing, the tributary to Belle Creek ranged from 2-10 feet wide and 5-8 inches deep in mid-November, 1976. The average discharge is about 13 cfs (See Table 6). The bottom consists of sand and gravel and the banks are 3-6 feet high on the outside of meanders and consist of gradual slopes on the insides of meanders. The exposed soils consist of a layer of loess over a cobbly zone.

The floodplain in this region is about 500 feet wide with both sides sloping gently away. The vegetation consists of open pasture with

FIGURE 3

SURFACE WATERS



MINNESOTA PIPE LINE CO.

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TABLE 6
ESTIMATED WATERSHED DISCHARGE DATA
(All Data Expressed as Cubic Feet/Second (cfs))

River Crossings and U.S.G.S Data	Period of Record	Extremes Period of Record Max.	Extremes Period of Record Min.	Extremes 1975 Max.	Extremes 1975 Min.	Means 1975 June	Means 1975 July	Means 1975 Aug.	Means 1975 Sep.	Average Discharge Period of Record
Vermillion River Basin near Empire City	May '42-June'45 Sept '69-present	2,030	8.4	1,390	8.4	141	62.4	46.7	39.1	-
Vermillion River	*	2,943	12.2	2,015	12.2	204	90.5	67.7	56.7	-
Cannon River Basin Straight R. near Fairbault	Oct '65-present	5,990	11	3,450	14	862	163	39.9	31.1	262
Cannon River	*	14,735	27	8,487	34.4	2,120	400	98.2	76.5	643
Belle Creek	*	295	0.5	170	0.7	42.4	8	2	1.5	12
Zumbro River Zumbro Falls, Minnesota	1909-1917 1930-present	35,900	27	8,220	51	1,652	602	359	362	518
South Fork Zumbro River near Rochester	Jan '52-present	19,600	8.4	2,630	47	322	154	90.5	59.9	152
North Fork Zumbro River	*	1,436	1.1	329	2	66	24	14.4	14.5	20.7
North Branch, Mid.Fork Zumbro River	*	3,330	4.6	447	8	54.7	26	15.4	10.2	25.8
Middle Fork Zumbro River	*	6,860	2.9	921	16.5	113	54	31.7	21	53.2
So. Br. Mid.Fork Zumbro River	*	12,350	5.3	1,657	29.6	203	97	57	37.7	95.8
South Fork Zumbro River	*	9,800	4.2	1,315	23	161	77	45	30	76
Root River, Lanesboro, MN	1910,1911-1917, 1940-present	22,100	29	7,340	72	524	329	256	181	337
North Branch Root River	*	4,420	5.8	1,468	14.4	105	66	51.2	36.2	67.4
Bear Creek	*	2,210	2.9	734	7.2	52	33	26	18	34
Deer Creek	*	1,547	2.0	514	5.0	36.7	23	18	13	24
Spring Valley Creek	*	663	0.9	220	2.2	16	10	8	5	10
South Br. Root River	*	17,680	2.3	587	6	42	26	21	14	27
Other Small Creeks:										
Tributary of Belle Creek	Avg. = 10 cfs									
Pine Island Creek	= 6 cfs									
Willow Creek	= 6 cfs									

*No data. Discharges are estimated.

Source: U.S. Geological Survey, Water Data Report Mn 75-1
Water Resources Data for Minnesota, Water Year 1975

TABLE 7

SELECTED DATA ON PROPOSED RIVER AND STREAM CROSSING

River Crossings	Location	November 1976 Width (feet)	November 1976 Depth (inches)	Discharge cfs Overall Average	Discharge cfs Ave. Summer 1976	Gradient Feet/mi.	Bottom	Banks	100 Year Floodplain (feet)
Vermillion River	T.114N.,R.18W. Sec. 21	25-30	12-15	-	72.3	5	Sand & gravel	2-3 feet variable	2,200[1]
Cannon River	T.112N.,R.17W. Sec. 9	110-130	30-36	643	673	6	Gravel & cobble Well armored	4 Ft. nearly vertical	500[1]
Tributary of Belle Creek	T.111N.,R.17W. Sec. 13	3-10	5-8	Intermittant Approx. 10 cfs		47	Sand & gravel	3-6 Ft. outside meanders; vertical	500[1]
Belle Creek	T.110N.,R.16W. Sec. 30	5-15	6-12	12	13.5	27	Silt	3-4 Ft.-straights 4-5 vertical on meanders	500[1]
Zumbro, No. Fork	T.110N.,R.16W. Sec. 29	20-30	15-18	20.7	29.7	4	Sand & gravel	8-10 Ft. ∿60° slope	1,000[1]
Pine Island Creek	T.109N.,R.16W. Sec. 14	10-20	12	Approx. 6		12	Sandy	2-5 Ft. ∿45° slope	Undetermined
Zumbro R., No. Branch of Middle Fork	T.109N.,R.16W. Sec. 25	5-20	6-12	25.8	26.5	9	Sandy	10-12 Ft. 45-60° slope	1,000[1]
Zumbro River Middle Fork	T.108N.,R.15W. Sec. 6	25-40	20-25	53.2	55	4	Sand & gravel Some cobble	N.Side: 20 Ft.,45° S.Side: 3-4 Ft.	1,500[2]
Zumbro R., So. Branch of Middle Fork	T.107N.,R.15W. Sec. 9	50	18-30	95.8	98.75	5	Sand & gravel	507 Ft.,45° slope	1,250[2]
Zumbro R.,So. Fork	T.106N.,R.15W. Sec. 13	30-40	8-12	76	78.3	5	Sandy	3-6 Ft. 45°	2,000[2]
Willow Creek	T.105N.,R.14W. Sec. 8	10	12	Intermittant Approx. 6		14	Sandy	3 Ft.,60° slope	Undetermined
Root R.,North Branch	T.105N.,R.14W. Sec. 26	40-50	6-18	67.4	64.5	6	Sandy	10-12 Ft., 45-60° slope	600[2]
Bear Creek	T.104N.,R.13W. Sec. 32	15-20	8-14	34	32.3	7	Sandy	S.Side: 4-5 Ft. N.Side: 20-25 Ft. ∿45°, stabilized	1,000[2]
Deer Creek	T.103N.,R.13W. Sec. 39	25-50	10-18	24	22.8	7	Gravel-cobble	3-4 Ft. 60° vertical	250[2]
Spring Valley Creek	T.103N.,R.13W. Sec. 26	10-25	12-18	10	10	10	Sandy	2-4 Ft. 45-70°	1,000[2]
Root River., So. Branch	T.102N.,R.13W. Sec. 25	10-20	12	27	25.8	8	Sandy	4 Ft., 60° Eroded	400[2]

[1]Floodplain Studies (Minnesota DNR)

[2]U.S.G.S. Topographic Maps.

a wooded region on the ridge to the north. Various weeds grow along the banks, but there are very few trees. The land-use in the vicinity of the river is pasture and cropland, with no known recreational uses made of the river.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Belle Creek

Belle Creek arises just northwest of Zumbrota (T.11N., R.17W.), and flows into the Cannon River near Welch, Minnesota. Belle Creek varied from 5-15 feet wide and 6-12 inches deep at the time of inspection. It has an average discharge of about 13.5 cfs (See Table 6). The bottom is silty and the banks are 3-4 feet high on straights with 1-2 foot gradual slopes on the insides of meanders and 4-5 foot nearly vertical slopes on the outside of meanders. Exposed soils consist of loess overlying loamy material. The floodpain is about 500 feet wide, consisting of unmanaged weedy fields with grasses and thistles. The hills at the edges of the floodplain are cultivated on the tops and as far down the sides as the slopes permit. Belle Creek is not known as a fishery resource or as a recreational river.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Zumbro River, North Fork

The North Fork of the Zumbro River arises just east of Faribault, Minnesota and forms the Zumbro River as it joins the South Fork of the Zumbro. At the proposed crossing, the river was 20-30 feet wide and 15-18 inches deep in mid-November. The average discharge is about 30 cfs (see Table 6). The bottom consists of sand and gravel. The banks are approximately 10 feet high on both sides with slopes of 45-60°. Although there is some stabilizing vegetation growing on the banks, there is considerable erosion. The soils consist primarily of loess.

The floodplain on the north side of the river is about 700 feet wide and on the south side is about 300 feet wide. On the north side, the

vegetation near the banks consists of a 30-50 foot wide bottomland forest with large cottonwoods along the river and smaller elms, soft maple, and aspen farther back. Very little aquatic vegetation was observed along the river. The rest of the floodplain on the north side of the river consists of cultivated fields. On the south side of the river, the slopes leading down to the floodplain consist of oak/aspen woods, with some elm. The floodplain consists of pasture mixed with local, small marshy areas, and the area near the banks consists of a 30-50 foot wide bottomland woods with large cottonwoods along the river and smaller elms, soft maple, and aspen farther back. The river is not considered a good fishing stream in this region.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Pine Island Creek

The proposed point of crossing is about 5 miles east of the origin of Pine Island Creek. From there it flows east/southeast into the south fork of the Zumbro River. In mid-November, the river was 10-20 feet wide and about 12 inches deep with a very sluggish flow. The average discharge of Pine Island Creek is about 6 cfs (Table 6). The bottom is sandy, with 2-5 foot banks on either side, sloping away at approximately 45° and showing considerable erosion on the outside of the meanders. The exposed soil consists of loess. There is no distinct floodplain surrounding Pine Island Creek; the area consists of pasture with a few elms and willow scattered along the banks.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Zumbro River, North Branch of the Middle Fork

The North Branch of the Middle Fork of the Zumbro River arises near Kenyon, Minnesota (T.109N., R.18W.), and flows into the middle fork of the Zumbro River just east of Pine Island. In mid-November, at the proposed point of crossing, the river was 5-20 feet wide and 6-12 inches deep. The average flow of the North Branch is approximately 26.5 cfs (See Table 6). There are 10-12 foot eroded, nearly vertical banks on

the outsides of the meanders and gradual slopes on the insides of the meanders. The exposed banks consist of loess over alluvial sand and gravel, and the bottom of the river is sandy. The floodpain is about 1,000 feet wide and the area surrounding the river is very flat, consisting of pasture and cropland to the edge of the river. There are scattered elms and alders along the banks.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Zumbro River, Middle Fork

The Middle Fork of the Zumbro River arises in eastern Steele County (T.108N., R.19W.), and joins the South Fork of the Zumbro approximately 10 miles north of Rochester. At the proposed crossing, the river was 25-40 feet wide and 20-25 inches deep in mid-November. The average discharge is approximately 55 cfs (See Table 6). The bottom consists of sand, gravel and some cobble. The exposed soils on the banks consist of loess. The banks on the north side of the river are 15-20 feet high, with a slope of approximately 45°, and there is considerable erosion. On the south side, the banks are only 3-4 feet high. The floodplain is about 1,500 feet wide, most of which is on the south side of the river. On the northside, plowed fields extend to the edge, and, on the south side, woods of elms and willows with tall grasses growing in openings extend about 400 feet back. There appears to be good game habitat in this area. The river is not known as a good recreation or fishing river.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Zumbro River, South Branch of the Middle Fork

The South Branch of the Middle Fork of the Zumbro River starts near the border of Steele and Dodge Counties directly east of Owatonna and flows into the Middle Fork of the Zumbro Rvier near Oronoco. In mid-November, the river was 50 feet wide and 18-30 inches deep at the proposed crossing. The average discharge is about 99 cfs. (See Table 6).

The bottom is sand and gravel and the exposed soils are fine alluvium or loess overlaying sand. The banks are 5-7 feet high on both sides and have a slope of approximately 45°. There is some erosion, but the banks appear to be fairly well stabilized with vegetation and tree roots. On the south side of the river, the 50 foot floodplain and the slopes arising away from it are covered with moderately dense oak woods. On the north side, a relatively flat cultivated field extends away from the river and the floodplain is approximately 1,200 feet wide. There are large cottonwoods and some brush on the banks. In this region, the river is considered to have high-quality smallmouth bass fishing.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Zumbro River, South Fork

The South Fork of the Zumbro River arises in southwest Dodge County (T.105N., R.16W.) and flows north through Rochester. It joins the North Fork of the Zumbro River to form the Zumbro River, near Zumbro Falls, Minnesota. At the proposed crossing, the river was 30-40 feet wide, and 8-12 inches deep in mid-November. The average discharge is 78.3 cfs See Table 6). The bottom is sandy and the soils along the banks consist of loess overlying sand. The banks are about 3-6 feet high with grasses, rushes and weeds growing right down to the river's edge. The terrain is relatively flat to either side of the river. Therefore, it is hard to determine an accurate floodplain. It is probably around 1,500-2,000 feet wide. The vegetation on both sides of the river consists of plowed cropland with a 20 foot wide zone of willows and cottonwoods on the banks. To the east of the crossing is a large, well-shaded pool with cottonwoods growing along the edge. The South Fork of the Zumbro is considered to be a good bass stream, especially in the pools just east of the proposed crossing. However, the quality of the river deteriorates quickly towards Maywood Lake as the stream drops its sediment load. The South Fork of the Zumbro River has been designated a canoe and boating route.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Willow Creek

Willow Creek arises approximately 2 miles south of the proposed crossing and flows into the South Fork of the Zumbro River. It was approximately 10 feet wide and 12 inches deep at the proposed crossing in mid-November. At this point, Willow Creek is an intermittent stream and has an average discharge of approximately 6 cfs (Table 6). The bottom is sandy and the soils along the banks consist of loess over sand. The banks are approximately 3 feet high and are well eroded. Because the creek is so high in its watershed, there is no distinct floodplain. On both sides of the creek is rolling terrain consisting of pasture land with scattered willows along the creek. There is an oak/aspen forest to the west of the proposed crossing. Willow Creek has no distinctive uses and the land on either side of it is heavily grazed.

Airphotos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Root River, North Branch

The North Branch of the Root River arises in north central Mower County (T.104N., R.16W.), and flows in a westerly direction through Stewartville and Chatfield, where it joins the Middle Branch of the Root River to form the Root River. The river was 40-50 feet wide and 6-18 inches deep at the time of inspection. The average discharge of the North Branch of the Root River is approximately 64.5 cfs (See Table 6). The bottom is sandy and the soils along the banks consist of loess over sand. The floodplain at this point is about 600 feet wide. On the west side are corn fields and on the east is pasture land with long grass and scattered willows, elms, and maples, ranging from 20-50 feet apart. The river is designated as a canoe and boating route. There is some bass fishing, but erosion and the fertile state of the water tends to reduce the potential fishery.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Bear Creek

Bear Creek arises in the prairie land of central Mower County and joins Deer Creek to form the Middle Branch of the Root River. At the proposed crossing, the river was 15-20 feet wide and 8-14 inches deep in mid-November. The average discharge is about 32 cfs (See Table 6). The bottom is sandy and the soil along the banks consists of loess. On the south side, the banks are only about 4-5 feet high. On the north side they are about 20-30 feet high. All the banks in the region appear to be well stabilized with no exposed soil. Large trees are growing on the banks adding to its stability. Oak groves extend back about 20-50 feet from the banks on the north side. The region to the south consists of corn fields, with 40 feet of woods and brush along the edge of the river. The floodplain is about 1,000 feet wide, most of which is on the south side of the river at this point. Bear Creek has some smallmouth bass, but is not considered a recreational river or a particularly good fishing river.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Deer Creek

Deer Creek arises just south west of Grand Meadow, Minnesota and joins Bear Creek near Fillmore, Minnesota to form the Middle Branch of the Root River. At the proposed crossing the river was about 25-50 feet wide and 10-18 inches deep in mid-November. The average discharge is aoubt 23 cfs (See Table 6). The bottom is gravelly with some cobble. The soil along the banks consist of fine alluvium. There are 3-4 foot high vertical-to-steep banks along the creek. The floodplain is about 250 feet wide and is bordered by 25-30 foot high limestone cliffs which are eroded away where the proposed route approaches the river. On the north side, the landscape consists of gently rolling pasture land, with a wooded ravine (oak/aspen) to the east of the route. The slopes leading to the floodplain consist of open woods and closely cropped pasture with elm, juniper, oak, and some birch. The floodplain is open with scattered trees, such as elm, willow, alder, and some oak. Along the

south side of the river is a wooded slope consisting of oak/aspen forest along the proposed route. In this region, the river is about 40% pools and 60% riffles. There is some smallmouth bass fishing, which improves farther downstream.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Spring Valley Creek

Spring Valley Creek arises about 6 miles west of the proposed crossing, and flows into Deer Creek near Fillmore, Minnesota. At the proposed crossing, the river was 10-25 feet wide and 12-18 inches deep in mid-November, 1976. The average discharge is estimated at about 10 cfs (See Table 6). The 3 foot high banks appear well stablized with grasses, rushes, and sedges growing along them. The soil in this region is loess. The floodplain is not well defined, but is about 1,000 feet wide. The landscape on both sides of the river consists of flat pasture land and plowed fields, with no trees near the crossing. This stretch of the river is designated as a trout stream, but there is no known trout reproduction, because of effluent from a sewage treatment plant about 1 mile up-stream of the proposed crossing. There is also very little shade along the banks, so it is unlikely that the stream will be stocked for trout in this region.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

Root River, South Branch

The South Branch of the Root River arises in the prairie land of Mower County about 5 miles southwest of Grand Meadow, Minneosta and joins the main stem of the Root River near Lanesboro, Minnesota. At the proposed crossing, the river was 10-20 feet wide and 12 inches deep in mid-November. It has an average discharge of about 26 cfs (See Table 6). The bottom is sandy and the soils consist of loess over sand. Outside the meanders, the banks are about 4 feet high and eroded. Inside the meanders, the banks slope gently away and consist mostly of sandy material. The floodplain is about 300-400 feet wide and is bordered by slopes

on both sides. On the southeast side of the river is approximately 300 feet of oak/aspen thickets gently dropping approximately 40 feet to a 100-200 foot floodplain consisting of open pasture with scattered oaks and elms. There is similar vegetation on the northwest side, but it remains more open along the slopes leading away from the floodplain. The South Branch of the Root River is designated as a trout stream approximately 5 miles downstream from the established crossing.

Air photos of the proposed crossing are included in Appendix B. A summary of river characteristics is included in Table 7.

2.2.3 Water Quality

Water quality in the Vermillion, Cannon, Zumbro, and Root Rivers is monitored by the Minnesota Pollution Control Agency. The locations of the monitoring sites are presented in Figure 3. Although the sites are not near the pipeline route, these are the only data available and give an indication of the water quality in these rivers. Table 8 summarizes these data. The data are from a STORET retrieval in November, 1976.

Table 9 is a list of data from a chemical analysis of stream water at the stream crossings. The samples were taken at the proposed stream crossings on November 8-9, 1976 (except Belle Creek, taken December 8, 1976). The values for these parameters will fluctuate over the year, and from year to year, in a manner similar to the ranges included in Table 8. The magnitude of these fluctuations is impossible to predict from this one set of data.

2.3 SOILS AND TOPOGRAPHY

2.3.1 General

Figure 4 is a map of geomorphic regions of southeastern Minnesota, as defined in the Minnesota Soil Atlas (2). The proposed pipeline route has been overlayed. The route lies in six geomorphic regions; Mississippi Valley Outwash (#29), Cannon Valley Outwash (#30), Kenyon-Taopi Plain (#38), Harmony-Plainview Uplands (#39), Red Wing-La Crescent

TABLE 8

SUMMARY OF WATER QUALITY FOR MPCA MONITORING SITES IN SOUTHEASTERN MINNESOTA

Watercourse	Period of Record	Total Phosphorus (mg/l) Mean	Total Phosphorus (mg/l) Range	Nitrate-Nitrite (mg/l) Mean	Nitrate-Nitrite (mg/l) Range	Ammonia (mg/l) Mean	Ammonia (mg/l) Range	Suspended Solids (mg/l) Mean	Suspended Solids (mg/l) Range	pH (standard units) Mean	pH (standard units) Range
Vermillion River at Farmington	06/79-08/76	1.40	0.48-3.00	2.23	0.96-7.90	5.45	<0.05-11.00	12	<0.5-46	8.0	7.6-8.3
Cannon River at Highway 61	06/63-07/63 05/64-08/64 11/64 05/65 07/65-08/65 04/72-05/72 07/72-08/76	0.283	0.100-1.200	2.75	-.32-7.98	0.19	<0.05-1.30	65	1-1500	8.1	7.2-9.3
Cannon River at Randolph	06/74-08/76	0.636	0.176-0936	2.44	1.08-4.28	0.45	<0.05-1.2	53	2-930	8.1	7.7-8.7
Zumbro River, South Fork, North of Rochester	07/73-08/76	0.998	0.450-2.640	3.68	1.38-9.91	0.94	<0.05-2.90	41	4.250	8.0	7.5-8.4
Root River 1 mi. from mouth	0/58-11/58 02/59 04/59 08/59 06/67 10/67 12/67 02/68 09/68 06/68-08/76	0.302	0.030-4.900	1.73	<0.04-5.90	0.15	<0.05-1.60	147	2-3000	7.5	6.3-8.6

Source: STORET retrieval 76/11/03 by Minnesota Pollution Control Agency

TABLE 9

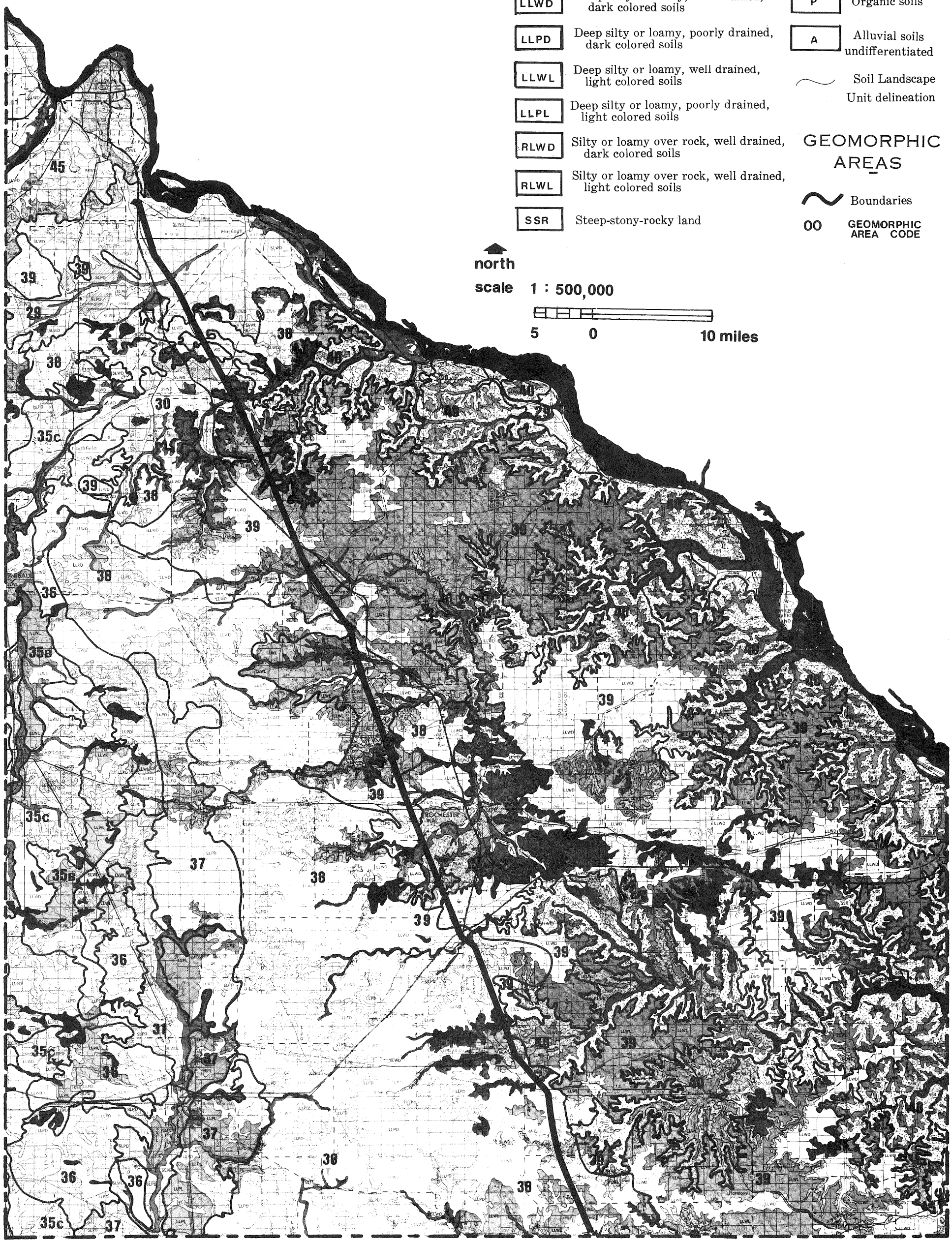
WATER QUALITY ANALYSES OF STREAMS AND RIVERS
NOVEMBER 8-9*, 1976

Watercourse	Total Phosphorus mg/l	Phosphorus mg/l	Nitrate mg/l	Ammonia mg/l	Suspended Solids mg/l	pH
Vermillion River	.620	.575	3.944	.055	12	7.8
Cannon River	.380	.355	1.686	.198	4	7.9
Tributary to Belle Creek	.074	.047	2.693	.025	21	8.1
Belle Creek	.031	.030	2.520	.058	3	7.3
North Fork Zumbro	.450	.415	.993	.115	3	8.0
North Branch Middle Fork Zumbro	.041	.039	1.374	.006	8	8.1
Middle Fork Zumbro	.086	.062	2.747	.004	8	7.7
South Branch Middle Fork Zumbro	.118	.095	.561	.004	10	8.2
South Fork Zumbro	.014	.033	1.904	.004	10	7.8
Willow Creek	.350	.438	2.230	.010	149	7.8
North Fork Root	.830	.612	1.455	2.090	10	7.7
South Fork Root	.031	.034	4.483	.021	10	8.0
Deer Creek	.019	.013	4.189	.010	4	7.9
Bear Creek	.053	.011	5.276	.010	20	7.9
Spring Valley Creek	.960	.805	7.072	.365	3	7.8

*Belle Creek Sampled December 8, 1976

FIGURE 4

SOILS



MINNESOTA PIPE LINE CO.

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Uplands (#40), and the Rochester Drift Plain (#41). Within each region, the soils have been identified and described. These are mapped on Figure 4. Descriptions are included below.

The soil designations (landscape units) are based on four factors:

1. Classification of the texture of the soil material below 5 feet as sandy (S); loamy or silty (L); or bedrock (R).
2. Classification of the texture of the material above 5 feet, or a significant part of it, as sandy (S); loamy or silty (L); or clayey (C).
3. Classification of drainage with moderately well, well, and excessively drained designated (W); and somewhat poorly, poorly, and very poorly drained designated (P). Units with (W) designation will normally have water tables below the rooting zone and units with (P), water tables commonly within the rooting zone.
4. Classification of the color of surface soil with dark color designated (D) and light color designated (L).

This results in a code such as "SLWD", meaning "loamy over sandy soil, well drained, dark in color". In addition, there are several designations which do not follow this pattern. These are:

P for peat or muck
M for marsh
R for rockland
A for floodplains
SSR for steep, stoney, rocky land
UC for unclassified city land
M-D for mines and dumps

2.3.2 Soil Descriptions (2)

The following discussion describes the nature of the soils found in each geomorphic region. Tables 10 through 15 provide a more detailed description of each soil/landscape unit which is traversed by the proposed pipeline route, and also lists the soils series included with each soil/landscape unit.

TABLE 10

SELECTED FEATURES OF SOIL LANDSCAPE UNITS WITHIN THE MISSISSIPPI VALLEY OUTWASH (29) GEOMORPHIC REGION

Soil Landscape Unit	Landscape Position	Most Common Texture and Thickness (feet)		Moisture Relationships		Approximate Fertility In Rooting Zone			Major Soil Series
		Rooting Zone	Substratum	Inches of Available Water to 5 Feet	Drainage Class	pH	P	K	
SLWD	Nearly level outwash plain	Sandy loam, loam or silt loam (2-3)	Sand and gravel (3-20+)	4-8	Well drained	5.1-6.5	Low to medium	Low	Waukegan Dakota
A	Nearly level stream bottom	Loam or silt loam (2-4)	Loam or silt loam (4+)	4-12	Well to poorly drained	5.6-7.8	Variable	Variable	Huntsville Colo Arenzville Unnamed

TABLE 11

SELECTED FEATURES OF SOIL LANDSCAPE UNITS WITHIN THE CANNON VALLEY OUTWASH (30) GEOMORPHIC REGION

Soil Landscape Unit	Landscape Position	Most Common Texture and Thickness (feet)		Moisture Relationships		Approximate Fertility In Rooting Zone			Major Soil Series
		Rooting Zone	Substratum	Inches of Available Water to 5 Feet	Drainage Class	pH	P	K	
SLWD	Nearly level outwash plain	Sandy loam, loam or silt loam (2-3)	Sand and gravel (3-20+)	4-8	Well drained	5.1-7.3	Low to medium	Low	Wadena Waukegan Dakota

TABLE 12

SELECTED FEATURES OF SOIL LANDSCAPE UNITS WITHIN THE KENYON-TAOPI TILL PLAIN, SILTY, UNDULATING (38) GEOMORPHIC REGION

Soil Landscape Unit	Landscape Position	Most Common Texture and Thickness (feet)		Moisture Relationships		Approximate Fertility In Rooting Zone			Major Soil Series
		Rooting Zone	Substratum	Inches of Available Water to 5 Feet	Drainage Class	pH	P	K	
LLWD	Gently sloping to moderately sloping upland	Silt loam or loam (4)	Loam or clay loam (4-20+)	8-12	Well drained	5.1-6.5	Low to high	Low to medium	Ostrander Racine Kenyon Kasson
LLPD	Nearly level and depressional upland	Loam, clay loam, silty clay loam (4)	Loam or clay loam (4-20+)	8-12	Poorly drained	5.6-7.3	Low	Medium	Floyde Clyde Skyberg
LLWL	Gently sloping steep upland	Silt loam, clay loam (4)	Loam or clay loam (4-20+)	8-12	Well drained	5.1-7.3	Low to high	Medium	Renova Kasson
RLWD	Gently sloping to steep upland	Loam, silt loam, clay loam (1-4)	limestone, sandstone, and shale bedrock (4+)	2-8	Well drained	5.1-6.5	High	Medium	Dodgeville Rockton Schapville
A	Stream bottoms subject to flooding	Sand, loam, silt loam (2-5)	Sand, sandy loam, loam, silt loam, silty clay loam (5-20+)	4-12	Well to poorly drained	6.1-7.8	Variable	Variable	Huntsville Colo Unnamed
RLWL	Gently sloping to steep upland	Loam, silt loam, clay loam (1-4)	Limestone, sandstone, and shale bedrock (4+)	2-8	Well drained	5.1-6.5	High	Medium	Dubuque Whalan Derinda
SLWD	Undulating to nearly level terrace or outwash	Loam, silt loam (2-3)	Sand and gravel (3-20+)	4-8	Well drained	5.1-7.3	Low to medium	Low	Waukegan Dakota

TABLE 13

SELECTED FEATURES OF SOIL LANDSCAPE UNITS WITHIN THE HARMONY-PLAINVIEW UPLANDS, SILTY, GENTLY ROLLING (39) GEOMORPHIC REGION

Soil Landscape Unit	Landscape Position	Most Common Texture and Thickness (feet)		Moisture Relationships		Approximate Fertility in Rooting Zone			Major Soil Series
		Rooting Zone	Substratum	Inches of Available Water to 5 Feet	Drainage Class	pH	P	K	
LLWL	Gently sloping to steep upland and valley slopes	Silt loam to light silty clay loam (4)	Silt loam (4-20+)	8-12	Well drained	4.5-7.3	High	Medium	Seaton Fayette Renova
LLWD	Gently sloping to moderately sloping upland	Silt loam to light silty clay loam (4)	Silt loam (4-20+)	8-12	Well drained	5.1-7.8	Medium to high	Medium	Mount Carroll Tama Racine Ostrander
RLWD	Gently sloping to steep upland	Silt loam, loam, and clay loam (1-3)	Limestone, sandstone or shale bedrock (3+)	2-8	Well drained	5.1-6.5	High	Medium	Dodgeville Rockton Schapville
RLWL	Gently sloping to steep upland and valley slopes	silt loam to light silty clay loam (1-4)	Limestone, sandstone or shale bedrock (3+)	2-8	Well drained	5.1-6.5	High	Medium	Dubuque Wahlen Derinda
A	Stream bottoms subject to flooding	Silt loam, loam (2-5)	Loam to sandy loam (5-20+)	4-12	Well to poorly drained	6.1-7.8	Variable	Variable	Huntsville Arenzville Unnamed
SLWD	Nearly level stream terraces	Loam, silt loam (2-4)	Sand and gravel (4-20+)	4-8	Well drained	5.1-7.3	Low to Medium	Low	Waukegan Dakota
LLPD	Depressional upland	Silt Loam to silty clay (2.4)	Loam to clay loam (4+)	8-12	Poorly drained	5.6-7.3	Low	Medium	Floyd Clyde Garvin

TABLE 14

SELECTED FEATURES OF SOIL LANDSCAPE UNITS WITHIN THE RED WING-LA CRESCENT UPLANDS, STEEP (40) GEOMORPHIC REGION

Soil Landscape Unit	Landscape Position	Most Common Texture and Thickness (feet)		Moisture Relationships		Approximate Fertility in Rooting Zone			Major Soil Series
		Rooting Zone	Substratum	Inches of Available Water to 5 Feet	Drainage Class	pH	P	K	
RLWL	Sloping to steep upland	Silt loam (2-4)	Limestone, sandstone, single bedrock (4+)	2-8	Well drained	5.1-6.5	High	Medium	**Dubuque Gale Whalan Derinda**
A	Stream bottoms subject to flooding	Silt loam, loam (2-4)	Silt loam, loam, sand (4+)	4-12	Well to poorly drained	6.1-7.8	Variable	Variable	**Huntsville Arenzville Unnamed**

TABLE 15

SELECTED FEATURES OF SOIL LANDSCAPE UNITS WITHIN THE ROCHESTER DRIFT PLAIN (41) GEOMORPHIC REGION

Soil Landscape Unit	Landscape Position	Most Common Texture and Thickness (feet)		Moisture Relationships		Approximate Fertility in Rooting Zone			Major Soil Series
		Rooting Zone	Substratum	Inches of Available Water to 5 Feet	Drainage Class	pH	P	K	
A	Stream bottom	Silt loam to loam (2-4)	Silt loam to loam (4+)	4-12	Well to poorly drained	6.1-7.8	Variable	Variable	Arenzville Huntsville
RLWL	Sloping to steep upland	Silt loam to loam (2-4)	Limestone, sandstone, shale bedrock (4+)	4-8	Well drained	5.1-7.3	High	Medium	Whalan Dubuque Derinda

Mississippi Valley Outwash (#29)

The Mississippi Valley Outwash consists of nearly level terraces and bottoms along the Mississippi River and some of its tributaries. The water table is normally deeper than 10 feet on the terraces, but on the bottom lands is between the surface and 6 feet deep. Most of the soils on the terraces range from loamy sand to a loam or silt loam less than 30 inches thick over sand and gravel. The water holding capacity ranges from low to moderate. Bottom land soils, mostly loam or silt loam in texture, are subject to occasional to frequent flooding.

Cannon Valley Outwash (#30)

The Cannon Valley Outwash consists of nearly level terraces and bottoms along the Cannon River. The water table is normally deeper than 10 feet on the terraces, but on the bottom lands occurs between the surface and 6 feet deep. Most of the soils on the terraces range from loamy sand to silt loam less than 36 inches thick over sand and gravel. The water holding capacity ranges from low to moderate. Bottom land soils are subject to occasional to frequent flooding, sometimes with significant sediment additions. Most are loam or silt loam in texture.

Kenyon-Taopi Plain (#38)

The Kenyon-Taopi Plain consists of a sloping, silt-mantled, eroded till plain. The dominant landform is one of long swell and swale relief with highs from 20 to 80 feet above the lows. Slopes are long, 250 to 1,000 feet. Water tables vary from 1 to 10 feet deep, seasonally. Depressions are few and nonexistent over much of the area. The drainage net is a well-established dendritic type, but few streams beyond the main trunks have incised the silty mantle. No lakes occur in this region.

Harmony-Plainview Uplands (#39)

The Harmony-Plainview Uplands consist of a loess-mantled plateau ranging from 1,100 to 1,300 feet above sea level. Slopes range from

nearly level to steep near drainageways. Most topography is controlled by underlying glacial till (probably Kansan) which is 20 or more feet thick on the western side of the region but thins to less than two feet over bedrock on the eastern side. Where glacial till is thin or absent, topography is bedrock controlled. Loess thickness ranges from 8 to 20 feet. The loess probably was deposited during the main Wisconsin glaciation. Sinkholes are common in an area from Spring Valley to Wykoff to Fountain, and south toward Preston. For the most part, these lie to the east of the proposed pipeline route.

Red Wing-La Crescent Uplands (#40)

The Red Wing-La Crescent Uplands consist of the coulees, bluffs, and associated ridges and valleys adjoining the Mississippi River and its minor tributaries. A loess-mantled plateau from 1,000 to 1,150 feet above sea level has been deeply dissected. Topography is largely bedrock controlled. Sloping to steeply sloping ridges are bordered by steep bluffs and steeply sloping valleys. Loess thickness ranges from 8 feet or more to less than two feet over bedrock. The loess probably was deposited during the main Wisconsin glaciation. The bluff faces have varying amounts of soil cover over the bedrock; normally thicker (2 to 3 feet) on north and east slopes and thinner (12 inches or less) on the south and west slopes. The loess lies directly on bedrock or on glacial till of varying thickness ranging from 6 inches to many feet over the bedrock. Water tables are normally in the bedrock. Caves are present in the underlying limestone strata.

Rochester Drift Plain (#41)

The Rochester Drift Plain consists of old landforms which seemingly had many feet of their surfaces eroded. Both wind and water were active. Some material was deposited as terrace and valley trains. Other material, chiefly sand, was deposited by wind on hilltops and generally in an easterly direction from Rochester. Source of the sand may have been local sandstone. Limestone and shale, being more resistant to erosion, were exposed, and comprise the surface of many of the hills around and in the City of Rochester. These hills are mantled by silt or loam to a depth

of 2 feet or less. The shale and limestone hills surround outwash material along the Zumbro River and Bear Creek. To the east from Eyota to Utica, the hills surround a plain over bedrock at 3-5 feet. The hills are steep, but the remaining area is nearly level to sloping. Water tables on the hills are in the bedrock. In the valleys, water tables range from 1 foot to over 20 feet seasonally.

2.3.3 Soil Capability Classes (3)

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing, forestry, and wildlife. It is a practical grouping based on the needs of the soils and their responses to management. The classes are defined below.

Class I.--Deep, well drained and moderately well drained, nearly level productive soils. Suitable for intensive cultivation over long periods without special practices other than those generally used for good farming.

Class II.--Soils suited to tilled crops, pasture, and trees but with moderate limitations when tilled.

Subclass IIe: Soils subject to moderate erosion.

Subclass IIw: Soils moderately limited by excess water.

Class III.--Soils suited to tilled crops, pasture, or trees. Areas are good for wildlife.

Subclass IIIe: Gently sloping to sloping soils where erosion is the most outstanding source of risk to sustained use under cultivation.

Subclass IIIs: Nearly level to gently sloping, droughty soils.

SubclassIIIw: Soils limited by excess water.

Class IV.--Soils suited to pasture, trees, but severely limited if used for tilled crops. Areas good for wildlife. Soils can be cultivated with special precautions.

Subclass IVe: Soils subject to severe erosion.

Subclass IVs: Soils with severely limited capacity to hold moisture.

Class VI.--Soils ordinarily not suitable for cultivation because of steep slopes, excess water, or other limitations, but suitable for pasture or woodland. Areas are good for wildlife.

Subclass VIe: Moderately steep to steep soils.

Subclass VIw: Soils limited by excess water.

Class VII.--Soils not suitable for cultivation and severaly limited for pasture or woodland. Areas are suited to wildlife.

Subclass VIIe: Moderately steep and steep soils.

Subclass VIIs: Moderately steep to steep soils.

Capability classes for the soil/landscape units which are traversed by the proposed pipeline route are presented in Table 16.

2.3.4 Engineering Properties of Soils

Table 17 presents selected engineering properties for the soil/landscape units which are traversed by the proposed pipeline route. These properties are liquid limit, plasticity index, permeability, shrink-swell potential, corrosivity, and potential for frost action. The Soil Conservation Service Soil Survey Interpretations sheets are included in Appendix C. These provide more detailed engineering data for each soil series included in the soil/landscape units.

2.3.5 Irrigation

The SLWD soils (located mostly in Dakota County) are extensively irrigated. The method is primarily center-pivot irrigation. Irrigation is much less extensive near the proposed route through Goodhue County, while little or no irrigation is practiced near the proposed route through Olmsted and Fillmore Counties. Three irrigated fields are known to be crossed by the proposed route.

TABLE 16

SOIL CAPABILITY CLASSES

Soil/ Landscape Unit	I	IIe	IIw	IIIe	IIIs	IIIw	IVe	IVs	V	VIe	VIs	VIIe	VIIs
SLWD	0-2*	2-6		6-12	(2-6)**		12-25	(6-12)			(12-25)		12-17
A			***										
LLWD	0-2	2-6		6-12			12-30						
LLPD			0-3										
LLWL	0-2	2-6		6-12			12-18					18-45	
LLWD	0-2	2-6		6-12			12-18			18-35			
RLWL				0-6			6-12					12-45	
RLWD		2-6		6-12						12-18		18-35	

* Numbers are percent slopes.

** Parentheses are for sandy loams; other numbers for this unit are for loams.

*** Means the soil falls in that class without any slope designations.

TABLE 17

SELECTED ENGINEERING PROPERTIES OF SOILS

Soil/ Landscape Unit	Liquid Limit	P I	Perm. (In/Hr)	Shrink-Swell Potential	Corrosivity		Potential Frost Action
					Steel	Concrete	
SLWD	25-40	NP-15	2.0-6.0	Low	Low	Low to Mod	Low
A	18-60	NP-30	0.6-2.0	Low to HI	Low to HI	Low to Mod	HI
LLWD	20-50	NP-25	0.6-2.0	Low to Mod	Low to Mod	Low to Mod	Mod to HI
LLPD	15-60	NP-30	0.2-2.0	Low to HI	HI	Low to Mod	HI
LLWL	20-45	4-25	0.6-2.0	Low to Mod	Low to HI	Low to Mod	Mod to HI
RLWD	25-60	5-30	0.6-2.0	Low to HI	Low	Low	Mod
RLWL	12-60	5-30	0.6-2.0	Low to HI	Low to HI	Low to Mod	Mod

2.4 GEOLOGY/GROUNDWATER

2.4.1 Bedrock Geology

Figure 5 is a map of the bedrock geology of southeastern Minnesota. A description of each formation is included in Table 18. North of New Trier, Minnesota, bedrock may be covered with as much as 500 feet of glacial drift. South of New Trier (about 7 miles north of Cannon Falls), bedrock lies at or near the surface. The topography of this region is bedrock controlled, and bedrock outcrops may be found on the sides of hills.

Approximately 14 miles of the route lies in areas where bedrock may be shallower than 5 feet in depth. These areas are: along the Cannon River; along Belle Creek; along the South Branch of the Middle Fork of the Zumbro River; an area of about 4 miles in length to the southwest of Rochester; along Bear Creek; along Deer Creek; along Spring Valley Creek; along the South Branch of the Root River; and near the Minnesota-Iowa Border. These areas are mapped in Fiture 4 of the Soils portion of this report, using symbols beginning with the letter "R". Within these areas, it may be possible to locate a route where the bedrock lies at a greater depth, but it is of such limited extent that it is not mappable. These areas could be anticipated in the "valleys" between hills or along draws leading to the rivers and creeks. Routing through these areas would reduce the mileage of bedrock which will be encountered.

Bedrock is exposed in cliffs along the Cannon River and Deer Creek. At the Cannon, the cliffs range from approximately 20 to 40 feet in height, and are dolomites of the Prairie du Chien Group. The proposed route lies along a slope on either side of the river where the cliffs are eroded away, so none of these cliffs are actually encountered.

At Deer Creek, the cliffs are approximately 20-40 feet in height, and are limestone of the Maquoketa Formation. Again, the proposed route has been chosen to take advantage of slopes through these cliffs, so that no cliffs are encountered along the proposed right-of-way.

Sinkholes occur in the Cedar Valley and Maquoketa Formations in a region from Spring Valley to Wykoff and Fountain, and southward to Preston.

TABLE 18
STRATIGRAPHIC COLUMN

SYSTEM	FORMATION & MEMBER	APPROX. THICKNESS IN FEET	DESCRIPTION
QUATERNARY	Loess	0-20	Wind deposited silt.
	Undifferentiated glacial drift	0-500	Glacial till, outwash sand and gravel, valley train sand and gravel, lake deposits, and alluvium of several ages and several provenances; vertical and horizontal distribution of units is complex.
DEVONIAN	Cedar Valley Fm.	300	Dolomite and Calcitic Dolomite, buff-gray to gray, shaly in parts.
ORDOVICIAN	Maquoketa Fm	70	Limestone, tan, with calcareous shale, shaly dolomite, and dolomite limestone.
	Dubuque Fm.	35	Limestone and shale, gray to grayish yellow.
	Galena Fm.	230	Limestone and shale, greenish gray to buff
	Decorah Fm.	90	Shale, bluish-green to bluish-gray; blocky; thin, discontinuous beds of fossiliferous limestone throughout formation.
	Platteville Fm.	Up to 35	Dolomitic limestone and dolomite, dark gray, hard, thin-bedded to medium-bedded; some shale partings; can be divided into five members.
	Glenwood Fm.	Up to 5	Shale, bluish-gray to bluish-green; generally soft but becomes dolomitic and harder toward east.
	St. Peter Ss.	150	Sandstone, white, fine-to-medium-grained, well sorted, quartzose; locally iron-stained and well-cemented; rounding and frosting of grains is common; 5-50 feet of siltstone and shale near bottom of formation.
	Prairie du Chien Group — Shakopee Fm. — Willow River Member	50	Dolomite, light-brown to buff, thin-to thick bedded cherty; shale partings; commonly sandy and oolitic.
	Prairie du Chien Group — Shakopee Fm. — New Richmond Member	0-10	Sandstone and sandy dolomite, buff; often missing.
	Prairie du Chien Group — Oneota Fm.	50-120	Dolomite, light-browhnish-gray to buff, thin- to thick-bedded, vuggy.
CAMBRIAN	Jordan Ss.	90	Sandstone, white to yellowish, fine-to coarse-grained, massive to bedded, cross-bedded in places, quartzose; commonly iron-stained.

. The proposed route lies on the westernmost edge of this region. Field investigation and air photo interpretation indicate that the proposed route does not encounter any sinkholes.

2.4.2 Surficial Geology

Figure 6 is a map of the surficial geology of southeastern Minnesota. It delineates areas covered by glacial drift, loess, alluvium, or bedrock outcrops. The glacial drift may include Kansan, ILlinoian, and Wisconsin age deposits. The drift ranges from as thick as 500 feet in the northern portion of the region, to absent in parts of the southern. In the vicinity of New Trier-Cannon Falls, it thins to a range of 0 to 50 feet thick. South of Rochester, the drift may be only several feet thick, or locally absent. Loess ranges from 0 to 20 feet in thickness, and may directly overlie bedrock in the southern portion of the region. Alluvium is deposited along rivers and streams. Its thickness varies. Bedrock outcrops along Deer Creek and the Cannon River. Outcrops which may occur locally are too small to be mapped at this scale.

2.4.3 Ground Water

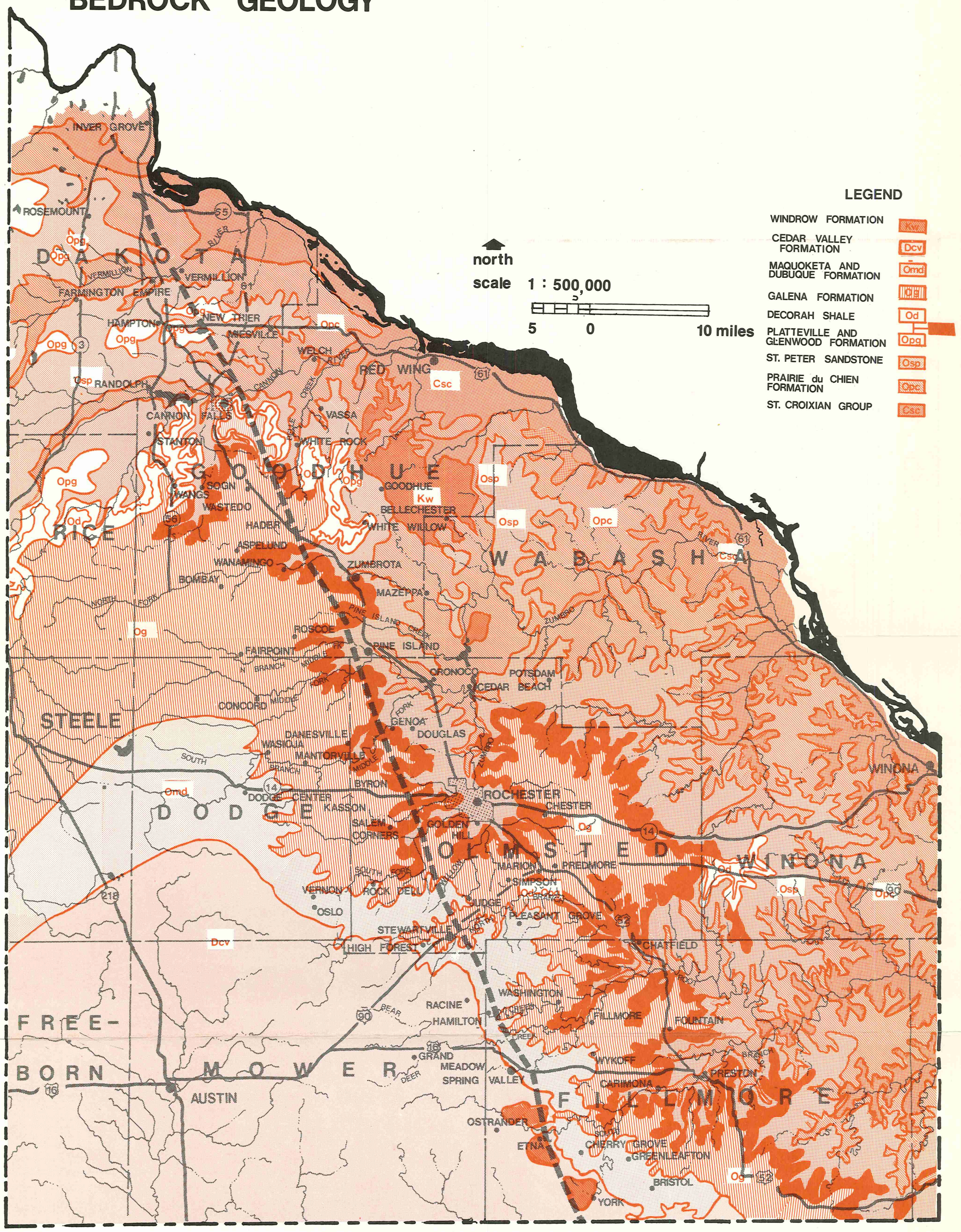
The major aquifers in the region are:

Glacial Drift: sand and gravel
Cedar Valley-Maquoketa: limestones and dolomites
Dubuque-Galena: limestones and dolomitic limestones
St. Peter: sandstone
Jordan-Prairie du Chien: interbedded dolomites and sandstones (Prairie du Chien), and sandstone (Jordan).

These aquifers are separated by aquitards, which make the rock formations within each aquifer perform as a single hydrologic unit. These aquitards do permit some water to move between aquifers. However, recharge areas for these formations are primarily areas where the aquifer outcrops at ground surface, or subcrops wiht permeable material (such as sand and gravel) overlying it. The entire area acts as a recharge area, with ground water moving through the soil materials and entering the bedrock.

FIGURE 5

BEDROCK GEOLOGY

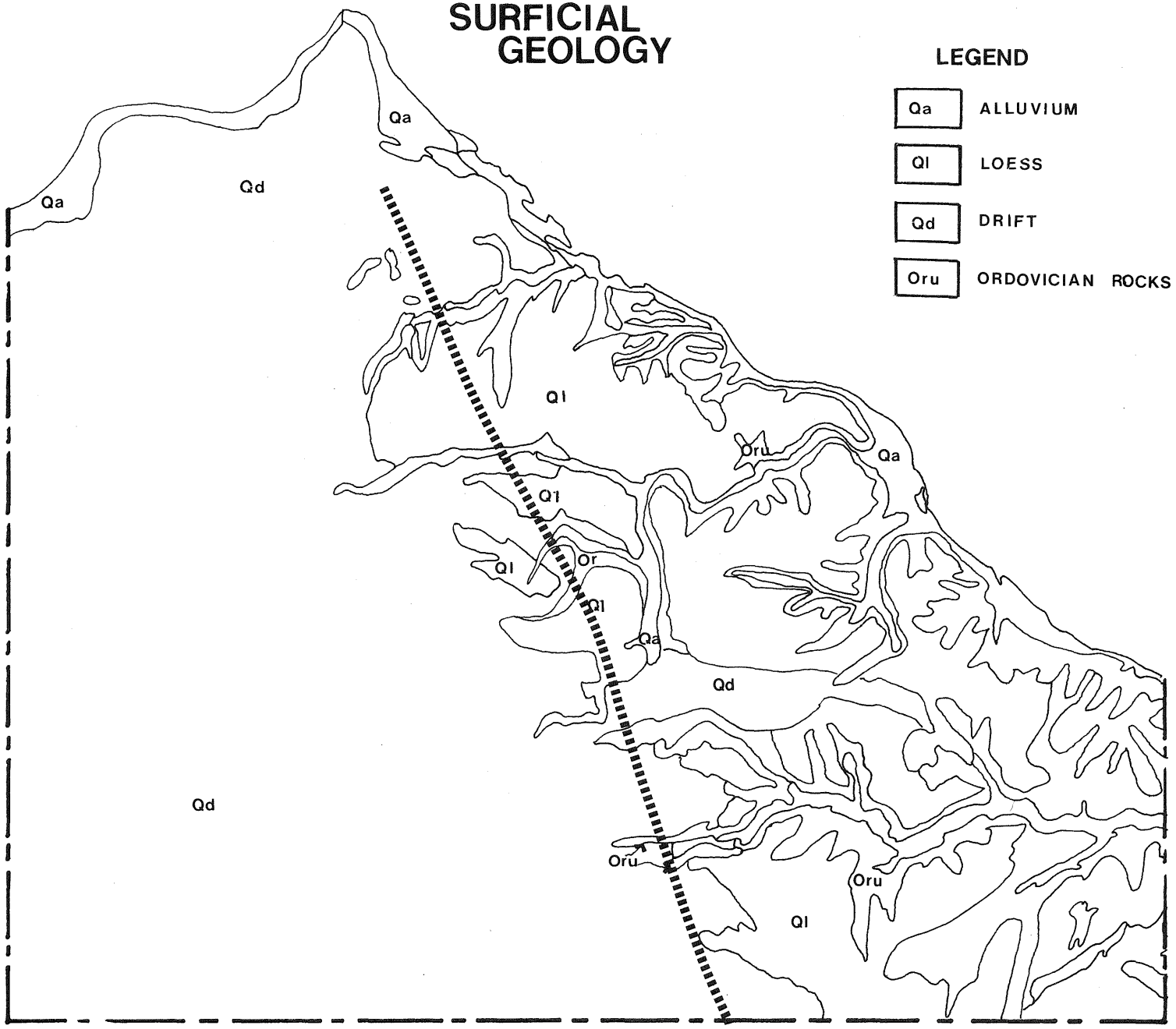


MINNESOTA PIPE LINE CO.

NATIONAL BIOCENTRIC, INC.
2233 Hamline Avenue North, St Paul, Minnesota 55113

FIGURE 6

SURFICIAL GEOLOGY



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2.5 BIOLOGICAL ENVIRONMENT

2.5.1 Vegetation

The natural vegetation of the region, as it existed before settlement, and as would be found in totally undisturbed locations, must be discussed briefly in order to gain a perspective of the existing vegetative patterns (4). The proposed pipeline route runs along the border zone, or ecotone, between the hardwood forests to the east and the prairie to the west. Forests occupy protected areas such as valley slopes and river bottoms, as well as some upland sites. Most of the upland in the vicinity of the pipeline route once consisted of what is known as oak savannah - scattered groves of oaks (mostly bur oak), oak-aspen thickets, and isolated trees growing on the open prairie.

The true hardwood forests (Big Woods) are found to the east of the pipeline route. They consist of various mixtures of oaks (mostly bur, white and red), sugar maples, basswood, hickory, elm, ash, and walnut, depending on the site characteristics. On drier upland sites, as mentioned above, oaks predominate, with black oaks preferring the driest sites, and bur, white, and red oaks being found on a wide range of sites. Protected slopes and well drained fertile soils are dominated by sugar maples and these are the classic maple-basswood forests. Common species include basswood, beech, white and red oak, slippery elm, hickory and ironwood (5).

Bottomland forests along river valleys and floodplains contain several different combinations of species. On pioneering sites along sand bars, mud flats, and other open places of recent soil disturbance near the water's edge, the usual forest is dominated by black willow and cottonwood. On open sites near the upland edge of the wet ground, river birch or swamp white oak are the usual dominants. As both of these types mature, they are invaded by silver maple and American elm. Green ash is often found in these communities and black walnut on the moist, but not wet, sites.

At the present time, approximately 96 percent of the proposed pipeline route consists of open upland habitat (See Land Use Section), most

of which is used for agricultural cultivation and grazing, with small, unmanaged areas remaining along fence rows, various right-of-ways, forest edges and on steep slopes. These areas include alfalfa, clover, grasses, pigweed, ragweed, goldenrod, and other common weed species. No known tracts of native prairie exist in the vicinity of the proposed route.

Only about 3 percent of the proposed route is actually forested; for, as mentioned above, most of the forested areas in southerastern Minnesota lie to the east (Figure 2). Upland wooded areas consist primarily of oak and oak/aspen thickets, generally found in areas where the terrain prohibits cultivation, especially along the hills leading down to the various rivers and streams. Windbreaks planted around farmsteads are numerous and may consist of a variety of species, including some not native to the area such as red pines, spruces, etc. These will be avoided, if possible.

Limited areas near the edges of woods consist of open brush, predominantly vegetated by hazel, dogwood, wolfberry, sumac, and blackberries. Some scattered small clumps of young aspen, oaks and other species are also present.

The bottomlands along the Cannon River constitute the only distinct bottomlands type ecosystem found along the route. The terraces leading down to the river consist of juniper thickets growing on sandy alluvial soil. The north floodplain consists of dense thickets of small elms, juniper and ironwood, with aspen, birch, and various oaks growing on the slopes. Large cottonwoods grow along the banks. Most of the other rivers have willows, elms and cottonwoods growing along the banks, but the floodplains, such as they are, consist of cultivated fields or pastures with various upland species (as mentioned above) growing in thickets.

Southeastern Minnesota is naturally well-drained and there never were very many natural wetland areas or lakes. The few wetlands that existed in the western portion of this region have been drained for agriculture and grazing. Thus, wetland and aquatic types of vegetation play a small role in the ecosystems found in the region of the proposed route. Along the streams there are islands and bars supporting aquatic

Other mammals found in the area are listed in Appendix D, as are the habitat preferences of the species mentioned above.

Waterfowl

Southeastern Minnesota was never a productive waterfowl area, because of the naturally well drained landscape and the resultant lack of lakes in the area. Therefore, southeastern Dakota, Goodhue, Olmsted, Mower, and Fillmore Counties are considered regions of low waterfowl value (7). The seasonally flooded areas along river courses provide limited waterfowl habitat, for none of the streams crossed, except for the Cannon River and Deer Creek, have well established floodplains in the vicinity of the proposed pipeline crossings. Virtually all of the upland depressions (Type II wetland area) and shallow meadow marshes (Type III) have been drained for agricultural purposes, thus severely reducing what limited waterfowl habitat may have existed in southeastern Minnesota. There are eight designated wildlife management areas within ten miles of the pipeline route, as shown in Figure 2. There are also a few impoundments and farm ponds within the vicinity of the pipeline route.

Only three species of ducks have nesting ranges that include southeastern Minnesota (east of Rice, Steele and Freeborn Counties). These are the blue-winged teal, the most important breeding duck in Minnesota (represents half the breeding populations in Minnesota), the mallard and the wood duck, both of which are important breeding ducks in Minnesota (8,9). In southeastern Minnesota, the wood duck is the most common waterfowl, preferring slow rivers, bottomlands and ponds. The wood duck nests in cavities of large trees such as willows, cottonwoods and oaks. The mallard inhabits waters of many kinds, and its only demands are waters with shallow areas, suitable nesting sites on the shore, and sufficient food, which often includes grain crops. The blue-winged teal nests in marshes in native prairie grasslands, of which there are very few in southeastern Minnesota. Several thousand Canadian geese winter in Silver Lake, located in Rochester, since a power plant keeps the lake open all winter. Several species of migrants may be encountered in

southeastern Minnesota, but the great numbers of ducks that migrate through the upper Midwest each year usually travel to the east or west of southeastern Minnesota because of the lack of suitable ponds, lakes, and wetlands in the area.

Upland Game Birds

Four species of upland game birds are found in southeastern Minnesota; these being the ring-necked pheasant, the ruffed grouse, the Hungarian partridge, and the bobwhite quail, which is found to some extent in Fillmore and Houston Counties, but more abundantly south of Minnesota (10,11).

The ring-necked pheasant is an introduced species that florished in this area in the 1930's and 40's. Recently, its numbers have dwindled due to reduction of required habitat, which includes relatively undisturbed weedy and brushy areas along the fringes of fields, transportation corridors and woods. These areas have been diminished by intensive agricultural practices.

The Hungarian partridge prefers a habitat that includes a mixture of grassland and agricultural land in small grain crops. These birds are found in greater numbers to the west of the pipeline route, where there is more open country and small grain fields. Hungarian partridge require relatively undisturbed grassy and low growing vegetation for nesting.

The ruffed grouse can be found in open woods and brushy areas, but it does not tolerate intensive cultivation and land use, so it is more common to the east of the pipeline route. Aspens provide summer and winter food for adults, as well as brooding habitat.

Bobwhite quail have habitat requirements similar to pheasants, but are relatively uncommon in Minnesota, being limited to southern Fillmore and Houston Counties. (See Section 2.5.4 - Rare, Unique or Endangered Species).

Other Birds

There are numerous species of birds found in southeastern Minnesota, all of which cannot be discussed. These include bitterns, and herons, hawks, woodpeckers, doves, jays, crows, starlings, chickadees, warblers, thrushes, blackbirds, sparrows and other upland songbirds.

2.5.3 Fishery Resources

From a recreational viewpoint, one of the more important species of fish in the region of the proposed pipeline route is the smallmouth bass. Seven of the rivers crossed are considered to have fair to good bass habitat in the region of the proposed corssings. Bass are not as particular as trout in their habitat requirements, but they do not do well in slow, silty, warm streams and rivers, nor in very small streams with gravelly or coarse bottoms. A high pool/riffle ratio is also important. They tolerate warmer water than trout (70°-80°F.), and can also tolerate the moderately fertile waters that result from agricultural activities and human encroachment.

None of the streams have known trout populations or habitat suitable for trout at the proposed crossing points. Most of the good trout habitat is found in smaller tributaries of the various branches of the Root River, generally lying to the east of the proposed route. These streams have swift flow and are better shaded than the more westerly streams.

Most of the streams have an assortment of suckers, minnows (includes dace, chubs, and shiners), darters, muddlers, and sticklebacks.

Included is a list of rivers crossed and selected notes on the fishery resources of each.

AVAILABLE INFORMATION (12,13,14,18)
FISHERY RESOURCES - BY INDIVIDUAL RIVER

Vermillion River

- warm, not good shading
- minnow-sucker stream

Cannon River

- cool-warm
- good bass habitat

Belle Creek

- warm, not well shaded, turbid
- minnow-sucker stream, poor game fish habitat
- water improvement project in process
- trout stream designation has been removed

North Fork Zumbro River

- warm
- poor-fair bass waters, mostly minnow-sucker, better bass downstream

Pine Island Creek

- warm, not well shaded, mostely pasture
- minnow-sucker stream

North Branch Middle Fork Zumbro River

- warm
- minnow-sucker value only
- relatively slow flow, poor game fish habitat

Middle Fork Zumbro River

- warm
- smallmouth habitat appears desirable

South Branch Middle Fork Zumbro River

- cool-warm
- smallmouth bass - excellent

South Fork Zumbro River

- cool-warm
- good bass stream especially in pools just east of proposed crossing, then deteriorates toward Maywood Lake as stream drops sediment load
- recent surveys sho high bass crops upstream

Willow Creek

- warm
- minnow-sucker stream
- during dry seasons, this stretch is almost dry

Root River, North Branch

- warm, turbid
- some bass fishing, but erosion and fertile state of water reduce potential fishery
- Stewartville sewer degrades water quality near crossing
- downstream, the river is probably the best smallmouth stream in southeastern Minnesota

Bear Creek

- warm (some shading, however)
- some smallmouth bass
- good smallmouth bass reproduction up- and downstream of proposed crossing

Deer Creek

- cool-warm, some shading
- 40 percent pools - 60 percent riffles
- some smallmouth bass and rock bass, suckers, minnows, etc.
- small bass in this region move downstream as they grow
- good smallmouth bass reproduction up- and downstream of proposed crossing.

Spring Valley Creek

- warm - no good shading
- very fertile water from sewage plant
- classified as trout stream but no trout reproduction is known

Root River, South Branch

- warm, mostly ponded, shade scanty, little aquatic vegetation
- minnow-sucker stream
- good trout stream 5 miles downstream, near Forestville State Park

2.5.4 Rare, Unique or Endangered Species (15)

The bobwhite quail is at the northern limit of its range in southern Minnesota. It has never been abundant in the state because of the severe winters. Also, the development of intensive farming practices and the resultant loss of brushy fence lines and unmanaged areas have had an adverse effect on bobwhite populations. The bobwhite is a protected species in Minnesota.

The wood turtle is a rare species, found in woodland habitat near water in southeastern Minnesota.

The Minnesota trout-lily is extremely rare and occurs nowhere else in the world than at a few sites (moist soils in hardwood forests) in southeastern Minnesota.

2.6 SOCIO-ECONOMIC ENVIRONMENT

2.6.1 Population

Table 19 presents past, present, and projected population figures for the counties traversed by and communities within two miles of the proposed pipeline route. A review of Table 19 indicates that, with the exception of Fillmore County, population in the study area has steadily increased and is expected to continue to grow. As a result of urban influences, Dakota and Olmsted Counties are experiencing the most rapid growth.

Table 20 illustrates the density of population in the unincorporated portions of the townships through which the pipeline is proposed to pass. Again, those locations in closest proximity to urban areas (Rosemount Township and Rochester Township) have the highest population and the highest densities.

2.6.2 Economics

Table 21 contains income characteristics for those counties to be traversed by the proposed pipeline. Table 22 breaks down the employment activity from which that income is derived.

As with population characteristics, the counties differ in terms of economic base and individual financial stability. Fillmore County, the only county in the study area experiencing a population decline, is the most heavily dependent on agriculture (31.5%) and has the lowest median income. All of these factors reflect the county's lack of a significant urban center. Dakota and Olmsted Counties, on the other hand, have a lower reliance on agriculture (2.2% and 5.3% respectively) and median incomes higher than that found in the state as a whole.

2.6.3 Transportation

The proposed route will traverse portions of the highway, rail, pipeline, cable and air transportation network. Appendix E contains a listing of all designated federal, state, and county roadways to be underlain by the pipeline. In addition to those listed, numerous

TABLE 19

PAST, PRESENT AND PROJECTED POPULATION

	1940	1950	1960	1970	1975	1980	1990	2000
Dakota County	39,660	49,019	78,303	139,808	158,100	181,100	234,600	293,300
Vermillion	NA	112	248	359	397	400	450	500
New Trier	77	73	106	153	146	150	150	150
Coates	NA	NA	202	212	220	200	200	250
Rosemount	364	567	1,068	1,337	4,706	5,650	9,800	15,500
Fillmore County	25,800	24,465	23,768	21,916	21,600	21,100	20,700	19,500
Spring Valley	2,133	2,467	2,628	2,572	NA	NA	NA	NA
Goodhue County	31,564	32,118	33,035	34,763	36,800	38,400	43,600	48,600
Pine Island	1,040	1,298	1,308	1,640	NA	NA	NA	NA
Zumbrota	1,386	1,686	1,830	1,929	NA	NA	NA	NA
Wanamingo	449	496	540	574	NA	NA	NA	NA
Cannon Falls	1,544	1,831	2,055	2,072	NA	NA	NA	NA
Mower County	36,113	42,277	48,498	43,800	44,000	44,100	45,000	43,100
Olmsted County	42,658	48,228	64,532	84,104	89,700	97,800	114,100	127,400
Stewartville	1,025	1,193	1,670	2,802	NA	NA	NA	NA
Rochester	26,312	29,885	40,663	53,766	NA	66,250	84,600	104,600

Sources: 1940-1970 - All areas, U.S. Census
1975-1990 - Counties, Minnesota State Demographer
1975-1990 - Dakota County Communities, Metropolitan Council
1975-1990 - Rochester, Olmsted COG

TABLE 20

RURAL POPULATION DENSITIES

County	Township	Population/Sq.Mi.
Dakota	Douglas	16.2
	Hampton	17.2
	Vermillion	22.6
	Rosemount	99.2
Fillmore	York	14.7
	Forestville	13.2
	Bloomfield	13.7
	Spring Valley	20.4
	Sumner	13.2
Goodhue	Roscoe	18.7
	Minneota	18.7
	Belle Creek	17.4
	Leon	19.0
	Cannon Falls	27.8
Mower	Racine	10.8
Olmsted	High Forest	28.0
	Rochester	139.7
	Salem	28.9
	Kalmer	27.1
	New Haven	26.0

Source: Extrapolated from U.S. Census Data, 1970

TABLE 21

INCOME

	Dakota County	Fillmore County	Goodhue County	Mower County	Olmsted County	State of Minnesota
Median Income	$12,120	$ 6,986	$ 9,085	$ 9,834	$10,972	$ 9,931
% of All Familes Earning >$15,000	30.4%	9.3%	14.9%	17.7%	23.6%	20.3%
% of All Familes w/ incomes < poverty level	3.5%	14.8%	9.5%	8.6%	5.4%	8.2%

Source: U.S. Census, 1970

TABLE 22

INDUSTRY OF EMPLOYED PERSONS, 16 YEARS OLD AND OVER

	Mower County		Dakota County		Fillmore County		Goodhue County		Olmsted County		State of Minnesota	
	#	%	#	%	#	%	#	%	#	%	#	%
Agriculture	1,607	9.9	1,179	2.2	2,518	31.5	1,911	14.3	1,865	5.3	111,030	7.6
Mining	10	0.1	27	---	21	0.3	20	0.2	12	---	14,008	0.9
Construction	657	4.1	3,507	6.6	450	5.6	770	5.8	2,025	5.8	82,759	5.7
Manufacturing	5,409	33.5	14,569	27.3	807	10.1	3,237	24.3	5,732	16.4	309,222	21.1
Trans/Comm/Util	597	3.7	5,043	9.4	403	5.0	774	5.8	1,552	4.4	96,004	6.6
Whole/Retail	3,065	18.9	10,927	20.5	1,492	18.7	2,613	19.6	6,928	19.8	322,579	22.0
F.I.R.E.	495	3.1	3,084	5.8	202	2.5	350	2.6	977	2.8	67,977	4.6
Service	2,889	17.9	9,852	18.5	656	8.2	1,271	9.5	2,549	7.3	309,870	21.2
Govt/Public	1,415	8.8	5,167	9.7	1,450	18.1	2,374	17.8	13,321	38.1	150,824	10.3
Total	16,144	100.0	53,355	100.0	7,999	100.0	13,320	99.9	34,961	99.9	1,464,273	100.0

Source: U.S. Census, 1970

nondesignated county and township/municipal roadways will be involved. A map of these is included in Appendix G.

The following rail lines intersect with the proposed pipeline route:

County	Rail Line
Dakota County	Chicago Northwestern RR
Goodhue County	Chicago Northwestern RR
	Milwaukee, St. Paul & Pacific RR
Olmsted County	Chicago Northwestern RR

As listed in the Project Description Section of this report, 11 existing gas or oil pipelines lie in the path of the proposed MPLC line. The majority of the existing lines carry gas and are owned by the Northern Natural Gas Company.

The proposed line will pass under numerous telephone and electrical transmission lines. Of significance are the proposed route's intersections with the following electrical transmission lines:

Voltage	End Points
100-161 KV	Alma-Adams
100-161 KV	Adams-Genoa (Wisc.)
345 KV	Prairie Island-Adams

Finally, the proposed route will transect portions of property owned by and adjacent to the Rochester Municipal Airport. This land is not a portion of the airport itself, but rather is cultivated acreage leased to area farmers.

2.6.4 Taxation

Governmental units in the State of Minnesota obtain operating revenues through the application of direct taxation, licensing, fees and fines. Of primary concern to the discussion herein will be the following:

- Personal Income Tax, applied by the state at a base flat rate of 7% on incomes less than $570/week and 8% on incomes above that amount.

- Sales Tax, applied by the state on all tangible personal property property at a rate of 4%. The purchase of food, clothing and medicine by private individuals is exempt from this tax.
- Property tax, applied by counties, municipalities, school districts, and other special districts, on all real property, certain personal property and utilities, at varying, but state supervised rates. The rates are in the form of mill levies which are applied to the assessed valuation of property subject to taxation. The assessed value of a property is a percentage of its true or market value. The 1976 mill levies and the total assessed valuation of taxable properties in the study area counties are as follows:

County	Mill Levy	Total Assessed Value
Dakota	19.44	$633,257,627
Fillmore	22.40	$ 60,331,254
Goodhue	10.52	$240,369,987
Mower	25.70	$138,438,210
Olmsted	21.54	$297,253,801

2.6.5 Services

The availability and adequacy of the health care, police and fire protection services will be of importance during both the construction and operation of the proposed project. Housing and educational service availability will not be dealt with in depth, due to the short-term nature of any population influx, the fact that the majority of the inmigrants will likely possess mobile, self-contained housing units*, and that inmigration will primarily occur during the summer (non-school) months. School age dependents generally return to their homes when school is in session, based on past experience.

1. Health Care - Table 23 presents an inventory of the availability of primary physicians** and general hospital beds in the study area

*See Appendix F for a listing of campsites available for mobile housing (camper-trailers and truck caps) along the proposed route.

**G.P., Internal Medicines, Pediatrics, Ob-Gyn.

TABLE 23

HEALTH CARE MANPOWER AND FACILITIES

County	Primary # Physicians	Physicians/ Population Ratio	Hospital	Beds	Beds/ Population
Dakota	39	1:4054	Devine Redeemer - South St. Paul	130	
			Regina Memorial - Hastings	100	
			Sanford - Farmington	47	
			Total	277	1:571
Fillmore	8	1:2700	Harmony Community - Harmony	18	
			Community Memorial - Spring Valley	35	
			Total	53	1:408
Goodhue	15	1:2453	Community - Cannon Falls	13	
			St. Johns - Red Wing	115	
			Zumbrota - Zumbrota	27	
			Total	155	1:237
Mower	22	1:2000	St. Olaf Hospital - Austin	147	1:299
Olmsted	153	1:586	Olmsted Community - Rochester	72	
			Rochester Methodist - Rochester	641	
			St. Mary's - Rochester	928	
			Total	1,641	1:55

Sources: Minnesota State Department of Health
Region 10 Development Commission

counties. The maximum safe physician to population ratio, as recognized by the Minnesota State Health Department, is 1:5000. All four of the counties are well within this standard. A more involved process, known as the Hill-Burton formula, is employed by the Health Department in assessing the adequacy of hospital bed availability.

According to the Minnesota State Health Plan, Dakota County, by virtue of its proximity to the Twin Cities Metropolitan Area, is adequately served. Mayo Clinic's facilities more than satisfy Olmsted County's needs. Fillmore and Goodhue Counties, however, have been determined to be lacking in hospital bed availability (by 38 and 134 beds respectively).

Emergency facilities, including both air and ground ambulance service, are available throughout the study area counties. As a general rule, dispatch communication is coordinated through the sheriff/police communications network.

2. Police Protection - The County Sheriff's Department in each of the study area counties provides law enforcement services to the unincorporated portions of their counties, as well as to those municipalities contracting for police protection. Municipalities not under contract with the Sheriff maintain their own police departments.

   Table 24 presents statistical information concerning the availability of law enforcement manpower and detention facilities throughout the study area counties. A Federal Bureau of Investigation Standard has been established which suggests a sworn officer to population ratio of not more than 1:1000. As Table 24 demonstrates, all but Fillmore County meet this standard.

3. Fire Protection - The following fire departments maintain contractual agreements with townships and municipalities along the proposed pipeline route to provide fire protection:

TABLE 24

LAW ENFORCEMENT MANPOWER AND FACILITIES

County	# Officers	Officers/ Population	Detention Facilities
Dakota County	46		X (Hastings)
South St. Paul	30		X
West St. Paul	19		X
Rosemount	6		
Mendota Heights	10		
Lilydale	4		
Lakeville	12		
Inver Grove Heights	14		
Hastings	15		
Farmington	6		
Eagan	18		
Apple Valley	13		
Burnsville	45		
Total	238	1:664	
Fillmore County	10		X (Preston)
Preston	2		
Lanesboro	1		
Mabel	3		
Rushford	1		
Chatfield	2		
Peterson	1		
Whalan	1		
Total	21	1:1029	
Goodhue County	15		X (Red Wing)
Red Wing	24		
Cannon Falls	4		X
Goodhue	1		
Kenyon	3		
Wanamingo	2		
Zumbrota	2		X
Total	51	1:722	
Mower County	23		X (Austin)
Austin	35		
Brownsdale	1		
Dexter	1		
Mapleview	1		
Total	61	1:721	
Olmsted County	43		X (Rochester)
Rochester	98		
Total	141	1:636	

Rosemount Township Fire Department
Hastings Municipal Fire Department
Rudolf Township Fire Department
Cannon Falls Municipal Fire Department
Melsville Municipal Fire Department
Wanamingo Municipal Fire Department
Zumbrota Municipal/Township Fire Department
Pine Island Municipal Fire Department
Rochester Municipal Fire Department
Stewartville Municipal Fire Department
Spring Valley Municipal Fire Department
Ostrander Municipal Fire Department
Lime Springs (Iowa) Fire Department

With the exception of the Rochester Municipal Fire Department, all are staffed on a voluntary basis. All of the departments meet minimum requirements, in terms of equipment and manpower training, to qualify for state aid. Most of the departments are either equipped with foam and fog or spray nozzles necessary to combat a petroleum fire, or are involved in a mutual aid agreement with a neighboring department with such equipment.

2.6.6 Archaeological/Historical Sites

The Minnesota Historical Society has prepared an evaluation of the proposed project. In reviewing their records, they found no historical or archaeological site along the proposed route. A letter to this effect from the Minnesota Historical Society is included in Appendix H.

2.7 AIR QUALITY AND NOISE

2.7.1 Air Quality

Goodhue, Olmsted, Mower and Fillmore Counties lie in Air Quality Control Region 128, while Dakota County lies in AQCR 131. Each of these regions has been assigned a "Priority Classification" by the EPA. The classification is based upon existing measured ambient air quality in the area of maximum pollutant concentration. The classification provides a rough measure of the regional air quality in each AQCR. Table 25 presents the classifications in each region for five commonly measured air quality parameters. Table 26 explains the values which are associated with each class.

TABLE 25

EPA PRIORITY CLASSIFICATION
BY REGION AND POLLUTANT

AIR QUALITY CONTROL REGION	SO_2	PART.	CO	NO_X	OX
128 Southeast LaCrosse (Interstate)	IA	II	III	III	III
131 Minneapolis St. Paul Metro Area	I	I	I	III	III

TABLE 26

VALUES OF EPA AIR QUALITY
PRIORITY CLASSIFICATIONS[1]

	I*	II	III
Particulate Matter	>95 $\mu g/m^3$	60-95 $\mu g/m^3$	<60 $\mu g/m^3$
Sulfur Oxides	>100 $\mu g/m^3$	60-100 $\mu g/m^3$	<60 $\mu g/m^3$
Nitrogen Oxides	$\geq$110 $\mu g/m^3$	N.A.**	<110 $\mu g/m^3$
Carbon Monoxide	$\geq$55 $\mu g/m^3$ (max 1-hr conc.) $\geq$15 $\mu g/m^3$	N.A.**	<55 $\mu g/m^3$ (max 1-hr conc.) <15 $\mu g/m^3$ (max 8-hr conc.)
Photo-chemical Oxidants	$\geq$195 $\mu g/m^3$	N.A.**	<195 $\mu g/m^3$

[1]Federal Register, Vol. 36, No. 158, Sat., August 14, 1971. Title 42, Chapter 4, Part 420, Subpart A, paragraph 420.3, pg. 15488.

*Priority "IA" indicates that emissions are primarily from a single point source.

**N.A. - not applicable; there is no priority II classification.

2.7.2 Noise

Permissible noise levels have been defined by the MPCA for various land activities. While these standards may not be the actual levels experienced at any particular point along the route, they do define the maximum levels which may be anticipated on a regional basis. Table 27 presents the standards as they apply along the proposed pipeline route.

TABLE 27

NOISE STANDARDS ALONG THE PROPOSED PIPELINE ROUTE (dbA)

	Day (0700-2200)		Night (2200-0700)	
Land Activity	L_{50}	L_{10}	L_{50}	L_{10}
Household Units Including Farm Houses	60	65	50	55
Agriculture and Related Activities	75	80	75	80

The U.S. Department of Labor has established 90 dbA as the allowable level for a working environment. This will be applicable to the proposed future pumping station.

2.8 CLIMATE (2)

Some of the general climate characteristics of southeastern Minnesota are given in Figure 7. The area has a typical continental climate with wide extremes in temperature from summer to winter. Total annual precipitation varies from 28 inches in the Minnesota River Valley in the northwest to 32 inches in the very southeast part. About 40 percent of the precipitation falls during the summer.

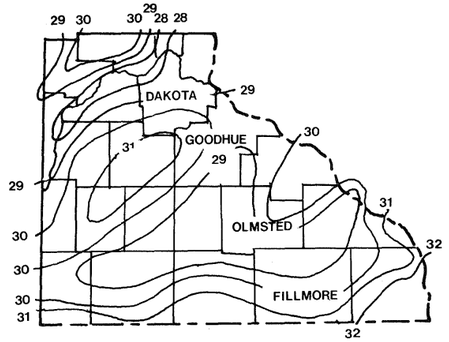
The annual snowfall averages about 40 inches. This approximates 4 inches of water content. Figure 20 and 21 show that this area averages about 30 to 45 days with 6 inches or more of snow on the ground and 10 to 20 days with over 12 inches.

The average date of the last occurrence of frost in the spring ranges from May 2 to May 12, the first frost in the fall ranges from September 26 to October 11.

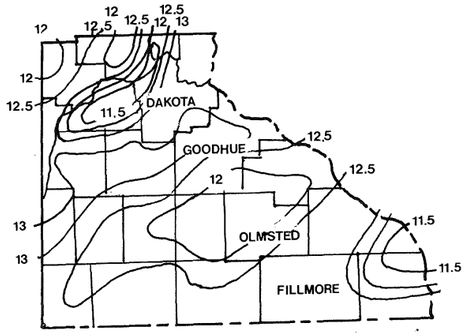
Summer weather is typically one of warm days and relatively cool nights. The maximum temperatures in July average 83°F. in the south central counties to 86°F. along the Mississippi River. The minimum temperatures in July average 58°F. in the south central to about 63°F. in the larger river valleys, the metropolitan areas, and the southwest part of the area.

FIGURE 7

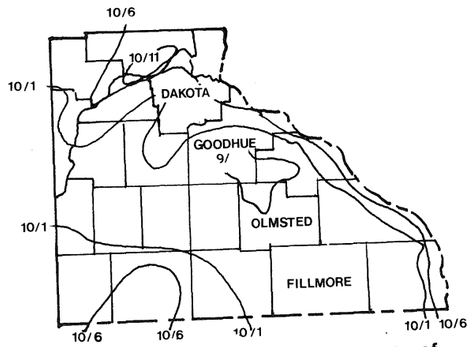
CLIMATE SUMMARY



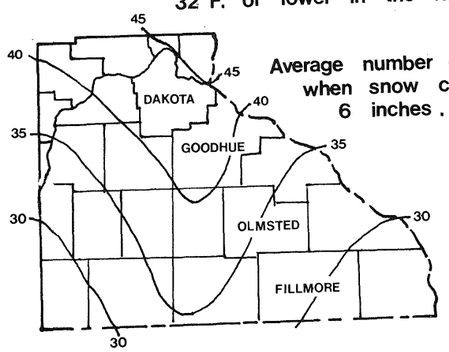
Annual normal precipitation in inches.



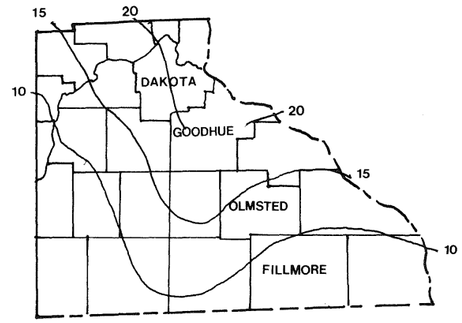
Summer normal precipitation in inches.



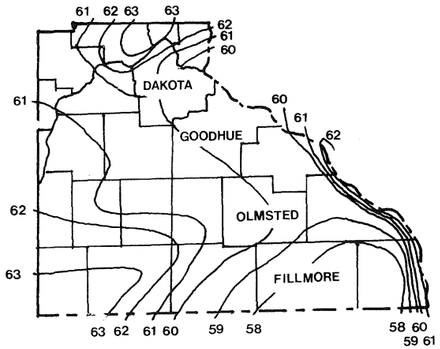
Average date of first occurrence of 32°F. or lower in the fall.



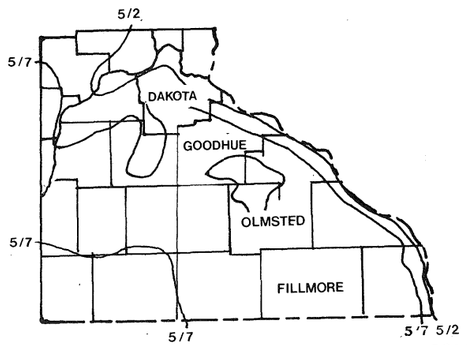
Average number of days per year when snow cover is more than 6 inches.



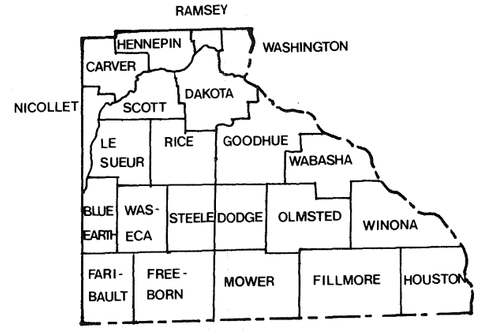
Average number of days per year when snow cover is more than 12 inches.

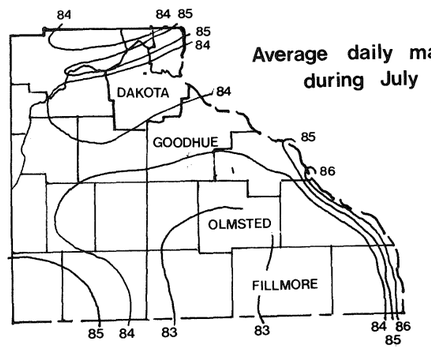


Average daily minimum temperature during July.



Average date of last occurrence of 32°F. or lower in the spring.





Average daily maximum temperature during July

ADAPTED FROM MINNESOTA SOIL ATLAS (ST. PAUL SHEET) EARL L. KUEHNAST

PIPE LINE CO.

MINNESOTA PIPE LINE CO.

prepared by: NATIONAL BIOCENTRIC, INC. 2233 Hamline Avenue North. St Paul. Minnesota 55113

3. ENVIRONMENTAL IMPACTS

3. ENVIRONMENTAL IMPACTS

3.1 CONSTRUCTION

3.1.1 Land Use

The major land use impacts during the construction phase will be the effects on agriculture: loss of crops, soil compaction, and possibly soil dilution. During the construction season, the use of the land on the 50 foot right-of-way will be limited to construction related activities by the Minnesota Pipe Line Company, and one season's crop will be incurred. The construction procedure may result in reduced productivity over the pipeline trench for a period of time. This impact will result from the mixing of subsoils with the overlying topsoil. Proper drainage of fields having drain tiles will not be disturbed, since the drain tiles, when cut, will be carefully repaired. The trench will be fenced or covered where necessary to protect grazing animals.

Along the portion of the route from the Iowa border to Pine Island, the proposed pipeline closely follows the existing American Oil products pipeline. By choosing a route near an existing pipeline, it is felt that there would be less of an overall effect to a given area than if an entirely new, independent route were selected.

Construction at all major roads, most minor roads and railroads will utilize a tunneling technique, rather than open trenching. This will eliminate the need for major road or rail line closures, thereby eliminating the traffic delays and inconveniences that would otherwise occur.

The proposed route does not go through any residential areas, nor does it pass within 300 feet of any residence.

Three rivers, the Cannon River, the South Fork of the Zumbro, and the North Branch of the Root River are designated as Canoe and Boating Routes. Of these three, the Cannon River is most heavily used for boating in the region of the crossing. Except for a few days during the actual construction across the river, boaters will experience no inconveniences. Even during the trenching process, boaters will be able to

pass around the crane. Furthermore, during weekends, when the river is most heavily used for boating, there will not be any construction activity.

3.1.2 Surface Waters

Construction impacts will primarily be short term impariment of water quality, as suspended solids loads will be increased while the trench is being excavated. There will be some additional suspended solids contribution during the backfilling operation. These impacts will occur during a short period, likely over several days to one week. The degree to which turbidity will be increased cannot be predicted. The stream bed will be restored to grade with the same soil as that which was excavated, so that the bottom integrity will be maintaned after construction is complete. If the bottom was armored, cobbles will be separated from the excavated soil and replaced on top of the backfill to maintain the armor after construction. The banks and floodplain will be restored, and anti-erosion measures such as seeding will be employed where necessary. The effects of the increased suspended solids loads upon fish are discussed in the Biology Section of the report. Construction contractors will not be permitted to discharge waste materials during equipment maintenance operations.

3.1.3 Soils and Topography

Irrigation

Construction may interfere with center pivot irrigation operation. During the irrigation season, construction procedures will be modified to cause the least possible interference with irrigation. Pipe will be piled alongside the edges of irrigated fields until needed, rather than strung out ahead of time. The trenching, laying and backfilling operations will be performed as quickly as possible through these fields.

Compaction

During construction, soils will be compacted by equipment along a fifty foot wide easement. Over the entire Minnesota portion of the project, this will amount to approximately 591 acres. Of these, approximately 469 acres will be cultivated, 102 acres will be pasture or open land and 20 acres will be forested.

The effects of compaction upon yield are difficult to quantify. Crop growth is a complex system involving precipitation, temperature, soil biology, nutrient availability and the transmission of air, water, and heat through the soil. Compaction affects the transmissibility of the soil, packing soil particles tighter and reducing the transmissibility. The degree to which this is beneficial or detrimental, in a specific case, depends upon the condition created in the soil, and upon climatic conditions. For example, the Agricultural Research Service at Lamberton, Minnesota, is conducting a study of the effects of compaction upon yields. While the study is incomplete, the ARS is finding that corn and soybeans actually produce increased yields on compacted soil during years of normal or greater precipitation (16). It appears that the ability of the compacted soil to hold more soil moisture than uncompacted soils is a benefit in dry years, maintaining a soil moisture content in the optimum range of corn and soybeans, but becomes a detriment during normal years, when the soil moisture content becomes too high for optimum growth. The effects of compaction over several years are difficult to predict, since they must rely heavily on the accuracy of any long-term predictions concerning precipitation patterns. Furthermore, the degree of compaction is lessened by tilling, by the action of plant roots, and by frost action. These mechanisms will reduce the effects of the initial compaction over time. The amount of time will vary for each specific case, and is not predictable from the available data. It should be noted that on Minnesota Pipe Line Company's Clearbrook line, there are no visible crop reductions in areas which underwent construction in 1973, and no complaints of reduced crop yields have been reported.

Mining

During construction, a trench will be excavated in which to lay the pipe. The trench will be three feet wide, and in most areas, approximately five feet deep. Over the Minnesota portion of the route, the trench will affect 34 acres. Of these, 28 acres will be cultivated, and 6 acres will be pasture or open land.

Approximately 50% of the route lies over soils which are described as loamy over loamy, 20% lies over rocky soils or steep slopes of poor

agricultural potential, and 30% lies over loamy over sandy soils. The construction procedure will result in a mixing of the topsoil and subsoil, resulting in reduced fertility over the pipeline trench. This impact will be greatest in the loamy over sandy soils, where the underlying sand will be mixed with the overlying topsoil. In the loamy over loamy soils, the concentration of organic material in the rooting zone will be lessened, but inorganic nutrients will not be severely affected, since the soil materials being mixed will be similar. This will result in some loss of fertility over the trench, but it will be small compared to the effects on the loamy over sandy soils. There will be similar effects on the rocky soils and steep slopes that are not under cultivation, but these will not have the impact upon agriculture which the effects upon the above soils will have.

Drainage

All topography and drainage patterns will be restored to their original contours. Anti-erosion measures such as seeding, sodding, rip-rapping, and building dikes will be used where appropriate or necessary to ensure that a change in the natural drainage patterns is not induced. No impacts upon drainage are anticipated.

Where drain tile is cut or damaged, the ends of the cut tile will be plugged and marked. After construction is complete, the tile will be repaired with new sections which will be laid to the same grade as the original tile. The soil underneath the tile repair will be compacted to prevent settling.

Sinkholes

Sinkholes occur in the area from Spring Valley eastward to Wykoff and Fountain, and south to Preston. The proposed route traverses the westernmost edge of this zone in the vicinity of Spring Valley. The route has been examined both in the field and on air photos, and no sinkholes are discernible along the route. If sinkholes are encountered during construction, the route will be adjusted to avoid the sinkhole. The route adjustment will be negotiated to be agreeable to both the landowner and Minnesota Pipe Line Company.

3.1.4 Geology/Groundwater

Geology

There will be no impacts upon the geology itself. The geology may affect the location of the pipeline within the right-of-way, as it is uneconomical to make a cut of greater than two feet in bedrock. Thus, the proposed route has taken advantage of such items as the fact that bedrock can be expected to be deeper in the "valley" between two hills, as compared to on the hill itself. The St. Peter sandstone is easy to excavate, while dolomite and limestone require special equipment, such as rippers and backhoes. In this manner, the kind of bedrock encountered may influence pipeline location and construction methods.

Groundwater

There will be no construction impacts upon groundwater. There will be no discharges of pollutants to groundwater. Construction contractors will not be permitted to discharge waste materials during equipment maintenance operations. If groundwater is encountered during trenching, there will be no dewatering operations. Since the entire region serves as a recharge area, the relatively small percentage of the area which is disturbed by the pipeline construction will not measurably affect recharge rates.

3.1.5 Biological Environment

Vegetation

Some minor disruption will occur to wildlife and vegetation in the immediate area of the proposed construction because of noise and required clearing; however, this disruption will be temporary. Upon completion, most of the land will revert to or be restored to its previous state.

The short-term effects of construction on the croplands will be the loss of the season's crop in the proposed right-of-way.

Vegetation along the proposed 50 foot wide right-of-way will be removed (over the trench) or otherwise damaged by construction machinery. Shrubs, saplings and trees will be removed completely along the proposed right-of-way by mechanical means. Approximately 20 acres of forest

vegetation will be removed. This represents 3.5 percent of the total right-of-way acreage to be affected. Approximately 2 acres of bottomland forest will be removed, the rest being upland forest found primarily on slopes not suitable for cultivation. Seventy-five percent of the bottomland forest is in the Cannon River Valley, and much of these woods consist of juniper thickets along the terraces leading down to the river. Only large trees will be kept out of the right-of-way; brush will be allowed to grow back. Shelterbelts and windbreaks near homes will be avoided, if possible, because of the impacts on the protection and aesthetic characteristics such vegetation provides. It will not be possible to avoid all windbreaks along fields. Where these are encountered, the width of tree removal will be kept as narrow as possible, yet wide enough to allow the proper construction techniques to be carried out. If any commercially valuable trees are encountered in the right-of-way, the landowner can hire a contractor to remove and buy the tree.

Reseeding and natural succession will result in rapid grass, weed, brush and sapling growth on the unmanaged portions of the right-of-way over one or two seasons. Regrowth of large trees on the right-of-way will be discouraged. Large tree roots will impinge upon the pipe itself and remove the protective coating. Complete regrowth of the forested areas would also hamper accurate aerial inspection of the right-of-way.

Wildlife

Wildlife populations occurring along the route of the proposed pipeline could be affected as a result of temporary displacement from habitat during construction. There are numerous small, unmanaged weedy and brushy areas along the right-of-way that could support various kinds of wildlife, including small mammals and birds (especially Hungarian partridge, pheasant, and bobwhite). Permanent population reductions in these areas are unlikely, because the weeds will grow back in one or two seasons, leaving the habitat basically unchanged.

As the forested areas are cleared, birds, small mammals and other animals inhabiting the proposed right-of-way will be displaced. However, wildlife populations may increase at certain points along the right-of-way. Induced and natural revegetation and vegetative succession in the

years following construction will improve habitat for certain species. There will be an increase of approximately six acres of ecotone per linear miles of forest in the years following construction. It is the ecotone or edge between two different types of habitat, such as forest and field, that provides the greatest carrying capacity for wildlife. In addition, creation of brush pile habitat and allowing grasses, weeds, and bushes to grow over the fight-of-way will increase the species diversity and carrying capacity of the right-of-way relative to adjacent woods and forest through which it passes.

There will be little or no impact on waterfowl populations or nesting sites as a result of the consturction of the proposed pipeline. At the proposed crossings, all the rivers are well incised with no marshy floodplains or backwater sloughs. The few bars and reedy areas along the banks of the rivers are prone to flooding and are not suitable for waterfowl nesting. The various rivers represent the only wetlands of any sort traversed.

Destruction of bass nesting sites is the only significant impact that could occur to the fishery resources of the various rivers. However, since construction will begin at Pine Bend on or after June 1, 1977, and will proceed at a rate of approximately one to two miles per day, bass nesting will be finished by the time most of the good bass streams are crossed. The bass nesting season is generally considered to be over by mid-June (12), so the Cannon River might be crossed during the latter part of the season, depending on any construction delays. Fish will be displaced from the construction sites, but this should not affect their populations. Inreased sediment loads during the construction will be short-lived and are not expected to affect fish habitat downstream, although increased turbidity could cause localized feeding problems for young-of-the-year smallmouth bass, which depend heavily on sight.

Rare, Unique or Endangered Species

At most, five or six acres of unmanaged area in Fillmore County suitable for bobwhite will temporarily be disturbed.

It is extremely unlikely that habitat suitable for trout lilies or wood turtles will be encroached upon.

3.1.6 Socio-Economic Environment

Population

Since contractors have not as yet been selected for this project, the forecasting of population impacts from construction is a somewhat speculative undertaking. However, based on Minnesota Pipe Line Company's estimates and experience, the following assumptions have been made:

- The Minnesota portion of the line would likely be constructed as a part of a single "spread".
- A work force up to 250 will be required.
- The prime contractor could be a non-Minnesota firm.
- Approximately 75 percent of the pipeline work force (188 workers) could be non-Minnesotans and would constitute a population influx.
- Approximately 50 percent (94) of the inmigrating workers could be accompanied by an average of 2.5 dependents (235) for a possible total inmigration of some 423 people (188 workers + 235 dependent = 423 total inmigrants.) (17)
- The pipeline work force would likely be broken into some 10 crews. The construction population would therefore be comprised of groups ranging in size from approximately 25-65 people.
- Duration of construction in Minnesota will be approximately two to three months, with the estimated stay of any inmigrant worker at a given location in the study area being approximately one month.
- For the most part, inmigrant wrokers would likely utilize self-contained mobile housing units. In some cases, motel accomdations would be utilized.

Based on these assumptions, it would appear that the impact on population from construction will be short-term, on a relatively small scale. In all probability, the larger communities along the proposed route (Cannon Falls, Pine Island, Zumbrota, Rochester) will serve as the short-term repositories for inmigrant workers and their dependents.

Economics

The proposed pipeline will have direct and indirect economic impacts on the study area during the preconstruction and construction phases. The first input to local economics will arise from the purchase of Minnesota Pipe Line Company of construction and use easements along the 50 foot right-of-way. The price of these easements will be determined on an individual basis through negotiations with each landowner. Therefore, the degree to which local economies will benefit cannot be determined at this time.

A second direct input to local economies will arise from payroll dollars spent by the project work force. It is estimated by Minnesota Pipe Line Company that average wages could amount to approximately $480/foot of pipe of $2,534,000 for 100 miles of pipeline in Minnesota. Assuming a work force of 250 workers, these figures represent $10,138 average total wages paid to each worker during the project in Minnesota. Crews are expected to be in the state for two to three months, working six day weeks, at ten hours per day.

It has been estimated that a local (Minnesota) laborer or an inmigrant worker with dependents will expend approximately 70 percent of take home pay on locally derived goods and services, while the inmigrant without dependents will expend roughtly 35 percent. (17)

Other direct economic impacts will result from payment for right-of-way and damages to property owners and rental fees paid by the contractor for temporary storage space.

A portion of the money directly introduced into the local economy (easement fees, payroll, damage compensation and rentals) will be reintroduced by the local merchants who provided the initial goods and services, at a rate approximately equal to that characteristic of non-resident workers with dependents (70%). (17) This "ripple" effect amounts to an indirect economic impact of the project's construction phase.

There will be an economic impact associated with yield reductions resultant from topsoil disturbances, particularly in those portions of Dakota County with 3 feet or less of loam overlying sand (See Figure 4 in the Soils Section). Based on a trench width of 3 feet, it is estimated

that less than 7.5 acres of productive land will be affected. Impact to a lesser degree is anticipated along the rest of the route as well. The degree to which crop yields will be influenced cannot be predicted. However, any reductions in yields will diminish over time. The duration of yield reduction cannot be forecasted, and will be governed by soil type, climate, farming practices, and restoration activities. Possible soils compaction in the right-of-way, caused by construction activities, may also affect yields, but the number of determinant variables involved makes impact projection impossible.

It should be noted that, on its Clearbrook line, (construction in 1973), Minnesota Pipe Line Company has not received any complaints of economic loss due to yield reductions beyond those negotiated during damage settlements.

Discussions with the county assessor from each county indicate that the pipeline will have no impact on either the market or assessed value of land, as long as the land maintains its current use designation. For instance, agricultural land values will not be affected. Should development opportunities become available, however, the potential value of the land within or near the right-of-way might be reduced somewhat, because of pipeline right-of-way development restrictions.

3.1.7 Transportation

As discussed in the Construction Techniques Section of this report, construction at all major roads, most minor roads, and railways will utilize a boring technique, rather than open trenching. This will eliminate the need for major road or rail line closures, thereby forestalling the traffic delays and inconveniences that would otherwise occur.

Permits will be obtained from the rail companies and a rail company representative will be present for any rail line borings.

As a result of agreements with local governments, some minor township gravel roads will be temporarily closed to permit trenching. Road closures will be brief (usually two days or less) and alternate routes will be identified.

Crossings of existing oil and gas pipelines will be accomplished by passing over or under them depending upon depth. The Minnesota Pine Line Company's line will in any event maintain a minimum cover of 3 feet. Crossing of existing pipelines will be coordinated with the pipeline owners.

Inasmuch as the proposed pipeline will intersect rather than parallel major electrical transmission lines, no safety hazards or corrosive impacts are anticipated.

No impact is anticipated at the Rochester Municipal Airport as a result of pipeline construction.

Taxation

The proposed project will not affect the system of taxation employed in Minnesota, but rather will marginally increase revenues generated by that system. During the construction phase, the state will benefit from the taxation of wages earned in the state by both resident and non-resident workers, who will be subject to the same withholding and refund policies. The state will also tax the purchase of all materials used on the project, whether purchased in or out of Minnesota, at a rate of 4 percent of sales price. The state will further benefit from the 4 percent tax on the sale of all non-exempt tangible personal property to workers and their dependents.

Services

The availability and adequacy of services varies from county to county. The influx of construction workers and their dependents could temporarily place some additional service burden on the affected areas, but not to the extent of requiring additional services.

3.1.8 Air Quality and Noise

Air Quality

Impacts upon air quality will be minor, and of short duration. They will consist mainly of exhaust emissions from construction equipment, and dust.

Noise

During construction, there will be short-term impacts associated with equipment operation. These may last from several days to a week at

any given point, depending upon the rate of construction. The impact will take the form of raising the ambient noise level periodically for short durations. It will not necessarily result in a violation of the standards. These levels should be similar to those of normal farm equipment.

3.1.9 Climate

There will be no impacts upon the climate.

3.2 OPERATION AND MAINTENANCE

3.2.1 Land Use

Approximately six acres per mile of proposed pipeline route will be designated to a permanent land use as right-of-way, although fences, roads, and crops will be permitted. Such restrictions do not represent a significant land use impact. Regrowth of large trees along the right-of-way will be discouraged; thus 20 acres of forest land will be permanently removed. Intensive land use areas, such as residential areas, have been avoided for several reasons, including the cost of compensation and the saxrifice of these uses.

Approximately 5 acres near U.S. Highway 14 along the proposed route may be taken out of productivity and designated as a pump station site sometime in the future. This depends on the volume demenad increases after the pipeline has been completed.

3.2.2 Surface Waters

The only potential impact upon the streams during operation is associated with oil spills. Extra heavy pipe, extra depth, and X-rays of all welds are measures taken to ensure that stream crossings are the least likely places for spills to occur. However, there is the low probability that a spill could occur near a stream, and the oil follow natural drainage ways to the stream. In this case, emergency cleanup measures would promptly be implemented. The oil would be removed from the water and banks using skimmers, absorbant media, physical removal, or other appropriate means.

3.2.3 Soils and Topography

Irrigation

Irrigation well sites will be restricted from the easement, unless no feasible alternative location is available. This may require that sites be relocated by a maximum of 25 feet (if the original site lay over the pipeline, less if it were only on the easement).

Productivity

The operation of the pipeline will not affect the productivity of the land which it traverses. All impacts in this respect are associated with construction.

Pipeline Temperature

The pipeline as proposed through Minnesota will operate near ambient soil temperatures. These will range from about 35°F. to 72°F. During winter months, the above freezing temperature of the pipeline may warm the surrounding soil. Snow may melt above the pipeline before it melts elsewhere. This effect disappears as soil temperatures rise naturally.

It is possible that at some date in the future a pumping station will be required. It is currently believed that the station will be located south of Highway 14, west of Rochester. If the station is built, there will be a temperature rise of about 10°F. in the crude oil as it leaves the station. This heat will be dissipated within 1 or 2 miles of the station, and the pipeline will operate at ambient soil temperature along the rest of the route.

Deep Tilling

The pipeline will be laid with a minimum cover of 36 inches, so that it will not interfere with normal agricultural practices which are currently in use. This allows ample clearance for sub-soilers, which reach a depth of 24 inches below the surface. Where found necessary, upon consultation with farmers, this may result in laying the pipeline deeper than 36 inches. If a landowner has plans to install drain tile in a field crossed by the pipeline, with which the placement of the pipeline would

interfere, the pipeline will be laid at a greater depth to avoid any interference with the tile installation.

Spills

If a spill occurs, the soils in the area of the spill will be contaminated. Clean-up measures by the company may include the excavation of the contaminated soil, and its replacement with uncontaminated soil. The replaced soil will probably experience effects similar to those described for compaction and trenching, above. In addition, an area surrounding the spill will experience the effects of compaction from equipment used in the cleanup.

3.2.4 Geology/Groundwater

Geology

There will be no impacts on the geology itself, and the geology will not affect operation of the pipeline.

Groundwater

The only operation related phenomenon which may affect groundwater is an oil spill. The degree to which the spill affects the environment depends upon how much oil is spilled, how permeable the soils or rocks are, whether or not there is frost in the ground, whether the spill ponds or runs, vegetative cover, and how much time elapses between the start of the spill and cleanup operations. Some components of the oil, most notably phenol, are water soluble and may infiltrate through permeable soils and rocks, eventually reaching the groundwater. This can be avoided if cleanup procedures are implemented rapidly after a spill occurs. When necessary, vacuum systems will be employed to remove oil contaminants from the groundwater.

3.2.5 Biological Environment

Impacts of operation and maintenance will be minimal, since 95 percent of the proposed right-of-way will return to its original state as cropland, pasture or unmanaged land, and virtually no maintenance activities will be required. The oil will flow through the pipeline at the

same temperature as the surrounding earth, so there will be no effects on the vegetation.

The forested sections of the right-of-way will be managed only to the extent of discouraging, by mechanical means, the growth of large trees, since the roots may damage the pipe, and since such trees would hamper aerial inspection. The vegetation differences along the forested portions of the right-of-way will result in a varied habitat capable of supporting a greater diversity and abundance of species and individuals than if the right-of-way were not present.

An accident such as an on-land spill could have temporary local damaging effects to vegetation and small animals within a small area. The cleanup and repair of such an accident, or the repair of any section of pipe would have short-term impacts similar to those of construction.

3.2.6 Socio-Economic Environment

Population

Population impacts as a result of operation of the line will be negligible, as Minnesota Pipe Line Company has, at this point, no plans for establishing new line maintenance centers along the proposed route, or hiring new employees to serve the new line.

Economics

No direct or indirect economic impacts are expected in the study area as a result of pipeline operation. However, as addressed earlier in this report, the pipeline will improve the petroleum supply situation in the upper Midwest, and thereby assist in the stabilization of petroleum related product prices.

Taxation

During the operation of the pipeline, the counties, incorporated areas, school and special districts in which the line is situated will apply their mill levies to the pipeline's assessed value (43 percent of its market value as determined annually by the Minnesota Department of Revenues).

Services

Service needs during future pipeline operation will be very limited, especially since no additional employees are planned and none of those presently employed will be located in the construction area.

3.2.7 Air Quality and Noise

Air Quality

There will be no operation related impacts upon air quality.

Noise

Along the pipeline route, there will be no noise impacts due to operation. Within the potential pumping station, personnel will be exposed to noise from the prime mover. This will probably be electric motors. These produce a high frequency noise which attenuates rapidly with distance from the source. Effects on personnel should be minimal, and in any event, the installation must meet state and federal standards. No personnel will be permanently located at the station. There will be only periodic checks by maintenace crews.

3.2.8 Climate

There will be no impacts upon climate.

4. IMPACT MITIGATION

4. IMPACT MITIGATION

4.1 LAND USE

Restoration of the right-of-way by the contractor will include cleaning up the right-of-way; removing large rocks and brush; repairing the fences; raking, disking and harrowing the ground; and reseeding (see Cleanup under Section 1.7). Many farmers may wish to apply their own restoration techniques (special fertilizers, etc.) and upon negotiation, the company will compensate the individual landowner for this activity.

4.2 SURFACE WATERS

The special construction methods and specifications discussed earlier are intended to prevent spills near rivers and streams. In the event that a spill does travel overland to a stream, appropriate cleanup measures will be initiated as quickly as possible.

Construction will be completed at stream crossings as quickly as possible, so that the period of increased suspended solids will be limited to the shortest possible duration. Restoration and anti-erosion methods, such as reseeding, sodding, and rip-rapping will be used on the banks and floodplains to prevent damage at these locations. The stream bed will be restored to grade with the same type of soil as that which was excavated to preserve bottom integrity and to minimize sedimentation after construction is complete. If the stream bottom is armored, the armor will be replaced after construction.

4.3 SOILS AND TOPOGRAPHY

The pipeline company will perform, or alternatively negotiate payment for, restoration procedures such as disking, fertilizing, seeding, or other more specialized procedures. The type and extent of these procedures will be negotiated with the landowner or tenant.

Steep slopes will be avoided if at all possible. Where unavoidable, slopes will be restored as nearly as possible to their original configuration with no change of drainage pattern. Seeding will be applied if necessary to allow time for the soil to stabilize. Water crossings will be

at as nearly right angles as possible to discourage erosion. Exposed soil not subject to cultivation will be reseeded with a grass mix suitable to the application and equitable to landowner or tenant.

Spills will be contained as rapidly as possible, and contaminated soil will be excavated and replaced.

4.4 GEOLOGY/GROUNDWATER

4.4.1 Geology

There will be no impacts to the geology to mitigate. The geology may influence the exact alignment of the pipeline, but this will not require mitigation.

4.4.2 Groundwater

Impacts upon the groundwater will be associated with oil spills. The most effective mitigation of spills is to cleanup the spill and excavate the contaminated soil rapidly enough to remove the contamination in the soil before it can reach the groundwater. If contamination does reach the groundwater, vacuum methods may be used to remove the contaminants. All cleanup measures are subject to the approval of the Minnesota Pollution Control Agency.

4.5 BIOLOGICAL ENVIRONMENT

The loss of habitat as a result of forest clearing cannot be directly mitigated; however, induced and natural revegatation and vegetative succession in the years following construction will improve the habitat for many species. Along steep slopes that have been cleared of wood and brush, erosion prevention measures such as immediate reseeding will be undertaken. Bottomlands (especially along the Cannon River) will be crossed in such a fashion as to minimize disruption to these areas.

The construction of the pipeline will start late enough to avoid the bass nesting season in most of the streams. The material replaced in the stream bottoms will be similar in nature (size of particles, sand, gravel, etc.) to that which was removed in order to avoid permanently disrupting the existing habitat.

In the event of an oil spill, immediate cleanup procedures will be carried out. The oil spill will be contained by various methods such as digging ditches and constructing earthen dikes. Vacuum trucks, pumps, and absorbants will be used to pick up the spill. The company will deal with the individual landowners, and the Minnesota Pollution Control Agency, concerning satisfactory restoration techniques. The contaminated soil could be hauled away, turned under and then reseeded, left alone to recover naturally, or treated in some other appropriate fashion. In the event that the oil gets into a stream or river, and damage to the fish or wildlife populations is sustained, the company will negotiate with the proper authority as to any compensation that may be made. (For further details on oil spills, refer to Appendix A).

4.6 SOCIO-ECONOMIC

4.6.1 Population

The impacts on population will result from the influx of non-Minnesota laborers and their dependents. This impact can be mitigated somewhat by the contractor maximizing the use of Minnesota workers. The fact is, however, that the majority of skilled and experienced pipeline workers available to this project are non-residents. A larger percentage of local residents could possibly be placed in those activities requirng skills not exclusively associated with pipeline construction or calling for unskilled assistance.

4.6.2 Economics

Impacts to the economy, in the form of crop yield reduction, can be mitigated through the reseeding and soils reconditioning activities addressed in the Land Use Section of this report. In addition, damages and compensation payments negotiated between the landowner and MPLC will serve to either fund mitigative measures to be carried out by the landowner or to supplement any economic losses sustained as a result of project related yield reductions.

Constraints to development posed by the proposed project's right-of-way restrictions can be mitigated by incorporating the right-of-way

into the development's design. For instance, the right-of-way could serve as a green-way, rear yard or land buffer.

4.6.3 Transportation

Adverse impacts associated with transportation will arise primarily from the use of trenching techniques across some predetermined county and township/municipal roads. The impacts will be chiefly in the form of travel inconvenience, and can be mitigated by establishing appropriate detour routes and by minimizing the duration of minor road closures.

4.6.4 Taxation

No mitigation required.

4.6.5 Services

No mitigation required.

4.7 AIR QUALITY AND NOISE

4.7.1 Air Quality

Exhaust emissions can be minimized by maintaining equipment and tuning the engines. Dust can be minimized by wetting down traveled dusty areas in specific instances, as deemed necessary. Much of the time, precipitation and soil moisture will perform this function without any special efforts on the part of the contractor.

4.7.2 Noise

Construction-generated noise can be minimized by maintaining equipment mufflers in good repair. The pumping station will be designed to meet state and federal standards.

5. ALTERNATIVES

5. ALTERNATIVES

5.1 TRANSPORTATION

5.1.1 Barge, Rail or Truck

Shipments of large crude oil volumes over the long-term by barge, rail, or truck are not considered realistic alternatives to pipline transportation. This conclusion is supported in general by their costs per unit volume transported (see Table 28) and operational safety records as compared to those for pipelines. It is true that some minor volumes are currently being delivered to the Minneapolis/St. Paul area by barge to effect an interim solution to the present short-fall problem, a function well served by barging. However, barging cannot be relied upon on a year-round basis because of winter icing in the Mississippi River. Barge traffic is also becoming a rather significant problem at certain locks along the river, the result of which is delay in transit. Approximately 1,000 trucks per day or 300 railroad tank cars per day would be needed to supply 100,000 barrels/day to the refineries.

TABLE 28

ESTIMATED TRANSPORTATION COSTS

All Figures Per 100 Barrels/Mile

Tanker	$0.0125	to	$0.0350
Pipeline	$0.0200	to	$0.1000
Barge	$0.0225	to	$0.1500
Rail	$0.1050	to	$0.5000
Truck	$0.470	t0	$0.6500

Source: Minnesota Energy Agency, Implications for Minnesota of Canadian Crude Oil Export Curtailments. 1976.

5.1.2 Other Pipelines

Consideration has been given to the possibility that a pipeline may be constructed from Kitimat, British Columbia on the Canadian west coast

to interconnect with the pipeline operated by Interprovincial Pipeline Company. If such is the case, certain volumes of domestic and/or foreign crude oil could be transported through the existing pipelines to the Minneapolis-St. Paul area in a manner similar to the present operation. These volumes are not forecast, however, to be sufficiently large to supply the entire shortfalls created as the result of the reductions in Canadian crude oil exports.

The extent to which the Kitimat pipeline affects the Patoka to Pine Bend pipline design is reflected in the pipeline diameter alternatives, 20-inch pipe versus 24-inch pipe. The size decision will be made as expeditiously as possible based upon the degree of certainty that the Kitimat pipeline may, or may not, be constructed. It should be noted that construction of the Kitimat pipeline does not eliminate the need for the Patoka to Pine Bend pipeline, but only influences its design relative to size.

A proposal has been made by Williams Brothers Pipeline Company to expand their products systems with the construction of an 18-inch pipeline from Mason City, Iowa to Pine Bend, Minnesota. This expansion would initially provide up to 60,000 BPD of capacity for batching crude oil shipments to Pine Bend. It should be noted that these limited volumes would provide only a partial solution to the overall Minnesota area liquid petroleum supply problem.

In summary, the transportation requirement to be met is one of transporting crude oil volumes sufficeint to supply refinery forecasts from near Patoka, Illinois to Pine Bend, Minnesota. The most effective and economical means to accomplish this end is to construct a pipeline from Patoka to Pine Bend over as direct a route as possible.

5.2 SITES AND LOCATIONS

5.2.1 Proposed Route

One of the most important considerations in choosing the proposed route was avoiding the steep valleys and forested regions found near the Mississippi River in southeastern Minnesota. This area is characterized

by considerable topographic relief, and valleys 150 to 250 feet deep are not uncommon. Examples of such deeply dissected valleys are the Root, Whitewater, Zumbro, and Cannon Rivers. Higher in the watersheds, at the proposed points of crossing, most of the rivers are relatively small (10-40 feet wide), the valleys are not deeply incised with steep slopes, and there are fewer forested areas than to the east. In this instance, avoiding added costs due to engineering and construction problems and avoiding the environmentally sensitive areas coincide.

Public lands, wildlife management areas and recreational areas were avoided because of possible detrimental impacts and procedural problems (permits, etc.) that may have occurred. The entire route is privately owned and the land use is relatively homogeneous, 80 percent of the route being cultivated land and 17 percent being either pasture or other open land. Thus, within the immediate vicinity of the proposed route, there are few constraints which would necessitate extensive route selection procedures. The proposed routes does not traverse any residential areas or incorporated areas, thus avoiding the displacement of human beings and houses.

From the Iowa border to Pine Island, the proposed route closely follows the existing American Oil Company right-of-way. By choosing a route near an existing pipeline, there would be less of an overall effect to a given area than if an entirely new, independent route were selected. Also, the American Oil pipeline avoids some of the same factors mentioned above, so it is natural that the two lines be in the same corridor.

In the region of the proposed route, most of the rivers do not present any significant engineering or environmental problems. They have been preliminarily inspected by a representative from the Minnesota DNR and the river crossing have been established so as to avoid extensive forested areas and steep banks. The river crossings are in straight stretches of the river, as opposed to meanders.

Several constraints necessitated a careful evaluation of the proposed Cannon River crossing. The City of Cannon Falls was avoided because of

the difficulties and disruption that would be caused by going through a built-up area. To the west of the city, built-up areas near Highway 52 and Byllesby Reservoir provided further constraints. Therefore, a route crossing the Cannon River to the east of the city was chosen. Pine Creek flows from the northwest into the Cannon River about one mile east of Cannon Falls. It was avoided because of its steep, narrow valley and exposed 40 foot cliffs. Along the Cannon River itself, one of the major objectives was to find a crossing where, on both sides, the cliffs were eroded away, providing a somewhat gradual approach with sufficient cover material for laying the pipe. At the proposed crossing, the stream bed is well armored with large stones, and is well protected against erosion. The avoidance of extensive upland and bottomland forests were also considered as an important constraining factor.

5.2.2 Alternative Routes

One of the alternatives considered was to follow the existing American Oil pipeline north from Pine Island towards Hastings and from this point to cut west towards Pine Bend. The major reason for rejecting this route was the extreme topography found in the vicinity of the Cannon River. The slopes along the river near Welch are over 250 feet high, providing many more environmental and construction problems then would be incurred closer to Cannon Falls.

Following existing highway or railroad right-of-ways was considered. However, the Highway Department does not allow such facilities to be built on its right-of-ways, and following railroads also poses probelms. Railroad lines run directly through the communities they serve, whereas the proposed pipeline route avoids all communities and residential areas. The number of route changes that would have to take place would defeat the purpose of following existing railroad right-of-ways.

5.3 ALTERNATIVE STREAM CROSSING TECHNIQUES

Placing the pipe above the ground at stream crossings and suspending the pipeline over the streams has been ruled out as an alternative for for several reasons. Placing the pipeline above the river creates

considerably more safety hazards than burying it. The pipe is exposed to various kinds of damage from natural forces and vandalism. Also, placing the pipe over a river would significantly detract from any aesthetic qualities that may exist at a given site.

5.4 NO ACTION

Implementation of the No Action alternative would result in no environmental disturbance along the proposed pipeline route in southeastern Minnesota. However, implementation of the No Action alternative would require the St. Paul area refiners to seek other forms of transportation to augment the dwindling supplies of Canadian crude oil. It is doubtful whether such alternative methods (mentioned in Section 5.1) could satisfy the crude oil supply needs of the Minnesota refiners.

6. UNAVOIDABLE ADVERSE IMPACTS

6. UNAVOIDABLE ADVERSE IMPACTS

The construction and operation of the proposed pipeline will result in certain localized, unavoidable adverse impacts on the surrounding environment along the proposed route. These impacts will be both short-term and long-term in nature. These impacts have been discussed in detail in Section 3, and include:

Short Term

- Loss of crop productivity on the right-of-way during construction.
- Disruption of terrestrial and aquatic communities during construction.

Long-Term

- Minor loss of wildlife habitat and forested area.
- Restriction of land use along the right-of-way.

The relative magnitude of the adverse environmental impacts is variable along the proposed route. These impacts will not result in a significant loss of environmental quality.

6.1 HUMAN RESOURCES IMPACTED

Due to the nature of the pipeline construction and operation, there will be a few adverse environmental effects. The one-time loss of productivity in cropland areas will be one of the significant impacts.

The socio-economic impacts generated by the proposed project were discussed in detail in Sections 3.1.6 and 3.2.6. Short-term impacts on human resources are associated with the construction phase of the proposed project because of the increased demand for community services by the construction crews. No major interruption of public services will occur, and as a result of the transitory nature of construction, no long-term adverse environmental impacts are expected.

The proposed pipeline will not result in population displacement or relocation of public and semi-public facilities. The local standard of living will not be lowered or threatened as a result of the proposed project.

6.2 USES PREEMPTED AND UNAVOIDABLE CHANGES

The unavoidable effect of the construction process will be the clearing, grading, earth moving and trenching associated with proper placement of the pipeline. Disruption will be a function of the amount of equipment and manpower necessary to prepare the site and lay the pipe. Mitigation and enhancement factors, discussed in detail in Section 4 of this report, include rapid construction techniques, confinement of all construction to the right-of-way and rapid restoration and revegetation techniques.

The clearing, grading, earth moving and trenching will result in the removal, disruption, and destruction of some natural vegetation, and the temporary displacement of related wildlife. However, this displacement is not expected to have a significant adverse effect on local populations.

Construction and restoration practices are designed to restore original confituration and fertility and to promote reestablishment of habitat damaged during construction. It is expected that seeding and natural succession will result in rapid vegetative cover following construction. The regrowth of large trees along the right-of-way will be discouraged, thus removing about 20 acres of land from forest use.

The construction and operation of the proposed pipeline will preempt certain future land use activities. However, the proposed project will not have a significant impact on the present or planned land use in so far as future development plans are known. Most of the land will remain in its present, agriculturally oriented use. The existence of the pipeline should not affect the future value of the land in terms of future development.

6.3 LOSS OF ENVIRONMENTAL QUALITY

There will be no permanent adverse changes in environmental quality as a result of the proposed action.

Any reduction in productivity as a result of the construction operation will not be permanent, since productivity will be gradually restored

as a result of proper agricultural practices (plowing, fertilizing, crop rotation, etc.).

A highly localized, short-term degradation in air quality may occur during construction because of dust generation and emissions from construction equipment. Through control of fugitive dust, no significant temporary decrease in air quality of the region is expected to occur from particulate matter.

Local, short-term water quality impairment may occur at stream and river crossings. Some erosion and turbidity may occur during construction as a result of the trenching operation, both in the water and on the banks.

7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed project will not irreversibly alter the availability of any known resources within the study area. A small portion of the area's most important resource, fertile soil, will be temporarily disrupted, but will be subject to restoration practices which should serve to reverse initial alterations.

Certain natural and manufactured resources, such as sand, gravel, steel pipe, valves and fittings, will be irretrievably committed to the proposed project.

The pipeline's planned operation will play a role in the irretrievable consumption of petroleum related resources. Indirectly, however, the pipeline will also foster energy (petroleum) conservation, as it is a far more energy efficient form of transportation than the alternative modes; rail, truck, or barge.

8. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

8. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

There will be local short-term disruption of vegetation and land surface along the right-of-way of the proposed pipeline. Further, some minor county and municipal roads will be closed for up to two days to allow pipe installation. The potential also exists for some short-term increases in turbidity during stream crossings. Crop losses and property damages will be compensated. Adequate detour routes will be designated for disrupted roads.

These short-term effects must be balanced against the long-term benefits of the proposed action:

- Continued efficient delivery of crude oil to supplement the decline in volumes available from current sources.
- Petroleum product price stabilization as a result of adequate supply.
- Long-term tax benefits to the state, counties, municipalities, school and special districts through which the pipeline will pass.

Long-term effects on the environment should be minimal, involving the removal and regrowth control of large trees within the forested portions of the right-of-way. Other revegetation will be aided and encouraged.

9. THE IMPACT ON STATE GOVERNMENT OF RELEVANT FEDERAL CONTROLS

9. IMPACT ON STATE GOVERNMENT OF RELEVANT FEDERAL CONTROLS

A permit to discharge water during hydrostatic testing of the pipeline will be required from the U.S. Environmental Portection Agency. Permits from the U.S. Army Corps of Engineers to cross various rivers and streams will not be required as long as the procedures described in Appendix I are followed. Neither of these federal controls will affect state actions with regard to this project.

10. MULTI-STATE RESPONSIBILITIES

10. MULTI-STATE RESPONSIBILITIES

An impact upon the states of Iowa and Illinois will occur if this project proceeds. This impact will be similar to the impact upon Minnesota which is discussed in this document. Conversely, if the Minnesota portion of the project is not implemented, the Iowa and Illinois portions will also not be implemented, and the potential environmental impacts within those states will not occur. This responsibility must be evaluated in full light of the fact that Iowa and Illinois will invoke whatever measures they deem necessary to protect the environment within those states, as Minnesota is doing with the preparation of this document. There are also controls and regulations established by the U.S. Army Corps of Engineers and the U.S. Department of Transportation which will aid in protecting the environment along interstate projects such as this one.

11. COORDINATION WITH AGENCIES AND INDIVIDUALS

11. COORDINATION WITH AGENCIES AND INDIVIDUALS

Agencies and organizations contacted:

Agricultural Research Service (USDA)

Dakota County
Auditor, Assessor, Sheriff, Planning Office

Fillmore County
Auditor, Assessor, Sheriff, Planning and Zoning Office

Fire Information Research and Education
(FIRE) Center, University of Minnesota

Goodhue County
Auditor, Assessor, Sheriff, Planning and Zoning Office

Minnesota Bureau of Economic Development

Minnesota Tourist Information Center

Minnesota Center for Health Statistics

Minnesota Crop and Livestock Reporting Service

Minnesota Department of Agriculture

Minnesota Department of Natural Resources

Minnesota Department of Revenues

Minnesota Geological Survey

Minnesota Pollution Control Agency

Minnesota State Planning Agency (MLMIS)

Mower County Zoning and Planning Office

Olmstead County
Auditor, Assessor, Sheriff, Zoning and Planning Office

Soil Conservation Service (USDA)

Turkey Growers Association

University of Minnesota

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REFERENCES

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   Soil Conservation Service, Soil Survey of Fillmore County, 1958.

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6. Big Game in Minnesota. Technical Bulletin #9, Minnesota Department of Conservation, Division of Game and Fish, 1965.

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10. Personal communication with Jack Heather, Area Game Manager, Department of Natural Resources, Rochester, Minnesota, November 1976.

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15. The Uncommon Ones, Minnesota Department of Natural Resources, October, 1975.

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17. Westinghouse Environmental Systems, Colstrip Generation and Transmission Project. 1973

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APPENDICES

APPENDIX A

EMERGENCY PROCEDURES

EMERGENCY PROCEDURES

INFORMATION DERIVED FROM MINNESOTA PIPE LINE COMPANY OIL CONSERVATION ALERT PROCEDURE, PERTAINING TO THE HANDLING OF CRUDE OIL SPILLS ON THE CLEARBROOK TO PINE BEND LINE.

THE ALERT PROCEDURE WILL BECOME EFFECTIVE IMMEDIATELY UPON THE DISCOVERY BY ANYONE OF AN OIL SPILL FROM A COMPANY INSTALLATION OR THE PRESENCE OF OIL OF ANY KIND WHICH COULD POSSIBLY POLLUTE SHORELINES, RIVERS, STREAMS OR LAKES OR WHICH COULD DAMAGE, FOUL, OR ENDANGER ANY PROPERTY OR WILDLIFE.

Internal Alert Procedure - Mandatory

1. Any company employee observing or being advised of an oil spill of any quantity must immediately notify his supervisor.

2. The supervisor will immediately notify H.M. Weed (night telephone - 459-6932). If Mr. Weed is not available, immediately notify one of the alternates in the order listed below:

   Alternates are: J. H. Kleis (night phone - 612-437-4269)
   R. A. Salchow (night phone - 612-771-6627)

3. At the time of notification, H. M. Weed (or the alternate contacted) and the supervisor making notification will make an assessment of the seriousness of the spill. H. M. Weed (or his alternate) and the supervisor will take immediate steps to contain the spill. H. M. Weed, the supervisor or a designated alternate will notify the required outside agencies contained in this procedure. After notification of the agencies, the following must be notified.

W. C. Campbell	612-437-9596
W. B. Noaeill	218-776-3605
J. H. Kleis	612-437-4269
R. L. Williams	316-722-5119
M. L. Harris	612-632-4208
F. C. Anderegg	612-437-9544
Anderegg (day phone)	612-437-4141
R. A. Salchow	612-771-6627

4. H. M. Weed (or the alternate contacted) or the designated alternate must notify the following outside agencies.

Mandatory

A. Environmental Protection Agency (EPA 24-hour service 800-424-8802).

B. The Minnesota Pollution Control Agency must be notified concerning any loss of material.

Personnel	Office	24 Hours
Dick Kable	612-296-7235	612-296-7373
John Aho	612-296-7364	
Daryl Hugget	612-296-7236	

Any unauthorized discharge of oil, toxic pollutants, etc., above the NPDES permit must be reported to the Compliance and Enforcement Section, Minnesota Pollution Control Agency, at 296-7236.

C. Others

1) U.S. Coast Guard: Minneapolis - R.J. Hughes
612-725-2319
Dubuque 319-582-1965

Numerous Federal laws require a report to the Coast Guard whether the spill is into navigable water, into navigable water tributaries, or such that the refuse might wash into navigable water, or is a pipeline spill in excess of 50 barrels. However, these requirements are met by notification of the EPA office because the EPA is the designated Federal on-the-scene commander for this area. The Coast Guard at Minneapolis and Dubuque, however, need to know should the spill be related to river transportation or river facilities.

2) The Corps of Engineers could be called when a spill is close to a lock and dam. (The Corps of Engineers has boats, motors, booms and personnel available on short notice for surveys.) Not mandatory.

3) The appropriate water supply authority could be called if the spill is into a drinking water source. Not mandatory.

4) If supplies or equipment are needed, the Miss-Ota-Croix OCC Committee has a stockpile trailer for member use. Minnesota Pipe Line Company is a member of this committee.

Oil Spills Task Force

A standing company oil spills task force will be designated to insure coordination of all company oil spill cleanup efforts. Its members should be free to devote their time to the handling of any major spill. They will have prior clearance for the necessary travel and expenses they may incur when the task force is called upon for assistance.

1. The task force will include as regular members:

   H. M. Weed or alternate - Commander
   M. L. Harris - Field Operations Supervisor
   J. H. Kleis - Safety Coordinator
   R. A. Salchow - Field Operations Coordinator
   W. C. Campbell - Products Control Superintendent
   As Needed - Designated personnel for communications, procurement and logistics, or accounting and documentation, etc.

2. The Commander is responsible for:

   A. Determining the seriousness of the spill and notifying company personnel who should be involved.

   B. Immediate notification of the proper authorities, providing information as needed.

   C. The assignment of personnel and their duties.

   D. Arranging for authorization for expense accounts for cash advances for housing and living expenses and for contractor hiring.

   E. As desired by management, coordinating all information given to authorities who will be monitoring the clean up progress, and providing proper information to be given to the news media.

   F. Coordinating the efforts of the company legal and insurance representatives in handling on-the-spot problems or potential problems.

   G. Meeting visitors such as environmentalists, pollution equipment salesmen, investigators from state and federal agencies, volunteers, and casual visitors.

   H. Working closely with the field operations supervisor to provide input to the clean-up procedures and help as needed.

3. The Safety Coordinator will:

   A. Assist in assessing hazard potential of the spill or leak.

   B. Assist in directing activities to eliminate or control such hazards, if any.

   C. See that all applicable company and other safety standards are understood and followed in repair and clean-up work.

   D. Provide where possible, safety equipment.

   E. Act as a consultant in any other safety or fire prevention matters.

4. The Field Operations Supervisor will:

A. Provide an inventory of the company's personnel and equipment for dealing with spills.

B. Provide a periodic review of the company's readiness for dealing with oil spills.

C. Provide technical data in the event of a spill, and for the appendices of this manual.

D. In the event of a spill, and upon preliminary notification, decide what contractor services may be needed. Such contractor(s) may be notified by the field operations coordinator to be on a stand-by basis. (This alerts the contractor to check equipment and to review manpower lists.) Depending upon the nature of the preliminary report, some delivery and/or deployment of containing booms or other containment devices may be suggested immediately.

E. In the event of a spill, make a full investigation. (If of considerable size, the best review is by aircraft.) If possible, a representative of the contractor, the company public relations designee and the Commander should also make the inspection tour.

F. Make a preliminary assessment of the problem and provide a plan for containment and clean-up for presentation to the Commander and to management.

G. Actively supervise the approved clean-up program, observing the contractor work closely and providing technical advise and help as needed. Ask for additional help when required for logistics and supply transportation, communications, legal, documentation, safety, accounting, a supply of cash or credit or contact and follow-up with contractors.

H. Communicate with management through the Commander providing information as needed for public relations, government liasons, the legal advisor and to document and accounting personnel.

I. Maintain good communication with the appropriate state and federal representatives so that they can express their assessments and suggestions and so we can work out mutually agreeable solutions to problems.

J. Coordinate clean-up materials flow and disposition of reclaimed products or waste materials.

5. The Field Operations Coordinator will:

   A. Be the clean-up office manager, communication as needed with contractors and with sources of supply.

   B. Keep a communication and operations log, records of purchases, records of contractor personnel and equipment time, etc.

   C. Be the source of information regarding clean-up progress for public relations, the government coordinator, for information needed by management on day-to-day costs, manpower use, etc.

6. The Products Control Superintendent will:

   A. Standby to advise regarding the disposition of products, the capabilities of marine facilities, and to provide Products Control personnel as needed.

Information to be Transmitted Internally or to Authorized Agencies

1. Time spill occurred or was first observed.

2. Where spill occurred and present location of movement.

3. Type of oil spilled.

4. Estimate of amount spilled or rate of release if continuing.

5. Environmental conditions - such as wind direction and speed, wave action, and current.

6. If from barges or vessels, name of craft, registry, owner or consignee, deadweight tonnage and draft.

7. Description of area likely to be affected such as river banks, beaches, properties, wildlife areas.

8. Cause of spill, if determined.

9. Action being taken to combat spill, if any.

10. Agencies or persons already notified.

Information to News Media

Statements or information should be given to news media only through the designated company official. All outside requests for information should be referred to him, or to the office where information is being reported.

Discussion of Handling Spills

1. Good equipment (see lists at the end of this section), thorough training and alert, informed and responsible personnel are a good recipe for limiting spills. With these, plus ingenuity, spills can be limited to an absolute minimum. This means following the API recommendations for construction and operation of tank farms, terminals, barge loading, etc.

2. Oils rarely are a serious fire hazard. (Even crude oil, after being on the water a short period is difficult to ignite.) Oil slicks move with wind and water current; oil moves across water at 2-4% of the wind velocity. Estimated volumes of oil are as follows in relation to appearance:

Slick Appearance	Bbls./Sq. Mile
Barely Discernable	25
Silvery Sheen	50
Faint Colors	100
Bright Band of Colors	200
Dull Brown	600
Dark Brown	1,300

3. How to Deal with Spills

   A. Limit the Spill. Train personnel; plan for emergencies.

   B. Contain the Spill.

      1) Petroleum spills on land can be contained by building dikes and diverting the spill into collection areas and diverting the spill with an earth dike into the ditch. Spills on paved surfaces can be contained with sand, sorbents, earth barriers, sandbags, and/or diverted into sumps dug into the earth (preferably lined with an impervious coating or sheeting). Sewer manholes, often leading to water, can be closed with plastic sheeting and dirt or sandbags.

      2) In shallow water such as small streams or creeks, use deflection booms or underflow dams.

      3) In larger bodies of water, usually contain the spill with booms; but take advantage of wind and currents for best placement of the booms. If there is a current, put the boom at such an angle to the shore that oil does not wash underneath and so that the oil will collect at the short end of the boom.

   C. Pick Up the Spill. Use vacuum trucks, pumps or absorbents.

Remote Station Alert Procedure

In the event of a spill at any remote station, the first move is to shutdown the station and isolate it from the pipeline as soon as possible. The line should then be shutdown and not started up again until a supervisor at the scene directs someone to do so.

All stations have dikes or low areas on Minnesota Pipe Line Company's property to contain a considerable spill. The major problem here seems to be the possibility of a fire. The operator should make sure all units are off, all valves closed and then remove power from the station to reduce the possibility of a fire.

Normal methods of ground clean-up and disposal are to be used here. Unless the spill is of major proportion, it should be contained on Minnesota Pipe Line Company's property. If of major proportions, dams for spill containment should be erected in the path of the flow.

Recovery by means of pads, hay, pumps, etc., as in Discussion of Handling Spills. Disposal in a manner approved by investigating agency.

Pipeline Alert Procedure (To be modified to apply to specifics of proposed pipeline.)

In the event it is necessary to make an emergency shutdown, first determine the nature of the emergency and proceed accordingly.

If a break is suspected, start shutting down at Clearbrook and proceed to the station upstream of the suspected leak. Then start at Cottage Grove and work back toward the suspected break, trying to keep the station immediately below the suspected break on as long as possible to reduce line drain up. Remotely operated valves should then be closed on both sides of the suspected break. Call the Chief Operator and the Superintendent as soon as possible.

On suspected unlocated spills during the daylight hours, call Air Patrol for assistance. Numbers are listed in Appendix A.

Spill containment and clean-up procedures along the pipe line could be of such a diversified nature that explicit instructions here would be self-defeating. Follow recommended API procedures and methods you have seen work under similar conditions.

Disposal of contaminated soils and materials to be in accordance with investigating agency's recommendation. Try to get a burning permit and burn unrecoverable oil if possible.

In the event of an unintential fire or injuries, use phone number provided on your local O.S.H.A. Emergency Numbers list for immediate assistance.

Cottage Grove Alert Procedures

All Cottage Grove storage and much of associated pumps and piping is within adjacent diked areas. Only a spill of large magnitude would have the possibility of reaching the nearest water, the Mississippi River. The greatest danger here is the possibility of fire and contamination of surface soils.

A spill not contained in diked areas would flow westward across Minnesota Pipe Line Company's property toward the river a mile away. Containment of a major spill could be accomplished with earth work on Minnesota Pipe Line Company's adjacent property or along the railroad track west of company property.

Pick up spill in pools with pumps and haul back to storage. Contaminated soil is to be removed and disposed in accordance with regulations set forth by investigating agency.

In the event of fire or injuries, use phone numbers provided on your O.S.H.A. Emergency Numbers List for immediate assistance.

KOCH REFINING COMPANY
EQUIPMENT LIST
(As of 10-6-75)

Barge Slip	10 bags of Cobs 4 packages Conwed Pads 500' Booms (In use, not available) Boat and motor
Hastings Terminal	8 packages Conwed Pads 6 bags of Cobs 200' fire hose booms Ropes, anchor, trailer 2 boats Gasoline engine skimmer
Refinery Storage (Minnesota Pipe Line Bldg.)	34 pads 65 cobs 300' boom Sand bags & miscellaneous gear
Minneapolis Terminal	210' asbestos boom with ropes and anchor 10 packages pads 10 cobs
St. Paul Terminal	60' boom
Safety	Small pumper truck
Refinery: Pick-up & Dumpster Trucks	Radios: cars, trucks, handsets
Junction City Storage (Havitz Barn)	35 packages pads 20 cobs 40' boom

OTHER EQUIPMENT, CONTRACTORS AND SERVICES

1.	Contracted Services	Earth Moving, Mobil Crane, Sewer Cleaning, Etc. Additional Supplies	J. H. Kleis 612-437-4269 R. A. Salchow 612-771-6627
2.	Corps of Engineers		
	Each Dam	2-16' skiff/10 H.P. motor 38' handy flat/ motor	H. C. Anderson 612-725-7511
	Fountain City, WI	600' Slick Bar 6"x6" 2 knot Truck and manpower	
3.	Members of O.C.C.C.	See O.C.C.C. Equipment, Appendix F (Attached)	
4.	Available for Purchase		
	Lake River Terminal	4x6 and 6x6 Booms	Call Chicago 312-433-1145 or 312-432-5351

Reference List of Contractors and Services - Must be contacted through J. H. KLEIS or R. A. SALCHOW.

1.	<u>Earth Moving</u>		
	Minnesota Limited	New Brighton	612-633-0700 or 612-588-8885 or 612-263-3143
	Blackie Wangerin	Minneapolis, MN	612-888-8710
	Jim Peters	Hastings, MN	612-437-4463
	Lloyd Knutson	Gully, MN	218-268-2574
	Mervin Prestebak	Thief River Falls, MN	218-964-3618
	R. J. Thompson	Clearbrook, MN	218-776-3296
2.	<u>Mobile Crane</u>		
	See J. H. Kelis or R. A. Salchow		
3.	<u>Vacuum Truck</u>		
	Schlomka	Newport, MN	612-459-3718
	Keller Construction	St. Paul, MN	612-644-4313
	Roto Rooter	Minneapolis, MN	612-544-9551

4. Third Party Clean-Up Services

Viking Service	Rosemount, MN	612-423-2317
Wangerin, Inc.	Bloomington, MN	612-888-8710
Minnesota Limited	New Brighton, MN	612-633-0700 or 612-588-8885 or 612-263-3143

5. Barges, Tow Boats, Work Boarts, Manpower (To install floating booms, river communications, etc.)

Twin City Barge & Towing	St. Paul, MN	612-735-5440

6. Celulose Pads

J. A. Black		612-834-8579 or 612-869-5645

7. 3M Absorbent

Warehouse (Denise)		612-733-5963
24 hour call		612-733-1110

Contact J. H. Kleis or R. A. Salchow

8. Maintenance for Pipelines

Minnesota Limited	New Brighton, MN	612-633-0770 or 612-544-9551 or 612-263-3143

9. Pipeline Air Patrol

Airport (Hanger #4)	Fleming Field	612-451-3445
Fran Treat	(Residence)	612-698-7238
Mike Treat	(Residence)	612-698-5938

10. Helicopter Charter

A. Imperial	Fleming Field	612-455-2929
Dale Dobesh		612-447-4317
Bob Rishovd		612-432-5938

Has: 2 - Two passenger Hillers at $120/hr.
1 - Four passenger Ranger at $199/hr.
3 - larger construction type

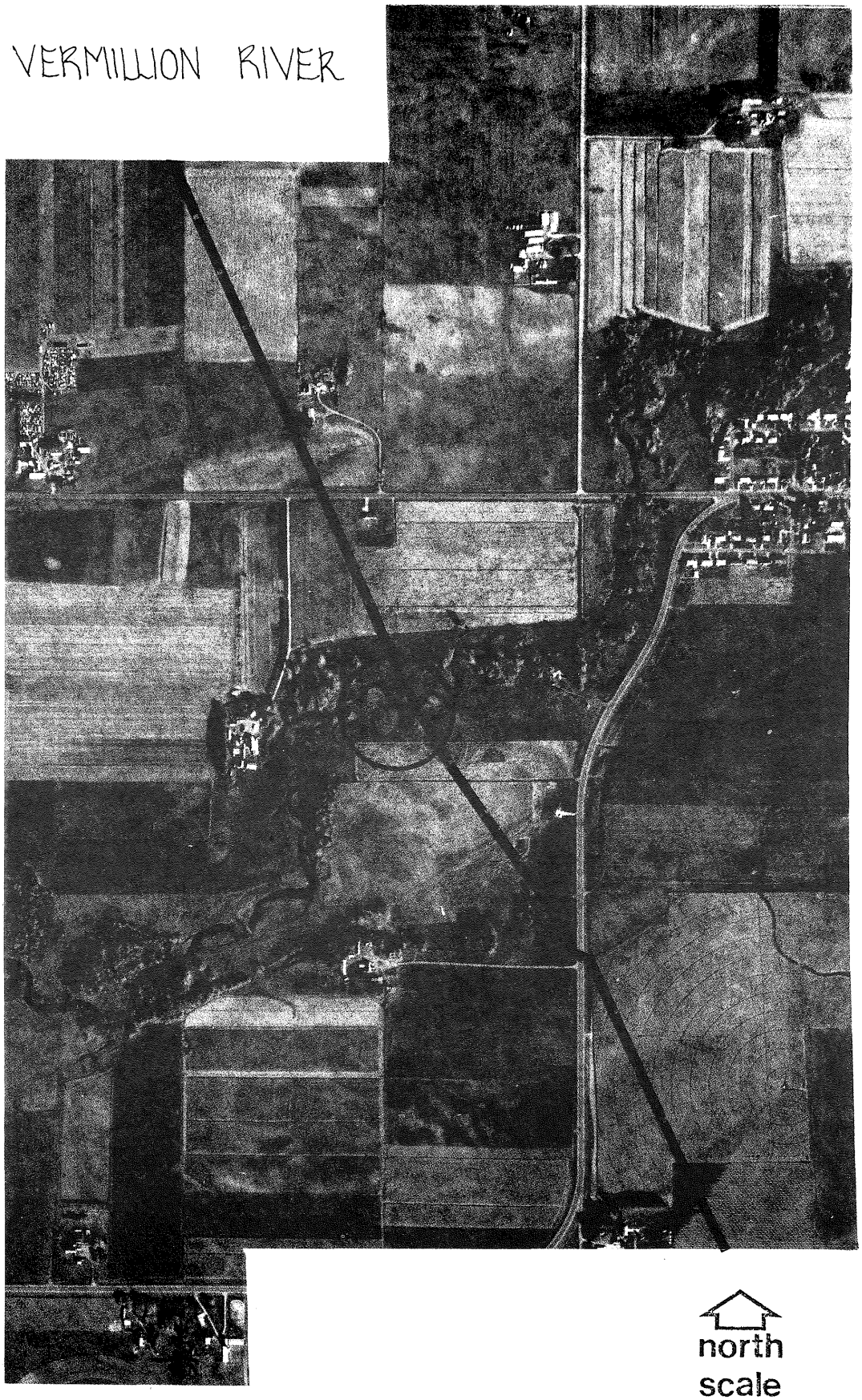
B. F.T.C.	Flying Cloud	941-4268
Chuck Gross		929-8359

Has: 1 - Two passenger Bell 47

APPENDIX B

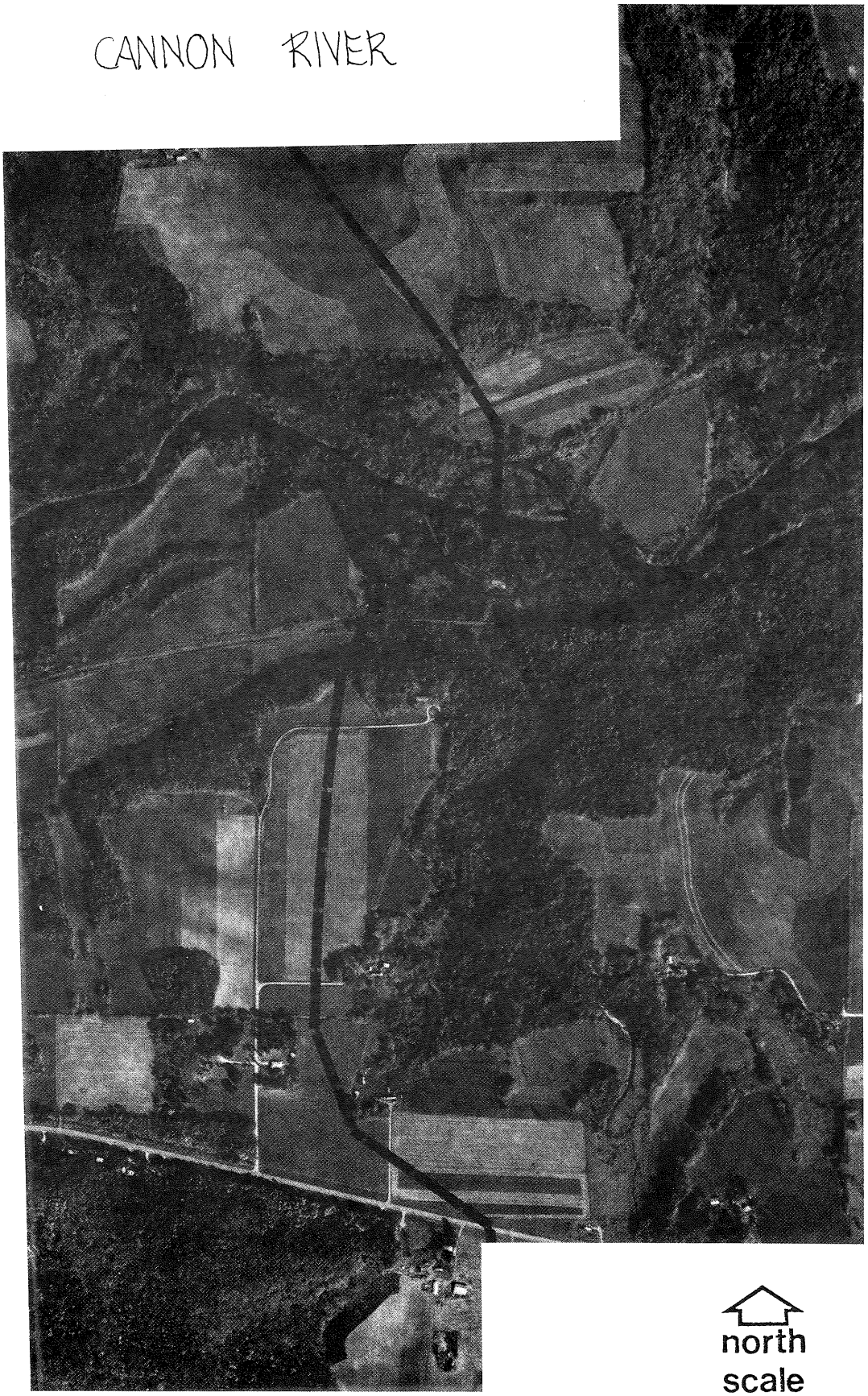
AIR PHOTOS OF STREAM CROSSINGS

VERMILLION RIVER



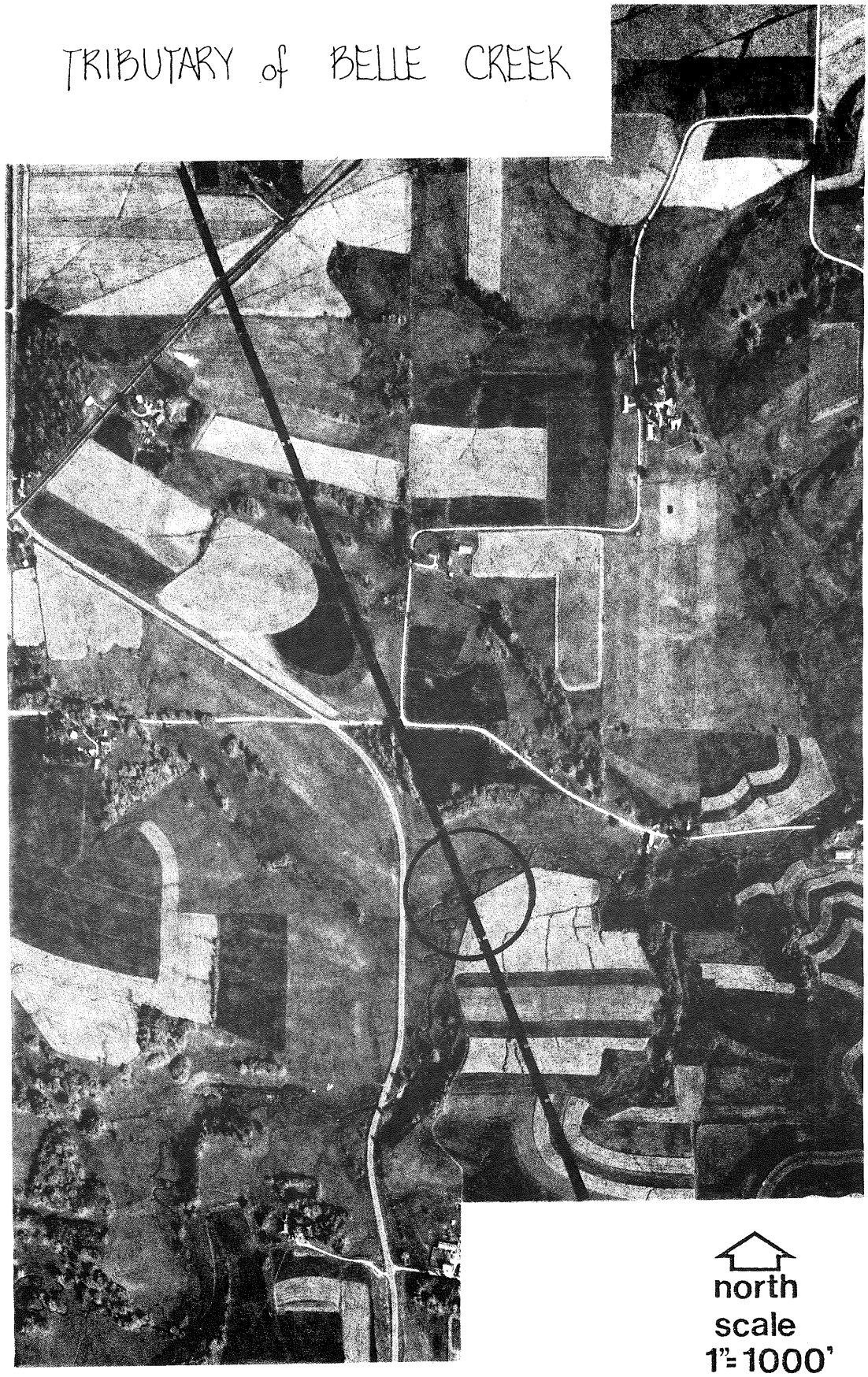
north
scale
1"= 1000'

CANNON RIVER



north
scale
1"= 1000'

TRIBUTARY of BELLE CREEK

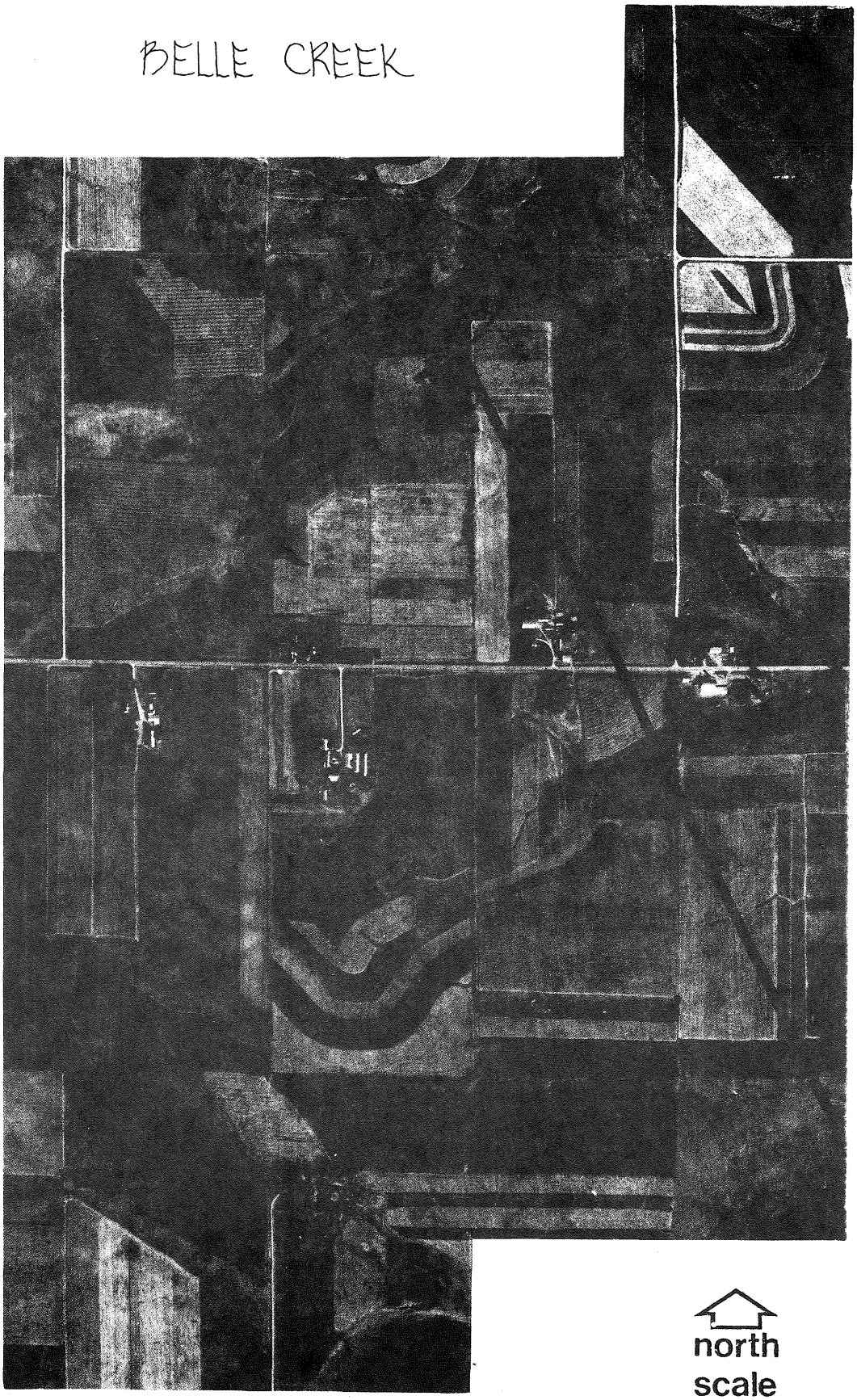


north

scale

1"= 1000'

BELLE CREEK



north

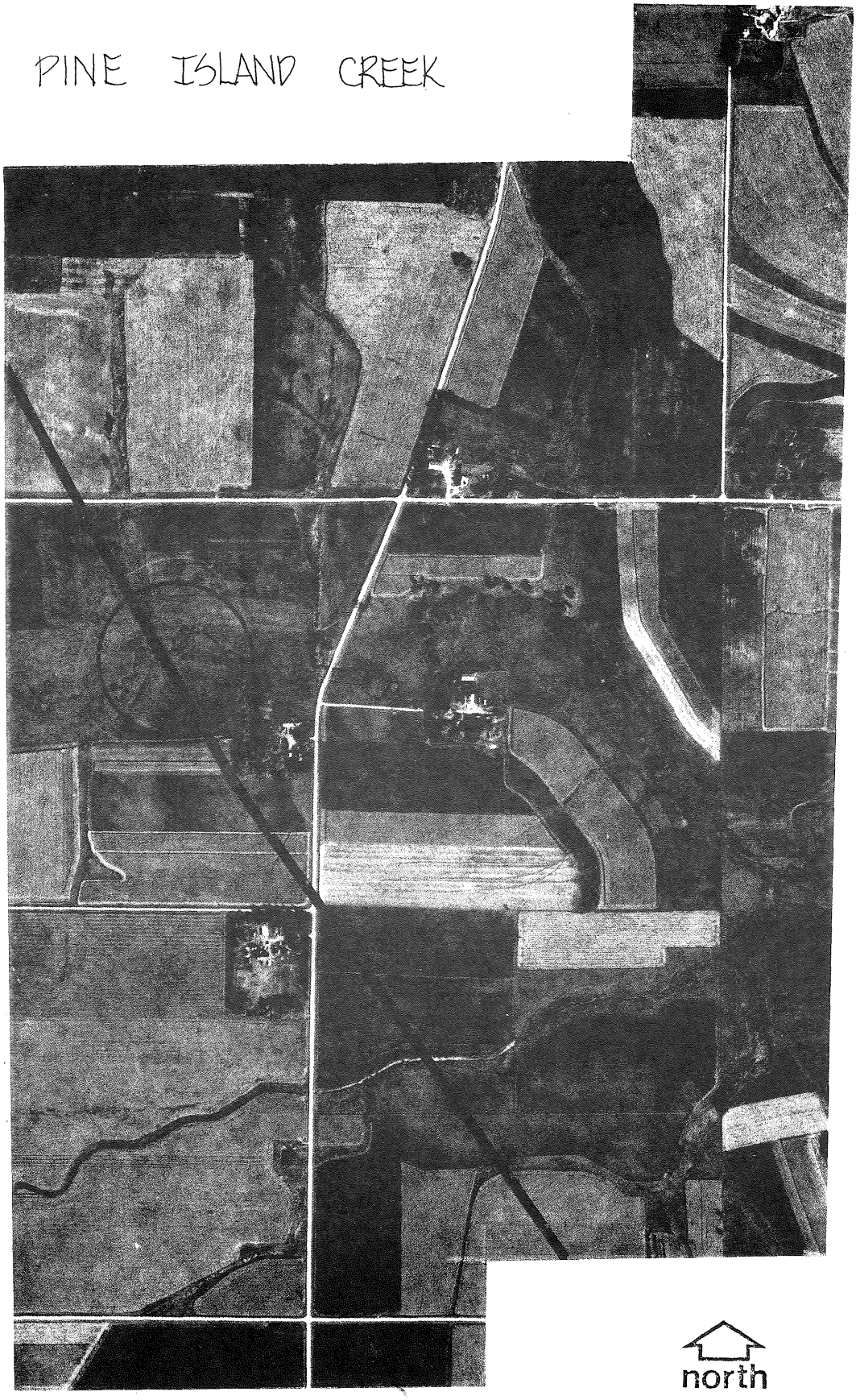
scale

1"= 1000'

NORTH FORK of the ZUMBRO RIVER

north
scale
1"= 1000'

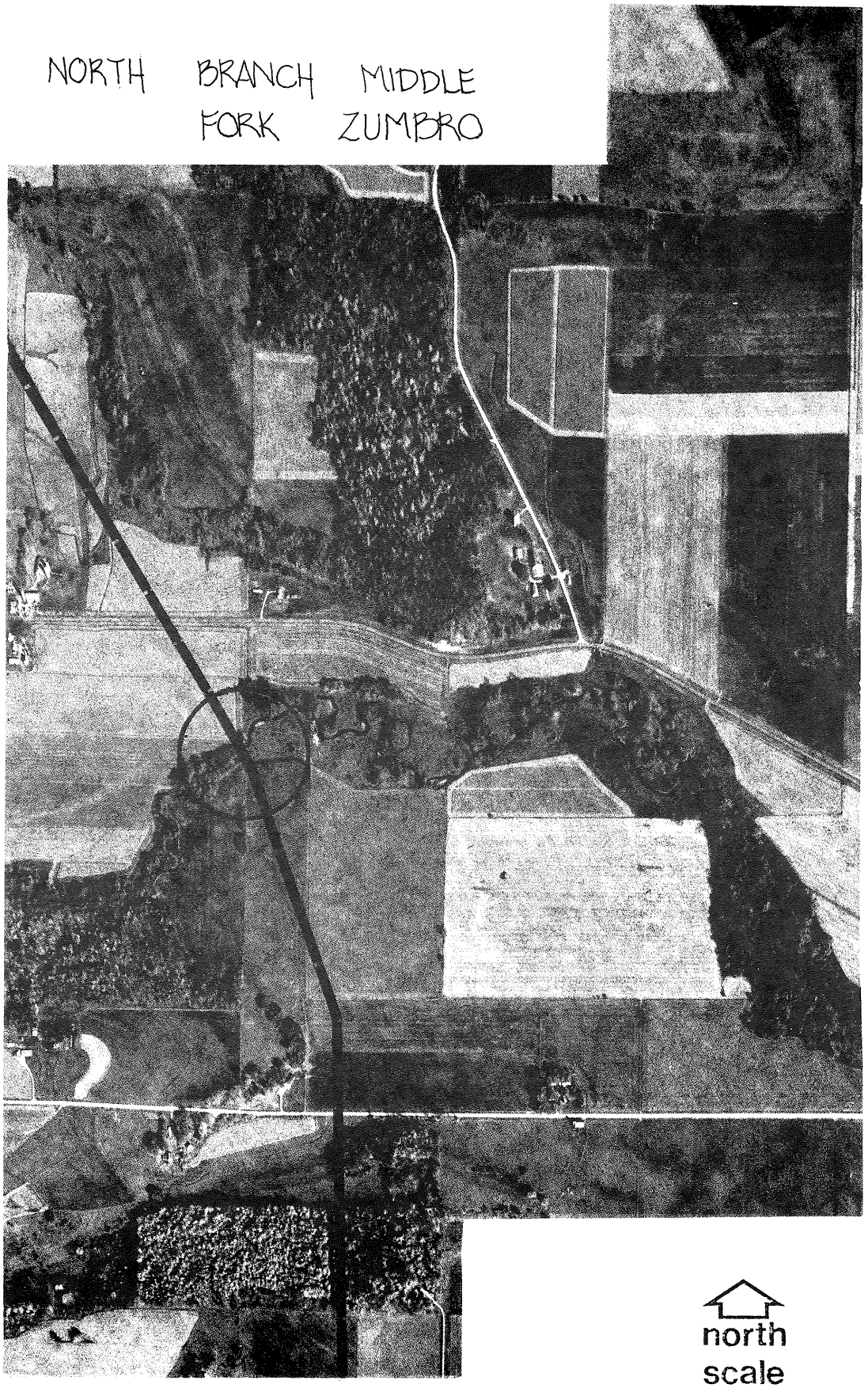
PINE ISLAND CREEK



north

scale
1"= 1000'

NORTH BRANCH MIDDLE FORK ZUMBRO



north
scale
1"= 1000'

MIDDLE FORK ZUMBRO

north

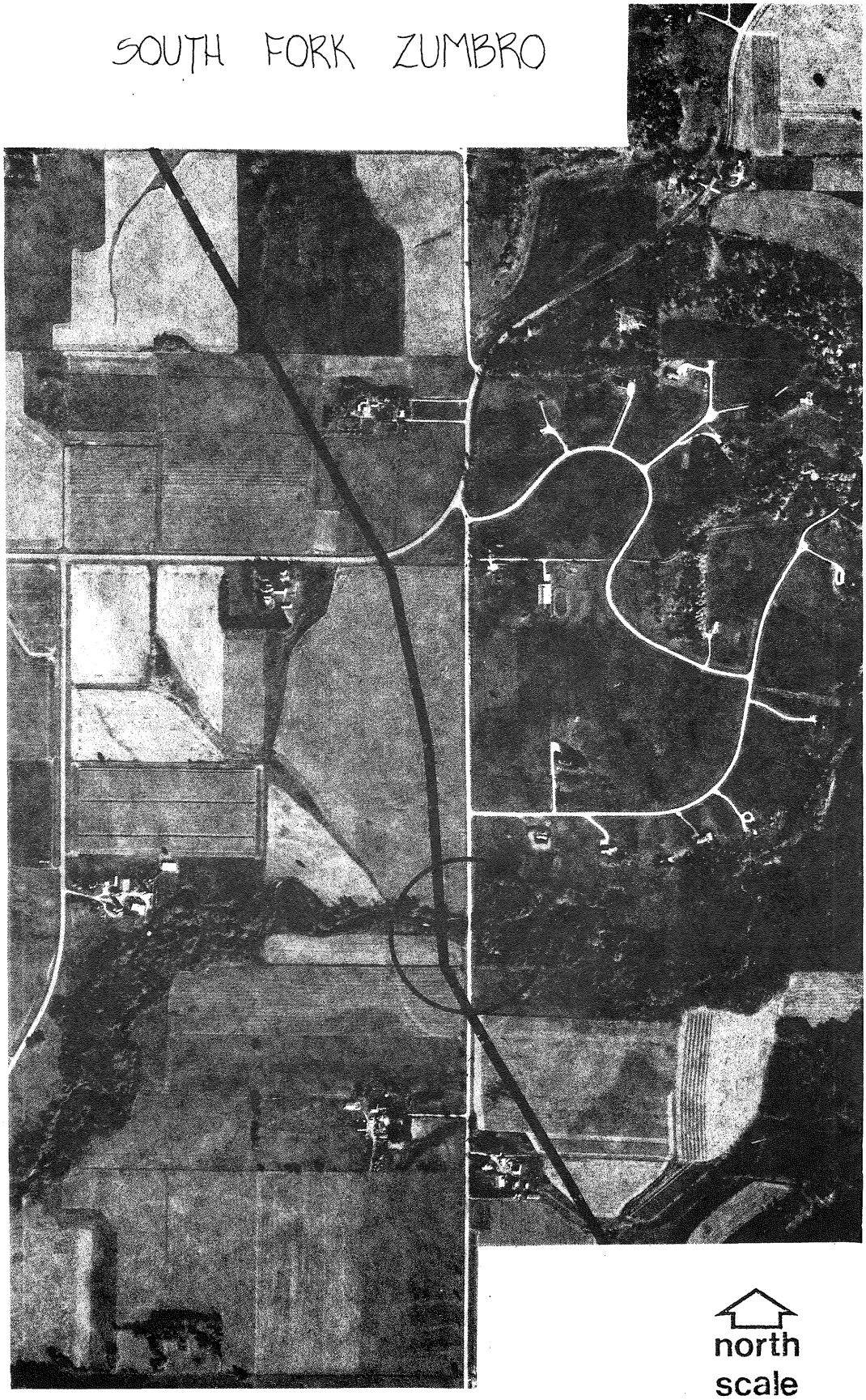
scale
1"= 1000'

SOUTH BRANCH MIDDLE FORK ZUMBRO

north

scale
1"= 1000'

SOUTH FORK ZUMBRO



north

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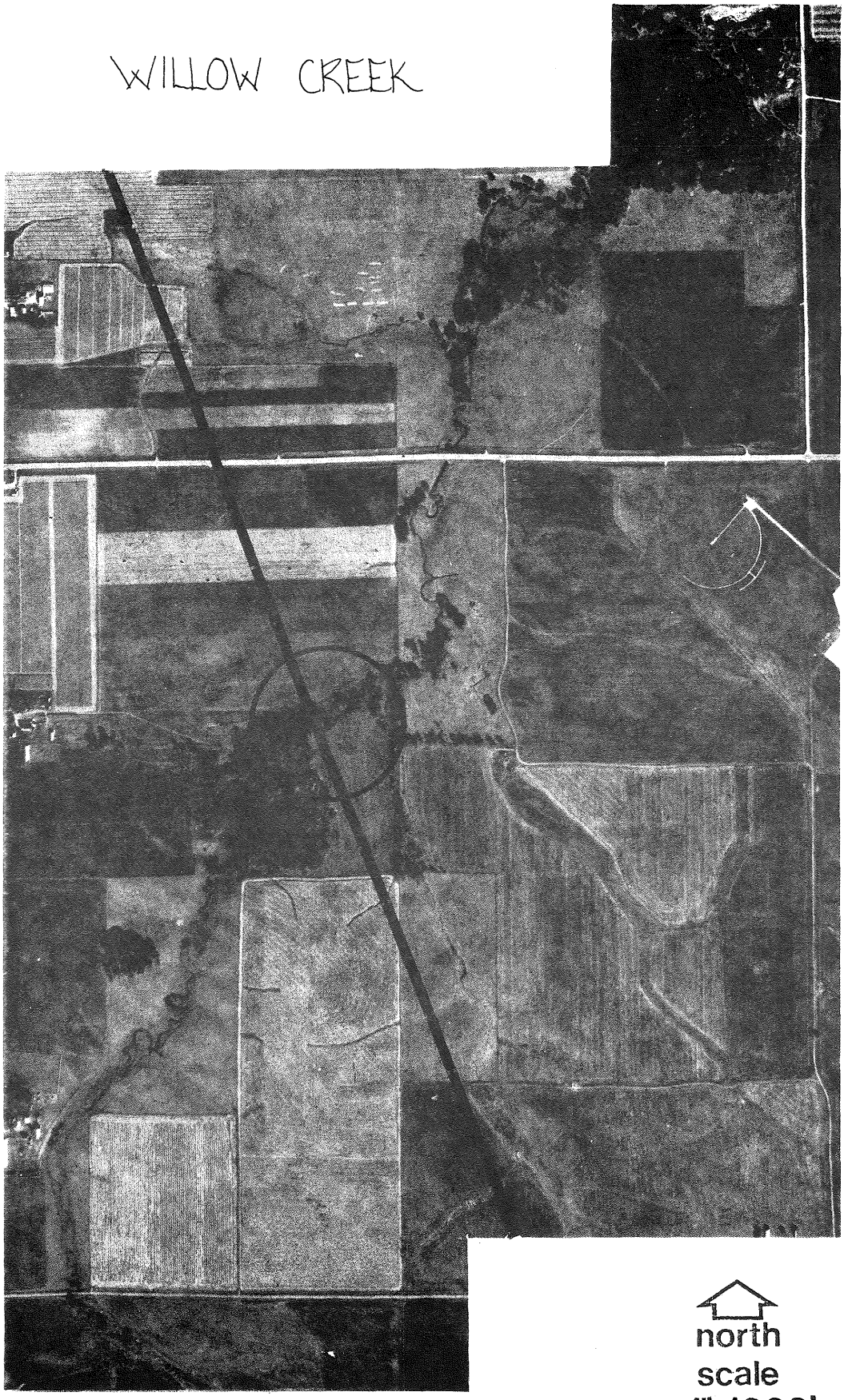
WILLOW CREEK

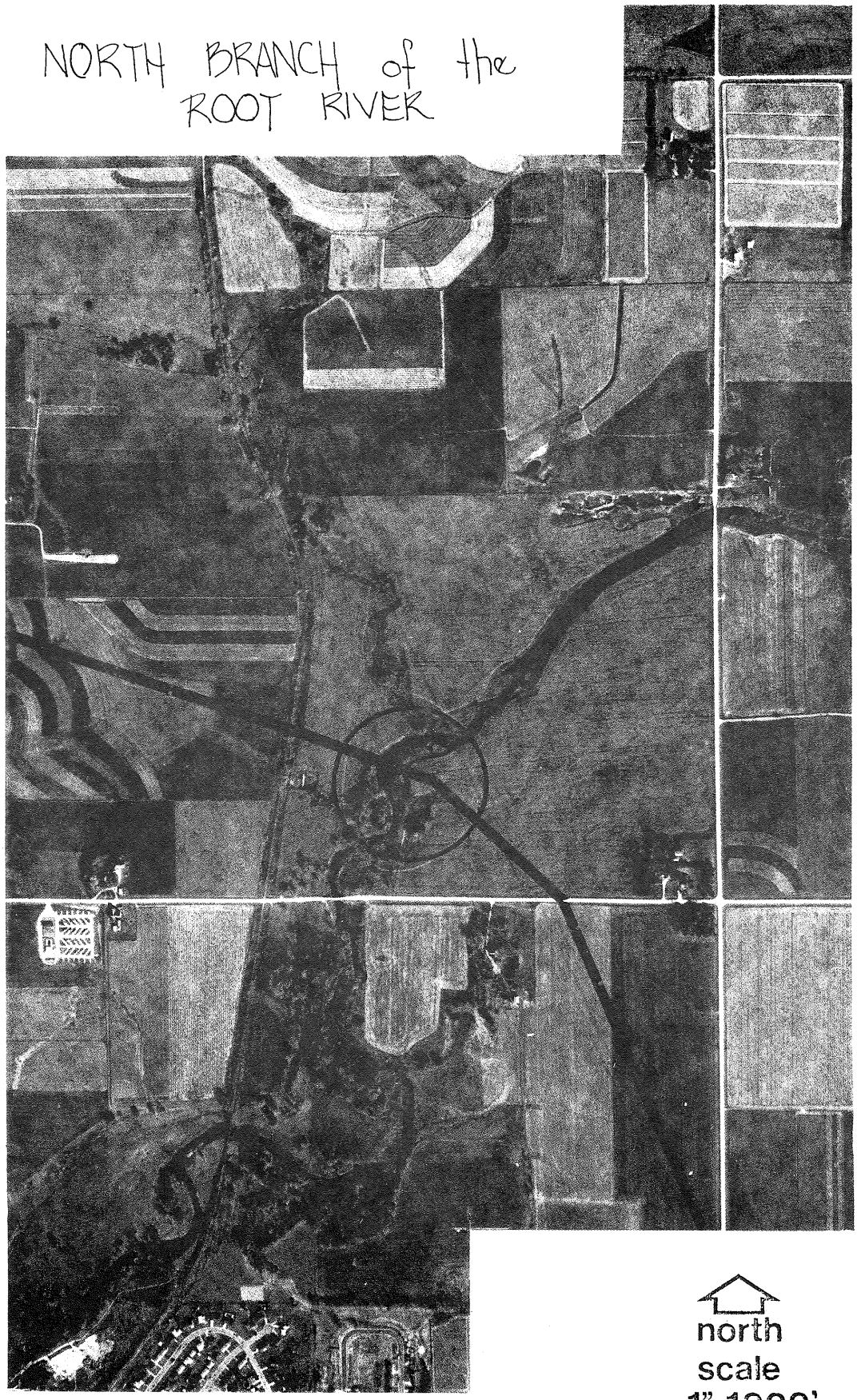


north

scale

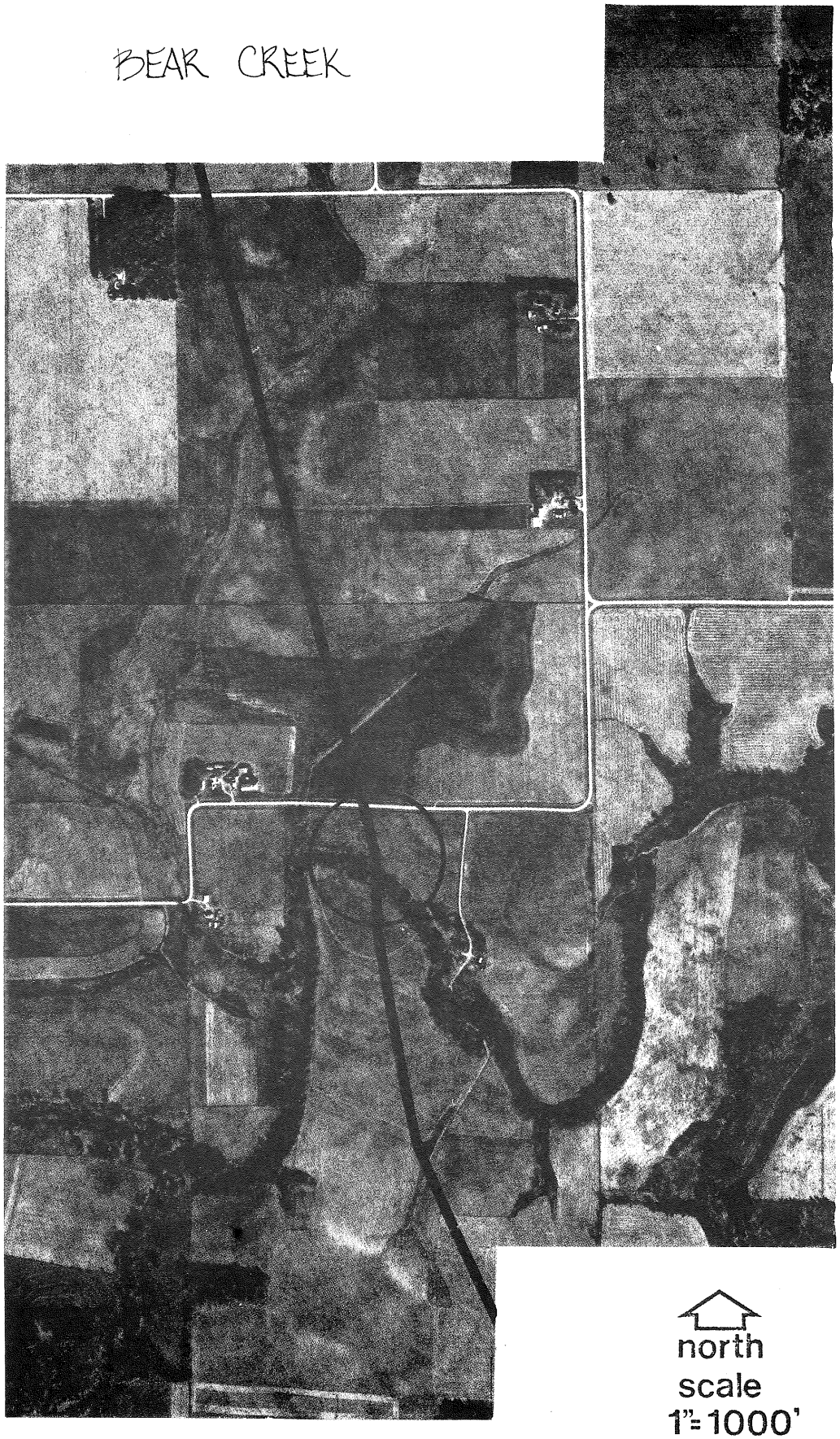
1"= 1000'

NORTH BRANCH of the ROOT RIVER



north
scale
1"= 1000'

BEAR CREEK



north

scale
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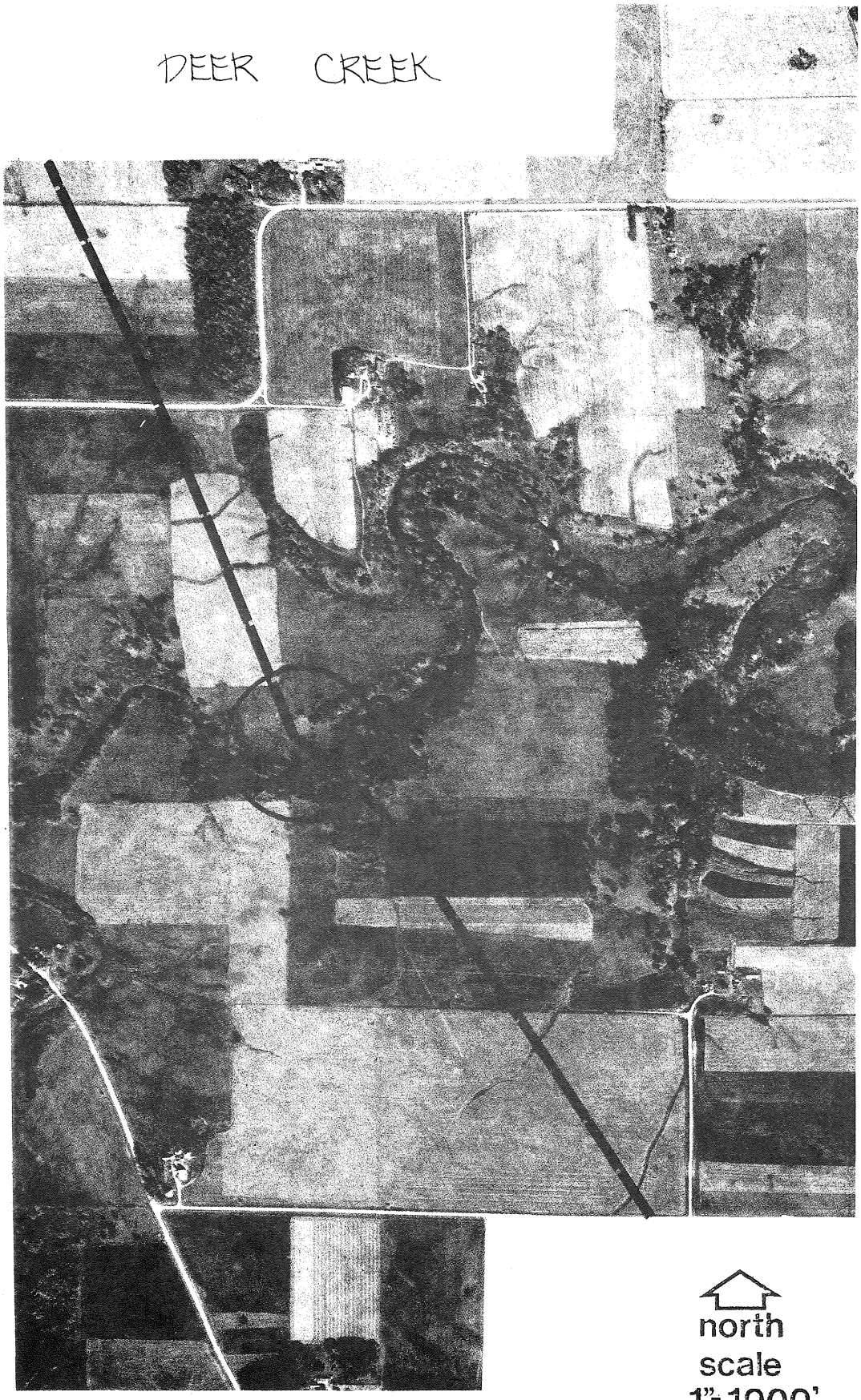
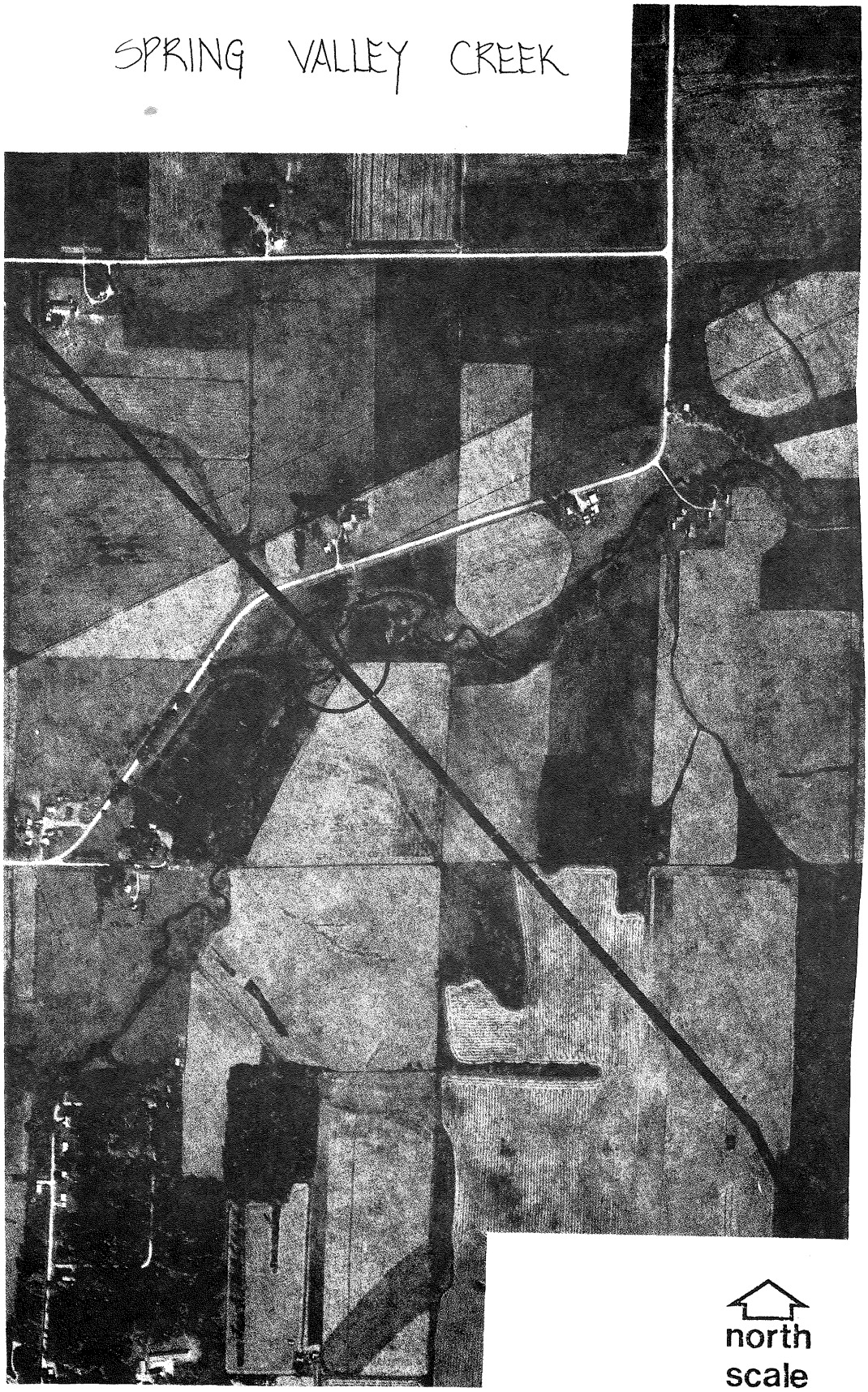
DEER CREEK



north

scale
1"= 1000'

SPRING VALLEY CREEK

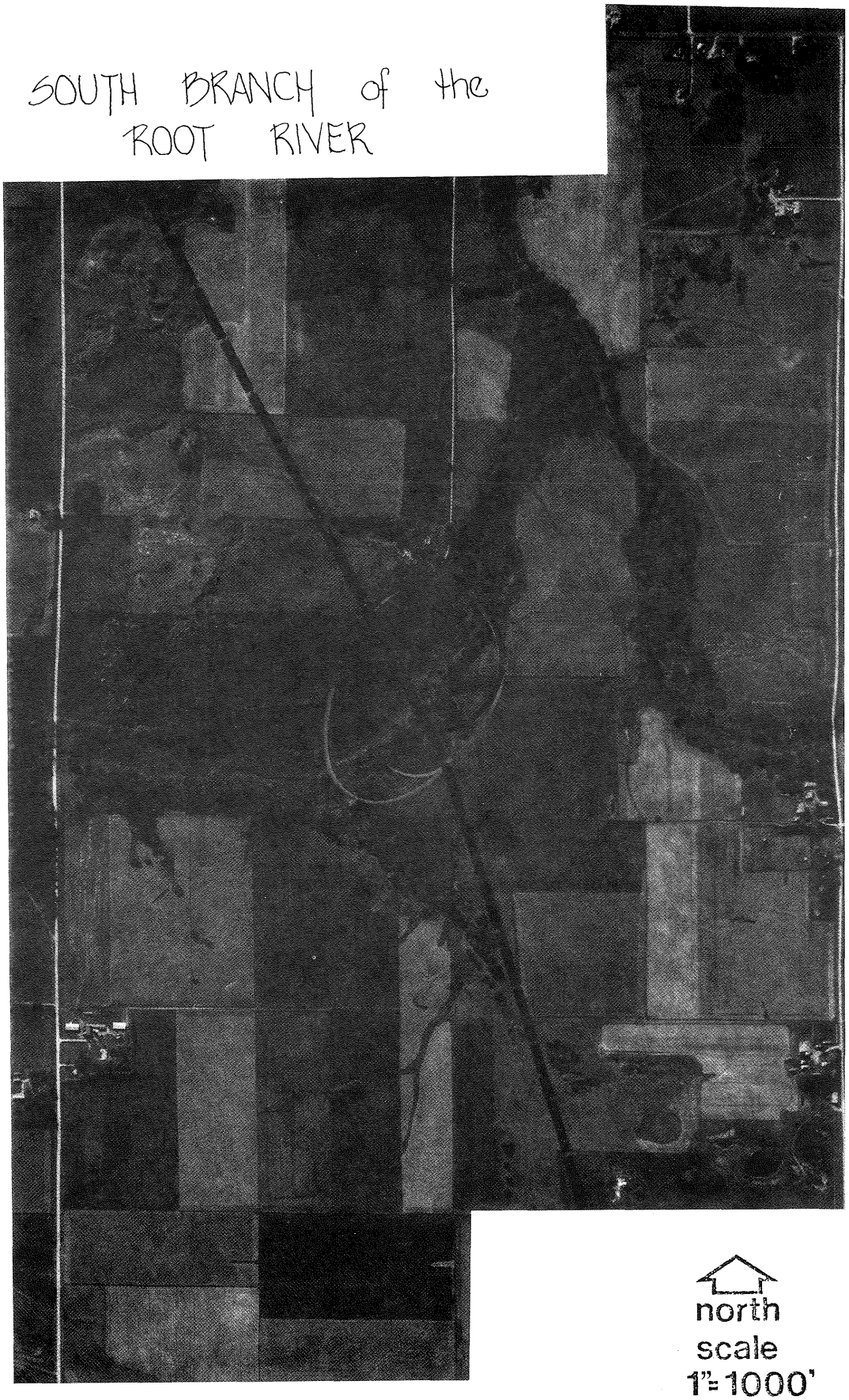


north

scale

1"= 1000'

SOUTH BRANCH of the
ROOT RIVER



north
scale
1"=1000'

APPENDIX C

SOIL DATA

ARENZVILLE SERIES

LRA(S): 104, 105, 108, 115
LRA, 1-74
TYPIC UDIFLUVENTS, COARSE-SILTY, MIXED, NONACID, MESIC

THE ARENZVILLE SERIES CONSISTS OF WELL DRAINED AND MODERATELY WELL DRAINED SOILS FORMED IN SILTY ALLUVIUM IN FLOOD PLAINS. TYPICALLY, THESE SOILS HAVE A DARK GRAYISH BROWN SILT LOAM SURFACE LAYER 10 INCHES THICK AND BROWN, DARK GRAYISH BROWN AND VERY DARK GRAYISH-BROWN, SILT LOAM STRATIFIED WITH LENSES OF FINE AND VERY FINE SAND UNDERLYING MATERIAL WITH A BURIED SURFACE LAYER OF BLACK SILT LOAM AT A DEPTH OF 25 TO 40 INCHES. SLOPES RANGE FROM 0 TO 3 PERCENT. USED MOSTLY FOR PASTURE AND WOODLAND.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-25	SIL	ML, CL-ML	A-4	0	100	100	95-100	80-90	25-35	5-10
25-40	SIL, SICL	ML, CL	A-4, A-6, A-7	0	100	100	90-100	70-95	35-45	10-15
40-60	SR-SIL-S	CL, CL-ML	A-4	0	80-100	80-100	80-95	50-85	20-30	5-10

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CONCRETE	EROSION FACTORS K	T	WIND EROD. GROUP
0-25	0.6-2.0	0.20-0.24	5.6-7.8	-	LOW	MODERATE	MODERATE	-	-	5
25-40	0.6-2.0	0.18-0.22	5.6-7.8	-	MODERATE	MODERATE	MODERATE	-		
40-60	0.6-2.0	0.12-0.16	5.6-7.8	-	LOW	MODERATE	MODERATE	-		

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
FREQUENT	BRIEF	NOV-JUN	3.0-6.0	APPARENT	NOV-JUN	-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-FLOODS
SEWAGE LAGOON AREAS	SEVERE-WETNESS, FLOODS
SANITARY LANDFILL (TRENCH)	SEVERE-FLOODS
SANITARY LANDFILL (AREA)	SEVERE-FLOODS
DAILY COVER FOR LANDFILL	GOOD

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-FLOODS
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODS
DWELLINGS WITH BASEMENTS	SEVERE-FLOODS, WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODS
LOCAL ROADS AND STREETS	SEVERE-FLOODS, FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	GOOD

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	PIPING, LOW STRENGTH
EXCAVATED PONDS AQUIFER FED	DEEP TO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	FLOODS
TERRACES AND DIVERSIONS	POOR OUTLETS
GRASSED WATERWAYS	FAVORABLE

REGIONAL INTERPRETATIONS

MLRA(S): 95, 104, 108
JDH, 4-75
TYPIC HAPLAQUOLLS, FINE-LOAMY, MIXED, MESIC

CLYDE SERIES

THE CLYDE SERIES CONSISTS OF POORLY DRAINED SOILS IN UPLAND DRAINAGEWAYS. THEY FORMED IN LOCAL ALLUVIUM 2 1/2 FEET THICK AND THE UNDERLYING GLACIAL TILL. THE 23-INCH SURFACE LAYER IS BLACK AND DARK GRAY SILTY CLAY LOAM. THE SUBSOIL TO 41 INCHES IS MOTTLED GRAYISH-BROWN, OLIVE-GRAY AND YELLOWISH-BROWN FRIABLE SILTY CLAY LOAM AND FROM 41 TO 54 INCHES IS MOTTLED GRAY AND YELLOWISH BROWN FIRM LOAM. THE SUBSTRATUM IS MOTTLED GRAY AND YELLOWISH-BROWN FIRM LOAM THAT IS CALCAREOUS BELOW 62 INCHES. SLOPES RANGE FROM 0 TO 3%. DRAINED AREAS ARE CULTIVATED; UNDRAINED AREAS ARE IN PASTURE OR IDLE.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-23	SICL, CL	OL, MH, CL	A-7	0	100	100	80-90	55-75	45-60	15-25
23-41	SICL, CL	CL	A-6, A-7	0	95-100	90-95	75-90	50-75	30-50	10-20
41-44	SL	SM, SM-SC	A-2	0-5	80-95	75-90	50-80	15-35	15-20	NP-5
44-66	L	CL, SC	A-6	0-5	90-95	85-90	75-90	45-65	25-35	10-20

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-23	0.6-2.0	0.21-0.23	6.6-7.3	-	MODERATE	HIGH	LOW	-	-	7
23-41	0.6-2.0	0.18-0.20	6.6-7.3	-	MODERATE	HIGH	LOW	-		
41-44	2.0-6.0	0.11-0.13	6.6-7.3	-	LOW	HIGH	LOW	-		
44-66	0.2-0.6	0.17-0.19	6.6-8.4	-	MODERATE	HIGH	LOW	-		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
FREQUENT	VERY BRIEF	MAR-NOV	1.0-3.0	APPARENT	OCT-JUN	-		>60		-		B/D	HIGH

SANITARY FACILITIES (A)

SEPTIC TANK ABSORPTION FIELDS	SEVERE-FLOODS, WETNESS
SEWAGE LAGOON AREAS	SEVERE-EXCESS HUMUS, WETNESS
SANITARY LANDFILL (TRENCH)	SEVERE-FLOODS, WETNESS
SANITARY LANDFILL (AREA)	SEVERE-FLOODS, WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS

COMMUNITY DEVELOPMENT (A)

SHALLOW EXCAVATIONS	SEVERE-FLOODS, WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODS, WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-FLOODS, WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODS, WETNESS
LOCAL ROADS AND STREETS	SEVERE-EXCESS HUMUS, FLOODS, FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-EXCESS HUMUS, WETNESS, FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL 1	POOR-WETNESS

WATER MANAGEMENT (A)

POND RESERVOIR AREA 2	FAVORABLE
EMBANKMENTS DIKES AND LEVEES 2	LOW STRENGTH, COMPRESSIBLE, HARD TO PACK
EXCAVATED PONDS AQUIFER FED 2	FAVORABLE
DRAINAGE 3	FAVORABLE
IRRIGATION	WETNESS, FLOODS
TERRACES AND DIVERSIONS	NOT NEEDED
GRASSED WATERWAYS	WETNESS, LARGE STONES

REGIONAL INTERPRETATIONS

RECREATION (A)

CAMP AREAS	SEVERE-FLOODS,WETNESS	PLAYGROUNDS	SEVERE-FLOODS,WETNESS
PICNIC AREAS	SEVERE-FLOODS,WETNESS	PATHS AND TRAILS	SEVERE-FLOODS,WETNESS

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		KENTUCKY BLUEGRASS (AUM)					
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-3%	2W		102		39		82		4.0		6.6					

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	SILVER MAPLE	35	POPLAR		LAUREL WILLOW		AMERICAN SYCAMORE	
	GREEN ASH	35	HACKBERRY		NORTHERN WHITE-CEDAR		EASTERN REDCEDAR	
	WHITE SPRUCE		NORWAY SPRUCE	22				

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	POTENTIAL AS HABITAT FOR: WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	GOOD	GOOD	GOOD	FAIR	POOR	-	GOOD	GOOD	GOOD	FAIR	GOOD	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A FLOODING IS DUE TO LOCAL RUNOFF AND IS FOR SHORT DURATION.
1 THE UPPER 2 FEET IS HIGH IN ORGANIC MATTER AND SOURCE FOR TOPSOIL IS GOOD WHEN SOIL IS DRY.
2 SANDY STRATA COMMON AT DEPTHS OF 2 TO 4 FEET.
3 WETNESS IS DUE IN PART TO SEEPAGE FROM ADJOINING SLOPES.
4 LARGE STONES ARE COMMON ENOUGH TO AFFECT WATERWAY CONSTRUCTION BUT NOT OTHER USES.

MLRA(S): 102, 103, 104, 105, 106, 107, 108, 109, 113, 115 COLO SERIES
REV. JRW, 10-75
CUMULIC HAPLAQUOLLS, FINE-SILTY, MIXED, MESIC

THE COLO SERIES CONSISTS OF DEEP, POORLY DRAINED SOILS FORMED IN MODERATELY FINE TEXTURED ALLUVIUM ON BOTTOM LANDS. THE SURFACE LAYER IS BLACK SILTY CLAY LOAM 38 INCHES THICK. THE NEXT LAYER IS VERY DARK GRAY, FIRM SILTY CLAY LOAM 14 INCHES THICK. THE SUBSTRATUM IS VERY DARK GRAY AND DARK-GRAY, FIRM SILTY CLAY LOAM. SLOPES RANGE FROM 0 TO 5 PERCENT. MOST AREAS ARE CROPPED.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-12	SIL	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
0-12	SICL	CL, CH, ML, MH	A-7	0	100	100	90-100	90-100	40-60	15-30
12-38	SICL	CL, CH, ML, MH	A-7	0	100	100	90-100	90-100	40-55	15-30
38-60	SICL, CL	CL, CH, ML, MH	A-7	0	100	100	95-100	80-100	40-55	15-30

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CONCRETE	EROSION FACTORS K	T	WIND EROD. GROUP
0-12	0.6-2.0	0.22-0.24	6.6-8.4	-	MODERATE	HIGH	LOW	-	-	6
0-12	0.2-0.6	0.21-0.23	5.6-7.3	-	HIGH	HIGH	MODERATE	-	-	7
12-38	0.2-0.6	0.18-0.20	6.1-7.3	-	HIGH	HIGH	MODERATE	-		
38-60	0.2-0.6	0.18-0.20	6.1-7.3	-	HIGH	HIGH	MODERATE	-		

FLOODING FREQUENCY	FLOODING DURATION	HIGH WATER TABLE MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	CEMENTED PAN MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
COMMON	BRIEF	MAR-JUN	1.0-3.0	APPARENT	NOV-MAY	-		>60		-		B/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY, WETNESS, FLOODS
SEWAGE LAGOON AREAS	SEVERE-EXCESS HUMUS, WETNESS, FLOODS
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS, FLOODS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS, FLOODS
DAILY COVER FOR LANDFILL	POOR-WETNESS

SOURCE MATERIAL

ROADFILL	POOR-WETNESS, SHRINK-SWELL, LOW STRENGTH
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	POOR-WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	FAVORABLE
EMBANKMENTS DIKES AND LEVEES	COMPRESSIBLE, LOW STRENGTH, HARD TO PACK
EXCAVATED PONDS AQUIFER FED	SLOW REFILL
DRAINAGE	FLOODS, WETNESS
IRRIGATION	FLOODS, WETNESS
TERRACES AND DIVERSIONS	NOT NEEDED
GRASSED WATERWAYS	WETNESS

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-WETNESS, FLOODS
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODS, FROST ACTION, WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-FLOODS, FROST ACTION, WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODS, FROST ACTION, WETNESS
LOCAL ROADS AND STREETS	SEVERE-FLOODS, LOW STRENGTH, FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	SEVERE-FLOODS,WETNESS	PLAYGROUNDS	SEVERE-WETNESS,FLOODS
PICNIC AREAS	SEVERE-WETNESS,FLOODS	PATHS AND TRAILS	SEVERE-WETNESS

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		KENTUCKY BLUEGRASS (AUM)		GRASS-LEGUME HAY (TONS)		SMOOTH BROMEGRASS (AUM)			
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2% SICL	2W			104		40		78		4.2		4.2		5.5			
2-5% SICL	2W			102		39		76		4.2		4.0		5.3			
0-2% SIL,OVERWASH	2W			109		42		82		4.2		4.3		5.8			
0-2% SIL,CALC. OVERW.	2W			99		38		74		4.1		4.1		5.2			
CHANNELED	5W			-		-		-		3.0		-		-			

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS					POTENTIAL PRODUCTIVITY		TREES TO PLANT
		EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	IMPORTANT TREES	SITE INDX	
							NONE		

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	GREEN ASH	36	SILVER MAPLE	35	LAUREL WILLOW	30	AMERICAN SYCAMORE	35
	POPLAR	30	HACKBERRY	25	EASTERN REDCEDAR	18	WHITE SPRUCE	25
	NORWAY SPRUCE	22						

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS						POTENTIAL AS HABITAT FOR:					
	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-2%	GOOD	FAIR	GOOD	FAIR	POOR	-	GOOD	GOOD	FAIR	FAIR	GOOD	-
2-5%	GOOD	FAIR	GOOD	FAIR	POOR	-	FAIR	V. POOR	FAIR	FAIR	POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

MLRA(S): 103, 104, 105 DAKOTA SERIES

Rec JJM-ELB, ~~11-72~~ 5/24/76

TYPIC ARGIUDOLLS, FINE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, MESIC

THE DAKOTA SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN 20 TO 40 INCHES OF LOAMY SEDIMENTS OVER OUTWASH SANDS UNDER TALL GRASS PRAIRIE INTERMINGLED WITH OAK AND BRUSH ON OUTWASH PLAINS, VALLEY TRAINS AND STREAM TERRACES. TYPICALLY THEY HAVE BLACK AND VERY DARK-BROWN LOAM SURFACE LAYERS 14 INCHES THICK; DARK-BROWN LOAM AND SANDY CLAY LOAM UPPER SUBSOILS 21 INCHES THICK; DARK-BROWN LOAMY SAND LOWER SUBSOILS 8 INCHES THICK; AND YELLOWISH-BROWN SAND UNDERLYING MATERIAL. SLOPES RANGE FROM 0 TO 18 PERCENT. MOST AREAS ARE CULTIVATED.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-14	L	ML, CL-ML	A-4	0	95-100	95-100	80-95	50-65	25-40	5-10
0-14	SL	SM	A-4	0	95-100	90-100	75-90	35-50	-	NP
14-35	L, SCL	CL	A-4, A-6	0	95-100	90-100	80-95	50-70	30-40	8-15
35-43	LS	SM	A-2	0	95-100	85-100	50-80	10-30	-	NP
43-60	S	SP	A-1	0	95-100	80-100	30-50	2-5	-	NP

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND ERODE GROUP
0-14	2.0-6.0	0.20-0.22	5.6-6.5	-	LOW	LOW	MODERATE	.28	3	6
0-14	2.0-6.0	0.14-0.16	5.6-6.5	-	LOW	LOW	MODERATE	.24	3	3
14-35	2.0-6.0	0.17-0.19	5.1-6.0	-	LOW	LOW	MODERATE	.24		
35-43	6.0-20	0.08-0.10	5.1-6.0	-	LOW	LOW	LOW	.17		
43-60	6.0-20	0.02-0.04	5.1-7.8	-	LOW	LOW	LOW	.17		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS 1	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE
DAILY COVER FOR LANDFILL	0-8%: FAIR-THIN LAYER 8-15%: FAIR-THIN LAYER,SLOPE 15+%: POOR-SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: MODERATE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE,FROST ACTION 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	0-15%: GOOD 15-18%: FAIR-SLOPE
SAND	GOOD
GRAVEL	POOR-EXCESS FINES
TOPSOIL	0-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	PIPING,SEEPAGE
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	0-2%: DROUGHTY,ROOTING DEPTH,SEEPAGE 2+%: SLOPE,ERODES EASILY,DROUGHTY
TERRACES AND DIVERSIONS	0-2%: NOT NEEDED 2+%: ERODES EASILY,ROOTING DEPTH
GRASSED WATERWAYS	ERODES EASILY,DROUGHTY

REGIONAL INTERPRETATIONS

PASTURE AND HAYLAND	GROUP 1

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE	PATHS AND TRAILS	0-15%: SLIGHT 15+%: MODERATE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)					
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	2S	80		28		65		3.5		5.0					
2-6%	2E	75		26		60		3.5		5.0					
6-12%	3E	65		24		55		3.0		4.2					
6-12% ERODED	3E	60		22		50		2.8		4.0					
12-18%	4E	60		-		50		2.8		4.0					
12-18% ERODED	4E	55		-		45		2.5		3.7					

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
0-12%	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	63	NORTHERN RED OAK
							WHITE OAK	63	WHITE OAK
							EASTERN WHITE PINE	59	SILVER MAPLE
							AMERICAN BASSWOOD	63	
12-18%	3R	MODERATE	MODERATE	SLIGHT	SLIGHT	SLIGHT	EASTERN WHITE PINE	55	WHITE OAK
							NORTHERN RED OAK	57	NORTHERN RED OAK
							WHITE OAK	57	AMERICAN BASSWOOD
							BUR OAK	55	EASTERN WHITE PINE
							AMERICAN BASSWOOD	57	

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
0-12%	EASTERN REDCEDAR	18	NORTHERN WHITE-CEDAR	16	WHITE SPRUCE	22	RED PINE	24
	GREEN ASH	28	HACKBERRY	25	BUR OAK	25	SIBERIAN CRABAPPLE	15
	GRAY DOGWOOD	12	TATARIAN HONEYSUCKLE	11	LILAC	12	EASTERN COTTONWOOD	50

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-6%	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	
6-12%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	
12-18%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

1 HAZARD OF POLLUTION

A MINNESOTA WINDBREAK GROUPS: 0-12%-GROUP 5; 12-18%-GROUP 7 (TOO STEEP FOR WINDBREAKS)

MLRA(S): 105, 108, 115
KEL, 1-75
TYPIC HAPLUDALFS, FINE, MIXED, MESIC

DERINDA SERIES

THE DERINDA SERIES CONSISTS OF MODERATELY WELL AND WELL DRAINED SOILS FORMED IN LOESS AND SOFT SHALE ON UPLANDS. THE SURFACE LAYER IS DARK GRAYISH-BROWN SILT LOAM ABOUT 7 INCHES THICK. THE SUBSOIL IS DARK YELLOWISH-BROWN AND BROWN SILTY CLAY LOAM IN UPPER 11 INCHES, MIXED GRAYISH-BROWN AND YELLOWISH-BROWN SILTY CLAY IN NEXT 5 INCHES AND MIXED BROWNISH-YELLOW, YELLOW AND STRONG BROWN LOAM IN LOWER 2 INCHES. THE SUBSTRATUM IS CLAY SHALE. SLOPES RANGE FROM 4 TO 12 PERCENT. MOSTLY USED FOR SMALL GRAIN, PASTURE, AND HAY CROPS.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USCA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-7	SIL	CL-ML, ML, CL	A-4, A-6	0	100	95-100	95-100	90-100	21-40	5-14
0-7	SICL	CL	A-6, A-7	0	100	95-100	95-100	90-100	35-50	16-25
7-25	SICL, SIC, C	CL, CH	A-7	0	80-100	75-100	70-100	65-100	40-60	15-30
25-60	WB	CL, CH	A-7, A-6	0	90-100	85-100	80-90	65-90	30-55	15-30

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-7	0.2-0.6	0.22-0.24	5.6-6.5	-	LOW	MODERATE	MODERATE	.43	3	6
0-7	0.06-0.2	0.11-0.20	5.6-6.5	-	MODERATE	MODERATE	MODERATE	.43	2	7
7-25	0.06-0.2	0.11-0.20	5.6-7.3	-	MODERATE	MODERATE	MODERATE	.32		
25-60	<0.06		7.9-8.4	-		HIGH	LOW			

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		20-40	RIPPABLE	-		C	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY,DEPTH TO ROCK
SEWAGE LAGOON AREAS	2-7%: SEVERE-DEPTH TO ROCK 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-DEPTH TO ROCK
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: FAIR-TOO CLAYEY,THIN LAYER 8-15%: FAIR-TOO CLAYEY,THIN LAYER,SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: MODERATE-DEPTH TO ROCK 8-15%: MODERATE-DEPTH TO ROCK,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SHRINK-SWELL,SLOPE
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-DEPTH TO ROCK,SHRINK-SWELL 8-15%: MODERATE-DEPTH TO ROCK,SLOPE, SHRINK-SWELL
SMALL COMMERCIAL BUILDINGS	4-8%: MODERATE-SHRINK-SWELL 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-SHRINK-SWELL,FROST ACTION 8-15%: MODERATE-SHRINK-SWELL,SLOPE, FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-THIN LAYER,LOW STRENGTH
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	POOR-THIN LAYER

WATER MANAGEMENT

POND RESERVOIR AREA	DEPTH TO ROCK
EMBANKMENTS DIKES AND LEVEES	THIN LAYER,LOW STRENGTH
EXCAVATED PONDS AQUIFER FED	DEEP TO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	SLOW INTAKE,ERODES EASILY,SLOPE
TERRACES AND DIVERSIONS	ERODES EASILY,ROOTING DEPTH
GRASSED WATERWAYS	PERCS SLOWLY,ROOTING DEPTH

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	0-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-PERCS SLOWLY,SLOPE	PLAYGROUNDS	2-6%: MODERATE-PERCS SLOWLY,SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE	PATHS AND TRAILS	SLIGHT

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPA-BILITY	CORN (BU)		SOYBEANS (BU)		WHEAT, WINTER (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)			
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
5-10% ERODED	3E	70		24		30		45		2.8		4.5			
5-10% SEV.ER.	4E	61		-		22		36		2.3		4.0			
10-15% ERODED	4E	66		20		26		39		2.6		4.3			
10-15% SEV.ER.	6E	-		-		-		-		2.3		4.0			

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
0-12%	3O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SLIGHT	WHITE OAK	70	EASTERN WHITE PINE
							NORTHERN RED OAK	70	SCOTCH PINE
							GREEN ASH		EASTERN REDCEDAR
							BUR OAK		RED PINE

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	EASTERN WHITE PINE		NORWAY SPRUCE		DOUGLAS-FIR		RED PINE	
	GRAY DOGWOOD		AUTUMN-OLIVE		RUSSIAN-OLIVE		AMUR MAPLE	

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	FAIR	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

SOIL SURVEY INTERPRETATIONS

Series Dodgeville LRA No. M-105 WISCONSIN

Map Symbol _____ Date 1971

Brief Soil Description: Silty, gently sloping to moderately steep soils, 15 to 30 inches thick, over clay residuum from dolomite. Well drained. These soils have moderate slow permeability in lower subsoil, moderately high natural fertility and medium and low available water capacity.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL

Typical Soil Profile		Classification			Percent Passing Sieve			Permeability	Percolation	Avail. Water Cap.	Soil Reaction	Shrink-swell Potential
Layer	Inches	USDA Texture	Unified	AASHO	No. 4 4.7 mm.	No. 10 2.0 mm.	No. 200 0.074 mm.	in./hr.	min./in.	in./in.		
Surface	0-12	sil	CL or ML	A-7	-	95-100	90-100	0.63-2.00	45-60	.20-.24	6.1-7.3	
Subsoil	12-21	sicl	CL	A-7	95-100	95-100	95-100	0.63-2.00	45-60	.18-.22	5.6-7.3	mod.high
	21-31	c	CH	A-7	95-100	90-100	85-95	0.20-0.63	> 60	.12-.16	5.6-7.3	high
Substratum	Dolomite											very low

Flood hazard: None Depth to rock: 1 to 3 ft.

Depth to water table: (seasonal) 5 ft. or more Hydrologic group: B

SUITABILITY AND MAJOR FEATURES AFFECTING SOIL AS RESOURCE MATERIAL

Topsoil	Surface - GOOD; subsoil - FAIR - clayey.
Sand	UNSUITABLE - dolomite bedrock.
Gravel	FAIR - dolomite can be source of gravel if crushed.
Roadfill	Subsoil - POOR; high shrink-swell potential; high compressibility and elasticity; substratum dolomite bedrock.

DEGREE OF LIMITATIONS AND MAJOR SOIL FEATURES AFFECTING SELECTED USE

Septic tank filter fields		SEVERE - bedrock restricts use.
Sewage lagoons		SEVERE - dolomite bedrock restricts use.
Sanitary land fill		SEVERE - danger of unameliorated leachate contaminating ground water.
Highway location		MODERATE - depth to dolomite bedrock is 2 to 4 feet; moderate frost heave potential; lower subsoil is highly plastic.
Streets and low-cost roads		MODERATE on 2 to 6%; SEVERE on steeper soils; subsoil has high shrink-swell potential and moderate compressibility; bedrock is very difficult to excavate.
Foundations for low buildings		SLIGHT when footings rest on dolomite bedrock; SEVERE where bedrock must be excavated.
Light industries		MODERATE on 0 to 6%; SEVERE on steeper soils; high shrink-swell potential; bedrock may hinder excavation; erosive on slopes.
Corrosivity	Uncoated steel	LOW
	Concrete	LOW
Pond reservoir area		Moderate permeability through subsoil; substratum is slowly permeable clay over fractured dolomite.
Embankments, dams and dikes		Subsoil - fair to poor stability and compaction; semipervious; high shrink-swell potential. Substratum is fractured dolomite bedrock.

The soil is evaluated only to a depth of 5 feet or less. In the following definitions, the ratings for suitability are listed first and the limitation ratings are listed second:
GOOD, SLIGHT - For a given use, the soils have no limitations or have limitations that are easy to overcome;
FAIR, MODERATE - For a given use, the soils have limitations that can be overcome by average management and manipulation; POOR, SEVERE - For a given use, the soils have limitations that are difficult to overcome;
UNSUITABLE, VERY SEVERE - The soils have limitations that generally preclude their use for a given purpose.

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Dodgeville

DEGREE OF SOIL LIMITATIONS AND MAJOR FEATURES AFFECTING RECREATION DEVELOPMENT

Camping areas - tent and trailer	MODERATE on 0 to 12%; SEVERE on steeper soils; sites remain wet and soft for short periods; surface compacts easily.
Picnic areas	SLIGHT on 0 to 6%; MODERATE on 6 to 12%; SEVERE on steeper soils; erosive on slopes.
Playgrounds and athletic fields	MODERATE on 0 to 2%; SEVERE on steeper soils; compacts easily and is muddy and slippery when wet; extensive leveling may expose dolomite bedrock.
Paths or trails	MODERATE on 0 to 12%; SEVERE on steeper soils; muddy and slippery when wet; erosive on slopes.
Golf course fairways	MODERATE on 0 to 12%; SEVERE on steeper soils; slow permeability; sites remain wet and soft for short periods.

CAPABILITY, SOIL LOSS FACTORS, AND YIELDS WITH HIGH LEVEL MANAGEMENT

Mapping Unit											
Slope		Erosion class	Capability Unit	Soil loss		Corn		Oats (bu.)	Alfalfa-brome hay (T.)	Bluegrass pasture (AUD)	Other
Symbol	Percent			K	T	Grain (bu.)	Silage (T.)				
B	2-6	2	IIe-2	.32	3	80	15	80	5.0	130	
C	6-12	2	IIIe-2			90	13	75	4.5	120	
C	6-12	3	IVe-2			80	11	65	4.0	110	
D	12-20	2	IVe-2			75	11	65	4.0	110	
D	12-20	3	VIe-2			-	-	60	3.0	100	

WOODLAND SUITABILITY

Mapping Unit				Potential Productivity					
Slope		Erosion class	Ord.	Important trees	S.I. class	Seedling mortality	Erosion hazard	Equip. limit.	Trees to plant
Symbol	Percent								
B	2-6		4o1			Mod	Sl	Sl	Red pine
C	6-12		4o1	Bur oak	ML	Mod	Sl	Sl	White pine
D	12-20		4r1	Red oak			Mod	Mod	Norway spruce

DEGREE OF SUITABILITY AND MAJOR FEATURES AFFECTING WILDLIFE HABITAT ELEMENTS

Grain and seed crops		GOOD ON 0 to 6%; FAIR on 6 to 12%; POOR on steeper soils; water erosion hazard.
Grass and legumes		GOOD on 0 to 12% slopes; FAIR on 12 to 20% slopes; POOR on steeper soils.
Wild herbaceous upland plants		GOOD on 0 to 20%; FAIR on steeper soils.
Woody plants	Hardwood	FAIR - grass competition.
	Conifers	FAIR - grass competition.
Wetland food and cover plants		POOR on 0 to 2% slopes; UNSUITABLE on steeper soils; few species suited.
Shallow and deep water developments		Moderate permeability in subsoil.

OTHER INTERPRETATIONS

Artificial drainage	Natural drainage is adequate.
Irrigation	Medium and low available water capacity; moderately deep soils; moderate water intake rate; sloping.
Terraces and diversions	Dolomite bedrock at 20- to 40-inch depth.

USDA-SCS-LINCOLN, NEBR. 1973-SR

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES DUBUQUE
STATE IOWA
MLRA 104, 108
JDH-1972

The Dubuque series consists of light colored well drained soils that developed from 20 to 40 inches of loess and a thin layer of residuum on limestone bedrock under forest vegetation. When not cultivated or eroded, they have a very dark gray silt loam surface 3 inches thick, a dark grayish brown and brown silt loam subsurface or A2 horizon, a yellowish brown silt loam and silty clay loam and a 5 inch layer of brown and reddish brown clayey subsoil that extends to 27 inches. The substratum is a fractured fragmented limestone in the upper part over hard level-bedded limestone.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract.	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO	>3 in. %	4	10	40	200						
0-11	silt loam	ML or ML-CL	A-4 or A-6	-	-	-	100	95-100	25-35	5-15	0.6-2.0	.20-.22	5.6-6.5	Moderate
11-22	siltloam & silty clayloam	CL	A-7 or A-6	-	-	-	100	95-100	35-45	15-25	0.6-2.0	.18-.20	5.6-6.0	Moderate to High
22-27	clay	CH	A-7	<5	90-95	90-95	90-95	65-90	50-70	30-45	<0.06	.11-.15	5.6-6.0	High
27+	lime-stone	-	-	-	-	-	-	-	-	-	-	-	-	-

Flooding None
Hydrologic group: B
Depth to water table: More than 10 feet
Depth to bedrock: 2 to 3 feet
Corrosivity - uncoated steel: Moderate
Corrosivity - concrete: Moderate

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair in upper 2 to 3 feet; limestone bedrock at 2 to 3 feet.
Sand	Not suitable - no sand
Gravel	Not suitable - no gravel
Topsoil	Fair upper 1-2 feet; low in organic matter; limestone at 2-3 feet.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe; 2 to 3 feet to fractured porous limestone; danger of contamination of ground water; satisfactory percolation rate
Sewage Lagoons	Severe limitations, 2 to 3 feet to fractured porous limestone; danger of contamination of ground water; satisfactory percolation rate.
Shallow Excavations	Moderate to severe limitations; fractured limestone bedrock at 2 - 3 feet.
Dwellings: With Basements	Moderate limitations on slopes 0-14%; severe on slopes >14%; fractured bedrock at 2-3 feet.
Dwellings: Without Basements	Slight limitations on slopes 0-9%; mod. on slopes 9-14%: severe on >14%; fractured bedrock at 2-3 feet.
Sanitary Landfill	Low potential; fractured limestone bedrock at 2 to 3 feet.
Local Roads and Streets	Moderate limitations; fractured limestone bedrock at 2 to 3 feet.
Potential Frost Action	Low; well drained; limestone at 2 to 3 feet.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Fractured limestone at 2 to 3 feet.
Embankments, Dikes, and Levees	Fractured limestone at 2 to 3 feet; clayey strata thin and discontinuous over limestone.
Drainage of Cropland and Pasture	Natural drainage adequate.
Irrigation	Moderately permeable; well drained; low to moderate available water capacity.
Terraces and Diversions	Limestone at 2 to 3 feet; limestone may crop out on surface in places.
Grassed Waterways	Limestone at 2 to 3 feet; limestone may crop out on surface in places.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

DUBUQUE--2

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Slight limitation on slopes less than 9%, moderate on 9-14%, severe on more than 14%; well drained; areas typically scenic.
Picnic Areas	Slight limitation on slopes less than 9%, moderate on 9-14%, severe on more than 14%; well drained; sites remain wet for short periods.
Playgrounds	Moderate limitation on slopes 2-5%, severe on more than 5%; well drained; muddy and slippery when wet.
Paths and Trails	Slight on slopes less than 14%, moderate on slopes 14-25%; well drained; remains wet for short periods; scenic.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		Corn	Soybeans	Oats	Alf-brome : Bluegrass:		Bromegrass:	Trefoil
		K	T	Bu/Ac	Bu/Ac	Bu/Ac	T/Ac: AUD	: AUD	: AUD	: AUD
2-5%	IIe	.37	3	93	35	74	3.9	195	110	170	170
5-9%	IIIe	.37	3	88	33	70	3.7	185	100	160	160
5-9% mod.er.	IIIe	.37	3	85	32	68	3.6	180	95	150	150
9-14%	IIIe	.37	3	79	30	63	3.3	165	90	140	140
9-14% mod.er.	IIIe	.37	3	76	29	60	3.2	160	85	135	135
14-18%	IVe	.37	3	64	24	51	2.7	135	75	115	115
14-18% mod.er.	IVe	.37	3	61	22	48	2.6	130	70	110	110
18-25%	VIe	.37	3	-	-	45	2.4	120	60	100	100

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-5%	Fair	Good	Good	Good	Good	VeryPoor	VeryPoor	Good	Good	VeryPoor
5-14%	Fair	Fair-Good	Fair-Good	Good	Good	VeryPoor	VeryPoor	Fair	Good	VeryPoor
14-25%	Poor	Fair	Fair	Fair	Fair	VeryPoor	VeryPoor	Fair-Poor	Good	VeryPoor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index *	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
0-18%	3s1	Oaks	Moderately High	Slight to Moderate	Slight	Slight	Slight or Moderate	Red Oak White Oak Green Ash Bl.Walnut HardMaple	E.Wh.Pine Red Pine ScotchPine E.RedCedar Walnut	
		Cottonwood	Mod. High							
		Conifers	Mod. High							

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor
	Conifers: Eastern White Pine; Red Pine; Scotch Pine; Eastern Red Cedar; Norway Spruce; Douglas Fir. Hardwoods: Norway Poplar; Siouxland Poplar, Robusta Poplar; Green Ash; Hackberry		

OTHER

*Suitability or suitability and site index

USDA-SCS-LINCOLN, NEBR. 1973

MLRA(S): 104, 105, 108 FAYETTE SERIES
REV. JDH, 7-75
TYPIC HAPLUDALFS, FINE-SILTY, MIXED, MESIC

THE FAYETTE SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOESS UNDER FOREST VEGETATION ON CONVEX RIDGETOPS AND SIDESLOPES ON UPLANDS AND STREAM TERRACES. THEY HAVE A VERY DARK-GRAY SILT LOAM SURFACE LAYER 3 INCHES THICK AND DARK-GRAY AND DARK GRAYISH-BROWN SILT LOAM SUBSURFACE LAYERS 8 INCHES THICK. THE SUBSOIL EXTENDING TO 47 INCHES IS BROWN, DARK YELLOWISH-BROWN AND YELLOWISH BROWN SILTY CLAY LOAM. THE SUBSTRATUM IS YELLOWISH-BROWN SILT LOAM. SLOPES RANGE FROM 0 TO 40 PERCENT. MOST AREAS ARE IN CULTIVATED CROPS. SLOPING AREAS ARE COMMONLY IN PASTURE OR WOODLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-11	SIL	CL-ML, CL	A-4, A-6	0	100	100	100	95-100	25-35	5-15
0-11	SICL	CL	A-7, A-6	0	100	100	100	95-100	35-45	15-25
11-47	SICL	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
47-73	SIL	CL	A-6	0	100	100	100	95-100	30-40	10-20

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-11	0.6-2.0	0.20-0.22	5.1-6.0	-	LOW	MODERATE	MODERATE	.37	5	6
0-11	0.6-2.0	0.18-0.20	5.1-6.0	-	MODERATE	MODERATE	MODERATE	.37	4	7
11-47	0.6-2.0	0.18-0.20	4.5-5.5	-	MODERATE	MODERATE	MODERATE	.37		
47-73	0.6-2.0	0.18-0.20	5.1-5.5	-	MODERATE	MODERATE	MODERATE	.37		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	HIGH

SANITARY FACILITIES (A)

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	ROADFILL	0-25%: POOR-LOW STRENGTH 25+%: POOR-LOW STRENGTH,SLOPE
SEWAGE LAGOON AREAS 1	0-2%: MODERATE-SEEPAGE 2-7%: MODERATE-SLOPE,SEEPAGE 7+%: SEVERE-SLOPE,SEEPAGE	SAND 3	UNSUITED
SANITARY LANDFILL (TRENCH) 1	0-15%: MODERATE-TOO CLAYEY 15-25%: MODERATE-SLOPE	GRAVEL 3	UNSUITED
SANITARY LANDFILL (AREA) 1	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	TOPSOIL 4	0-8%: FAIR-THIN LAYER 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE
DAILY COVER FOR LANDFILL	0-8%: FAIR-TOO CLAYEY 8-15%: FAIR-SLOPE,TOO CLAYEY 15+%: POOR-SLOPE		

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	EMBANKMENTS DIKES AND LEVEES	COMPRESSIBLE,LOW STRENGTH,ERODES EASILY
DWELLINGS WITHOUT BASEMENTS 2	0-8%: MODERATE-LOW STRENGTH,SHRINK-SWELL 8-15%: MODERATE-SLOPE,SHRINK-SWELL, LOW STRENGTH 15+%: SEVERE-SLOPE	EXCAVATED PONDS AQUIFER FED	NO WATER
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-LOW STRENGTH,SHRINK-SWELL 8-15%: MODERATE-SLOPE,LOW STRENGTH, SHRINK-SWELL 15+%: SEVERE-SLOPE	DRAINAGE	NOT NEEDED
SMALL COMMERCIAL BUILDINGS 2	0-4%: MODERATE-SHRINK-SWELL,LOW STRENGTH 4-8%: MODERATE-SLOPE,SHRINK-SWELL, LOW STRENGTH 8+%: SEVERE-SLOPE	IRRIGATION	ERODES EASILY,SLOPE
LOCAL ROADS AND STREETS	0-15%: SEVERE-FROST ACTION,LOW STRENGTH 15+%: SEVERE-FROST ACTION,LOW STRENGTH,SLOPE	TERRACES AND DIVERSIONS	COMPLEX SLOPE,ERODES EASILY,PIPING
LAWNS, LANDSCAPING AND GOLF FAIRWAYS		GRASSED WATERWAYS	FAVORABLE

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE,SLOPE

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15%: SLIGHT 15-25%: MODERATE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		KENTUCKY BLUEGRASS (AUM)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)			
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
2-5%	2E		113		43		90		4.0		4.7		7.8			
5-9%	3E		108		41		86		3.8		4.5		7.5			
9-14%	3E		99		38		80		3.6		4.2		7.0			
9-14% SEV. ER.	4E		90		34		72		3.5		3.8		6.3			
14-18%	4E		84		32		67		3.3		3.5		5.8			
14-18% SEV. ER.	6E		-		-		62		3.0		3.2		5.3			
18-25%	6E		-		-		60		3.1		3.4		5.6			
18-25% SEV. ER.	6E		-		-		-		2.5		3.0		4.5			
25+%	7E		-		-		-		3.0		-		-			
2-5% SEV.ER.	3E		108		41		86		3.8		4.5		7.5			
5-9% SEV.ER.	4E		100		38		80		3.6		4.2		7.0			

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
0-14%	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	WHITE OAK	65	EASTERN WHITE PINE
14-25%	2R	MODERATE	MODERATE	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	65	RED PINE
25+%	2R	SEVERE	SEVERE	SLIGHT	SLIGHT	MODERATE		65	NORWAY SPRUCE
								65	SCOTCH PINE
									WHITE SPRUCE
									EUROPEAN LARCH
									BLACK WALNUT
									SUGAR MAPLE

WINDBREAKS (B)

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	EASTERN WHITE PINE	32	RED PINE	27	BLUE SPRUCE	18	NORWAY SPRUCE	
	SCOTCH PINE	28	WHITE SPRUCE		EUROPEAN LARCH		EASTERN REDCEDAR	21
	GREEN ASH	36	HACKBERRY		SILVER MAPLE		DOUGLAS-FIR	25

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	POTENTIAL AS HABITAT FOR: WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-5%	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
5-15%	FAIR	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
15-25%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE					
POTENTIAL PRODUCTION (LBS./AC. DRY WT):							
FAVORABLE YEARS							
NORMAL YEARS							
UNFAVORABLE YEARS							

FOOTNOTES

1 MANY AREAS ARE UNDERLAIN BY A SLOWER PERMEABLE GLACIAL TILL AT DEPTHS GREATER THAN 6-10 FEET.
2 FROST ACTION EASILY OVERCOME BY EXTENDING FOOTINGS BELOW FROST LINE.
3 SAND MAY BE AT DEPTHS OF BELOW 6 FEET ON LOESS COVERED STREAM BENCHES WITH SMALL AMOUNTS OF GRAVEL.
4 LOW IN ORGANIC MATTER.
A BENCH PHASES HAVE DANGER OF POLLUTION OF GROUNDWATER DUE TO POROUS STRATA BELOW 5 FEET.
B CONIFERS LISTED ARE ESPECIALLY SUITED FOR FARMSTEAD WINDBREAKS, AND HARDWOODS ARE FOR FIELD WINDBREAKS.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES Gale
STATE Wisconsin
MLRA M 105
R.E.F. Rev. 12/72

Well drained, gently sloping to very steep silty soil, 20 to 40 inches thick, over sandstone. These are moderately permeable soils with medium available water capacity.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-13	sil	ML	A-4	-	100	100	90-100	80-90	15-25	1-4	0.6-2.0	.20-.22	5.6-6.5	Low
13-31	sicl	CL	A-6,A-7	-	100	100	95-100	85-95	35-45	15-25	0.6-2.0	.18-.20	5.1-6.0	Low
31-39	s	SP	A-3	-	100	95-100	55-65	1-5	-	NP	6.0-20	.06-.08	5.1-6.0	Low
39-60	weakly cemented sandstone bedrock													

Flooding - None
Hydrologic group: B
Depth to water table: >5 feet
Depth to bedrock: 20 to 40 inches
Corrosivity - uncoated steel: Low
Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair; medium shear strength; fair compaction.
Sand	Poor; thin layer of sand above bedrock.
Gravel	Unsuitable; little or no gravel present.
Topsoil	Fair; less than 16 inches thick.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	- Moderate for 2 to 12% slopes; severe for 12 to 20% slopes; very severe for steeper soils; 20 to 40 inches to weakly cemented sandstone.
Sewage Lagoons	- Very severe; 20 to 40 inches to weakly cemented sandstone; 2 to 30% slopes.
Shallow Excavations	- Moderate for 2 to 12% slopes; severe for 12 to 20% slopes; very severe for steeper soils; sandstone bedrock rippable.
Dwellings: With Basements	Moderate for 2 to 12% slopes; severe for 12 to 20% slopes; very severe for steeper soils; rippable sandstone at 20 to 40 inches.
Without Basements	- Slight for 2 to 6% slopes; moderate for 6 to 12% slopes; severe for steeper soils.
Sanitary Landfill	- Moderate for 2 to 12% slopes; severe for 12 to 30% slopes; very severe for steeper soils; weakly cemented sandstone at 20 to 40 inches.
Local Roads and Streets	- Slight for 2 to 6% slopes; moderate for 6 to 12% slopes; severe for steeper soils; sandstone bedrock is rippable.
Potential Frost Action	- Low.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	- Weakly cemented sandstone at 20 to 40 inches.
Embankments, Dikes, and Levees	- Low shrink-swell potential; medium shear strength.
Drainage of Cropland and Pasture	- Natural drainage is adequate.
Irrigation	- Moderate permeability; medium available water capacity.
Terraces and Diversions	- Erodible; slopes range from 2 to more than 30 percent.
Grassed Waterways	- Erodible; slopes range from 2to to more than 30 percent.
Golf Course Fairways	- Slight on 0 to 6% slopes; moderate for 6 to 12% slopes; severe for steeper soils.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

Series Gale

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate on 2 to 12% slopes; severe on 12 to 20% slopes; very severe on steeper soils; sites remain wet and soft for short periods; surface compacts easily.
Picnic Areas	Slight on 2 to 6% slopes; moderate on 6 to 12% slopes; severe on 12 to 20% slopes; very severe on steeper soils; erosive on slopes.
Playgrounds	Moderate on 2 to 6% slopes; severe on 6 to 12% slopes; very severe on steeper soils; compacts easily; is muddy and slippery when wet; erosive on slopes; extensive leveling may expose sand-/stone bedrock.
Paths and Trails	Moderate on 2 to 12% slopes; severe on 12 to 20% slopes; very severe on steeper soils; muddy and slippery when wet; erosive on slopes.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn grain (bu)	Corn silage (T)	Oats (bu)	
B 2-6%	IIe2	.37	3	90	15	65	
C 6-12%	IIIe2			85	14	60	
D 12-20%	IVe2			80	12	55	
E 20-30%	VIe2			-	-	-	
F 30-45%	VIIe2			-	-	-	

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production
B,C 2-12%	Ao1	Alfalfa-brome hay - 3.5 T/A; pasture (bluegrass) - 100 AUD
D 12-20%	Ao1	Alfalfa-brome hay - 3.0 T/A; pasture (bluegrass) - 80 AUD
E,F 20-45%	Ar1	Alfalfa-brome hay - 2.5 T/A; pasture (bluegrass) - 60 AUD

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- Openland Wildlife	Woodland Wildlife	Wetland Wildlife
B 2-6%	Good	Good	Good	Good	Good	V. poor	V. poor	Good	Good	V. poor
C,D 6-20%	Fair	Good	Good	Good	Good	V. poor	V. poor			
E,F 20-45%	V. poor	Poor	Good	Good	Good	V. poor	V. poor			

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity: Important Trees	Potential Productivity: Site Index	Woodland Management Hazards: Erosion Hazard	Woodland Management Hazards: Equipment Limitations	Woodland Management Hazards: Seeding Mortality	Woodland Management Hazards: Plant Competition	Suitable Species: To Favor	Suitable Species: To Plant	Other
B,C 2-12%	2d3	red oak white oak	ML	Slight	Slight	Slight	Slight	red oak wh. oak	red pine	
D,E,F 12-45%	2d4			Moderate	Moderate	(Sl.N&E (Mod S&W				

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

MLRA(S): 104, 105, 108
JDH, 5-73
TYPIC HAPLAQUOLLS, FINE-SILTY, MIXED, MESIC

GARWIN SERIES

THE GARWIN SERIES CONSISTS OF POORLY DRAINED SOILS FORMED IN LOESS UNDER PRAIRIE GRASSES AND SEDGES AT THE HEAD OF DRAINS AND UPLAND DIVIDES ON UPLANDS AND STREAM BENCHES. THEY HAVE BLACK AND VERY DARK-GRAY SILTY CLAY LOAM SURFACE LAYERS 18 INCHES THICK. THE SUBSOIL IS DARK-GRAY, FRIABLE SILTY CLAY LOAM IN UPPER 24 INCHES AND OLIVE-GRAY FRIABLE SILT LOAM IN THE LOWER 6 INCHES. THE SUBSTRATUM IS OLIVE-GRAY AND LIGHT OLIVE-GRAY, FRIABLE SILT LOAM. SLOPES RANGE FROM 0 TO 2 PERCENT. MOST AREAS ARE IN CULTIVATED CROPS.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-18	SICL	CL, OH, CH	A-7	0	100	100	100	95-100	45-55	20-30
18-42	SICL	CH, CL	A-7	0	100	100	100	95-100	45-55	25-35
42-75	SIL	CL	A-6	0	100	100	100	95-100	30-40	15-20

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-18	0.2-0.6	0.21-0.23	5.6-6.5	-	HIGH	HIGH	MODERATE	-	-	7
18-42	0.2-0.6	0.18-0.20	6.1-7.3	-	HIGH	HIGH	MODERATE	-		
42-75	0.6-2.0	0.20-0.22	6.6-7.3	-	MODERATE	HIGH	MODERATE	-		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			1.0-3.0	APPARENT	NOV-JUN	-		>60		-	-	B/D	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS, PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-WETNESS, EXCESS HUMUS
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	POOR-WETNESS

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS, SHRINK-SWELL, LOW STRENGTH
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS, SHRINK-SWELL, LOW STRENGTH
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS, SHRINK-SWELL, LOW STRENGTH
LOCAL ROADS AND STREETS	SEVERE-WETNESS, SHRINK-SWELL, LOW STRENGTH
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-WETNESS, LOW STRENGTH, FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	POOR-WETNESS

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	COMPRESSIBLE, LOW STRENGTH, EXCESS HUMUS
EXCAVATED PONDS AQUIFER FED	SLOW REFILL
DRAINAGE	FAVORABLE
IRRIGATION	WETNESS, SLOW INTAKE
TERRACES AND DIVERSIONS	NOT NEEDED
GRASSED WATERWAYS	WETNESS

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	SEVERE-WETNESS	PLAYGROUNDS	SEVERE-WETNESS
PICNIC AREAS	SEVERE-WETNESS	PATHS AND TRAILS	SEVERE-WETNESS

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)		KENTUCKY BLUEGRASS (AUM)		SMOOTH BROMEGRASS (AUM)	
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
DRAINED	2W	125		47		94		5.0		6.3		4.1		6.3	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS (A)

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	SILVER MAPLE	35	POPLAR		LAUREL WILLOW		AMERICAN SYCAMORE	
	GREEN ASH	35	HACKBERRY		NORTHERN WHITE-CEDAR		EASTERN REDCEDAR	
	WHITE SPRUCE		NORWAY SPRUCE	22				

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	POTENTIAL AS HABITAT FOR: WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	GOOD	GOOD	GOOD	FAIR	POOR	-	GOOD	GOOD	GOOD	FAIR	GOOD	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A CONIFERS ARE ESPECIALLY SUITED FOR FARMSTEAD WINDBREAKS AND HARDWOODS ARE ESPECIALLY SUITED FOR FIELD WINDBREAKS.

MLRA(S): 95, 103, 104, 105, 108, 114, 115
KEL, 4-75
CUMULIC HAPLUDOLLS, FINE-SILTY, MIXED, MESIC

HUNTSVILLE SERIES

THE HUNTSVILLE SERIES CONSISTS OF MODERATELY WELL AND WELL DRAINED SOILS FORMED IN ALLUVIUM ON FLOODPLAINS. THE SURFACE LAYER IS VERY DARK-BROWN AND DARK-BROWN SILT LOAM 54 INCHES THICK. THE UNDERLYING MATERIAL IS DARK-BROWN LOAM. SLOPES RANGE FROM 0 TO 5 PERCENT. WIDE FLOODPLAINS ARE CULTIVATED AND NARROW FLOODPLAINS USUALLY ARE IN PASTURE OR WOODLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-54	SIL	CL, ML	A-6, A-4, A-7	0	100	98-100	90-100	80-100	36-50	10-25
54-60	L, SIL, SL	CL, ML, SM	A-4, A-6, A-2	0	90-100	80-100	55-95	45-85	18-37	NP-21

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-54	0.6-2.0	0.22-0.24	6.1-7.3	-	MODERATE	LOW	LOW	-	-	6
54-60	0.6-2.0	0.12-0.21	6.1-7.8	-	LOW	LOW	LOW	-		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
OCCASIONAL	BRIEF	APR-JUN	>6.0			-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-FLOODS
SEWAGE LAGOON AREAS	SEVERE-FLOODS
SANITARY LANDFILL (TRENCH)	SEVERE-FLOODS
SANITARY LANDFILL (AREA)	SEVERE-FLOODS
DAILY COVER FOR LANDFILL	GOOD

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-FLOODS
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODS
DWELLINGS WITH BASEMENTS	SEVERE-FLOODS
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODS
LOCAL ROADS AND STREETS	SEVERE-FLOODS,FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	GOOD

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	LOW STRENGTH,PIPING
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	FAVORABLE
TERRACES AND DIVERSIONS	NOT NEEDED
GRASSED WATERWAYS	NOT NEEDED

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	SEVERE-FLOODS	PLAYGROUNDS	MODERATE-FLOODS
PICNIC AREAS	MODERATE-FLOODS	PATHS AND TRAILS	SLIGHT

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT) (A)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		WHEAT, WINTER (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)			
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	1			130		45		55		80		5.5		7.9	
2-5%	2E			130		45		55		80		5.5		7.9	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
ALL	1O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	EASTERN COTTONWOOD	110	EASTERN COTTONWOOD
							AMERICAN SYCAMORE		BLACK WALNUT
							YELLOW-POPLAR	98	AMERICAN SYCAMORE
							CHERRYBARK OAK		RED MAPLE
							SWEETGUM		SUGAR MAPLE
							GREEN ASH		GREEN ASH
									HACKBERRY

WINDBREAKS

CLASS-DETERMING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	EASTERN WHITE PINE		RED PINE		NORWAY SPRUCE		WHITE FIR	
	DOUGLAS-FIR		FORSYTHIA		GRAY DOGWOOD		AMUR HONEYSUCKLE	

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	POOR	GOOD	GOOD	POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				

POTENTIAL PRODUCTION (LBS./AC. DRY WT):
FAVORABLE YEARS
NORMAL YEARS
UNFAVORABLE YEARS

FOOTNOTES

A LEVEE PROTECTED

MLRA(S): 104, 105
SJH-TOT, 4-75
AQUOLLIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

KASSON SERIES

THE KASSON SERIES CONSISTS OF MODERATELY WELL-DRAINED SOILS FORMED IN LOESS AND THE UNDERLYING GLACIAL TILL ON UPLANDS. THE SURFACE LAYER IS VERY DARK BROWN SILT LOAM, 9 INCHES THICK. THE UPPER SUBSOIL IS DARK BROWN AND BROWN SILTY CLAY LOAM, 11 INCHES THICK. THE LOWER SUBSOIL IS DARK YELLOWISH-BROWN, BROWN, AND YELLOWISH-BROWN LOAM, 41 INCHES THICK. THE UNDERLYING MATERIAL IS YELLOWISH-BROWN LOAM. SLOPES RANGE FROM 0 TO 7 PERCENT. MOST AREAS ARE IN CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	SIL	ML, CL	A-4, A-6	0	100	100	95-100	75-95	25-40	4-15
9-20	SICL, SIL	CL	A-6, A-7	0	100	95-100	90-100	75-95	35-45	15-25
20-70	L	ML, CL	A-6, A-7	0	95-100	85-100	85-95	60-80	30-45	10-18

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-9	0.6-2.0	0.22-0.24	5.6-6.5	-	MODERATE	HIGH	LOW	.32	5-4	5
9-20	0.6-2.0	0.16-0.19	4.5-5.5	-	MODERATE	HIGH	MODERATE	.32		
20-70	0.2-0.6	0.17-0.19	5.1-8.4	-	MODERATE	HIGH	MODERATE	.32		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			1.0-3.0	PERCHED	MAR-MAY	-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY,WETNESS
SEWAGE LAGOON AREAS	0-2%: MODERATE-WETNESS,SEEPAGE 2-7%: MODERATE-WETNESS,SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS
SANITARY LANDFILL (AREA)	MODERATE-WETNESS
DAILY COVER FOR LANDFILL	GOOD

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	MODERATE-WETNESS
DWELLINGS WITHOUT BASEMENTS	MODERATE-SHRINK-SWELL
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SHRINK-SWELL,SLOPE
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	FAIR-THIN LAYER

WATER MANAGEMENT

POND RESERVOIR AREA [1]	FAVORABLE
EMBANKMENTS DIKES AND LEVEES	LOW STRENGTH,SHRINK-SWELL
EXCAVATED PONDS AQUIFER FED	DEEP TO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	PERCS SLOWLY
TERRACES AND DIVERSIONS [2]	FAVORABLE
GRASSED WATERWAYS	FAVORABLE

REGIONAL INTERPRETATIONS

PASTURE AND HAY	GROUP 1

RECREATION

CAMP AREAS	MODERATE-PERCS SLOWLY	PLAYGROUNDS	0-2%: MODERATE-PERCS SLOWLY 2-6%: MODERATE
PICNIC AREAS	SLIGHT	PATHS AND TRAILS	SLIGHT

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		CORN SILAGE (TONS)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		KENTUCKY BLUEGRASS (AUM)			
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-3%	2S		95		14		20		65		3.8		6.0		
3-7%	2E		95		14		20		65		3.8		6.0		

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT.Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
ALL	20	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	EASTERN COTTONWOOD	85	BLACK WALNUT
							AMERICAN BASSWOOD	70	EASTERN COTTONWOOD
							SUGAR MAPLE	60	AMERICAN BASSWOOD
							BLACK WALNUT	55	EASTERN WHITE PINE

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	GREEN ASH	35	WHITE SPRUCE	22	NORTHERN WHITE-CEDAR	19	GRAY DOGWOOD	12
	SILVER MAPLE	45	EASTERN WHITE PINE	28	SIBERIAN CRABAPPLE	18	TATARIAN HONEYSUCKLE	11
	HACKBERRY	34	RED PINE	28	AMUR MAPLE	23	LILAC	12

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHA_LOW WATER	OPENLD WILDLF	POTENTIAL AS HABITAT FOR: WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	FAIR	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE			

POTENTIAL PRODUCTION (LBS./AC. DRY WT):

FAVORABLE YEARS				
NORMAL YEARS				
UNFAVORABLE YEARS				

FOOTNOTES

1 NEAR SUMMIT OF TERRAIN.
2 TERRACE CHANNELS MAY BE WET AND REQUIRE ARTIFICIAL DRAINAGE.
A WINDBREAK GROUP 1, MN.

MLRA(S): 90, 104, 108 KENYON SERIES
JDH, 4-75
TYPIC HAPLUDOLLS, FINE-LOAMY, MIXED, MESIC

THE KENYON SERIES CONSISTS OF MODERATELY WELL AND WELL DRAINED SOILS FORMED IN LOAMY SEDIMENTS OVER FIRM LOAM GLACIAL TILL ON UPLANDS. THEY HAVE BLACK, VERY DARK-BROWN AND VERY DARK GRAYISH-BROWN LOAM SURFACE LAYERS 14 INCHES THICK. THE SUBSOIL IS BROWN FRIABLE LOAM IN UPPER 5 INCHES AND DARK YELLOWISH-BROWN, YELLOWISH-BROWN, BROWN AND GRAYISH-BROWN FIRM LOAM IN LOWER 35 INCHES THAT HAS COMMON MOTTLES BELOW 33 INCHES. THE SUBSTRATUM IS MOTTLED YELLOWISH-BROWN DARK YELLOWISH-BROWN, DARK-BROWN AND GRAY, FIRM LOAM. SLOPES RANGE FROM 1 TO 15 PERCENT. MOST AREAS ARE CULTIVATED.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USCA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-14	L, SIL	CL	A-6	0	100	95-100	85-95	65-75	30-40	10-20
14-54	L, CL	CL	A-6	0-5	90-95	85-95	80-90	50-65	30-40	10-20
54-76	L	CL	A-6	0-5	90-95	85-95	80-90	50-65	25-35	10-20

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-14	0.6-2.0	0.20-0.22	5.6-6.5	-	LOW	MODEFATE	MODERATE	.28	5-4	6
14-54	0.2-0.6	0.17-0.19	5.1-7.3	-	LOW	MODERATE	MODERATE	.28		
54-76	0.2-0.6	0.17-0.19	7.4-8.4	-	LOW	MODERATE	MODERATE	.37		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES (A)

SEPTIC TANK ABSORPTION FIELDS	0-8%: SEVERE-PERCS SLOWLY 8-15%: SEVERE-SLOPE,PERCS SLOWLY
SEWAGE LAGOON AREAS	0-2%: MODERATE-EXCESS HUMUS 2-7%: MODERATE-SLOPE,EXCESS HUMUS 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	SLIGHT
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: GOOD 8-15%: FAIR-SLOPE

COMMUNITY DEVELOPMENT (A)

SHALLOW EXCAVATIONS	0-8%: MODERATE-WETNESS 8-15%: MODERATE-SLOPE,WETNESS
DWELLINGS WITHOUT BASEMENTS 1	0-8%: MODERATE-FROST ACTION 8-15%: MODERATE-SLOPE,FROST ACTION
DWELLINGS WITH BASEMENTS 1	0-8%: MODERATE-WETNESS 8-15%: MODERATE-SLOPE,WETNESS
SMALL COMMERCIAL BUILDINGS 1	0-4%: MODERATE-FROST ACTION 4-8%: MODERATE-SLOPE,FROST ACTION 8+%: SEVERE-SLOPE,FROST ACTION
LOCAL ROADS AND STREETS	0-8%: MODERATE-FROST ACTION,LOW STRENGTH 8-15%: MODERATE-SLOPE,FROST ACTION, LOW STRENGTH
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	FAIR-LOW STRENGTH,FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	0-8%: GOOD 8-15%: FAIR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	FAVORABLE
EMBANKMENTS DIKES AND LEVEES	FAVORABLE
EXCAVATED PONDS AQUIFIER FED 2	NO WATER
DRAINAGE 3	NOT NEEDED
IRRIGATION	SLOPE
TERRACES AND DIVERSIONS 4	FAVORABLE
GRASSED WATERWAYS	PERCS SLOWLY,WETNESS

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	0-8%: MODERATE 8-15%: MODERATE-SLOPE,PERCS SLOWLY	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE	PATHS AND TRAILS	SLIGHT

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPA-BILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		KENTUCKY BLUEGRASS (AUM)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)			
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	1		115		44		92		4.2		4.8		8.0		
2-5%	2E		113		43		90		4.2		4.7		7.8		
5-9%	3E		108		41		86		4.0		4.5		7.5		
5-9% ERODED	3E		105		40		84		3.8		4.4		7.3		
9-14%	3E		99		38		80		3.7		4.2		7.0		
9-14% ERODED	3E		96		36		76		3.4		4.0		6.6		

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS (B)

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	EASTERN WHITE PINE	32	RED PINE	27	BLUE SPRUCE	18	NORWAY SPRUCE	
	SCOTCH PINE	28	WHITE SPRUCE		EUROPEAN LARCH		EASTERN REDCEDAR	21
	GREEN ASH	36	HACKBERRY		SILVER MAPLE	35	DOUGLAS-FIR	25

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERBS	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-5%	GOOD	GOOD	GOOD	GOOD	GOOD	-	FAIR	FAIR	GOOD	GOOD	FAIR	-
5+%	FAIR	GOOD	GOOD	GOOD	GOOD	-	POOR	FAIR	GOOD	GOOD	FAIR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NRCS)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A PERCHED WATER TABLE IS PRESENT FOR SHORT PERIODS DURING EXTENDED WET PERIODS.
1 SUBJECT TO HILLSIDE SEEPAGE.
2 PERCHED WATER TABLE NOT DEPENDABLE FOR EXCAVATED PONDS.
3 ARTIFICIAL DRAINAGE GENERALLY NOT NEEDED BUT IN EXTENDED WET PERIODS INTERCEPTOR TILE MAY BE BENEFICIAL.
4 A COMBINATION OF TILING WITH TERRACES MAY PROVE TO BE MOST SUCCESSFUL.
B CONIFERS LISTED ARE ESPECIALLY SUITED FOR FARMSTEAD WINDBREAKS AND HARDWOODS ARE FOR FIELD WINDBREAKS.

MLRA(S): 104, 105, 108, 115
KEL, 8-73
MOLLIC HAPLUDALFS, FINE-SILTY, MIXED, MESIC

MT. CARROLL SERIES

THE MT. CARROLL SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOESS ON UPLANDS. THE SURFACE LAYER IS VERY DARK-BROWN SILT LOAM 8 INCHES THICK. THE SUBSURFACE LAYER IS BROWN SILT LOAM 5 INCHES THICK. THE SUBSOIL IS YELLOWISH-BROWN AND DARK YELLOWISH-BROWN SILT LOAM 33 INCHES THICK. THE UNDERLYING MATERIAL IS MIXED BROWN,GRAYISH-BROWN,STRONG-BROWN, GRAY AND LIGHT OLIVE-BROWN SILT LOAM. SLOPES RANGE FROM 1 TO 20 PERCENT. THESE SOILS ARE MAINLY CROPPED.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-13	SIL	CL	A-4, A-6	0	100	100	100	95-100	25-36	7-18
13-46	SIL	CL	A-6, A-4	0	100	100	100	95-100	27-38	8-20
46-80	SIL, SI	CL	A-4, A-6	0	100	100	100	90-100	26-37	7-17

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-13	0.6-2.0	0.22-0.24	5.6-7.3	-	LOW	LOW	MODERATE	.32	5-4	6
13-46	0.6-2.0	0.20-0.22	5.6-7.3	-	LOW	LOW	MODERATE	.32		
46-80	0.6-2.0	0.20-0.22	5.6-8.4	-	LOW	LOW	MODERATE	.32		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-7%: MODERATE-SEEPAGE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	0-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	0-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	LOW STRENGTH
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	FAVORABLE
TERRACES AND DIVERSIONS	FAVORABLE
GRASSED WATERWAYS	FAVORABLE

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15%: SLIGHT 15+%: MODERATE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		WHEAT (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)			
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	1	116		39		51		75		4.8		7.0			
2-4%	2E	116		39		51		75		4.8		7.0			
7-12%	3E	98		26		40		64		4.3		6.2			
7-12% SEV.ER.	4E	80		-		27		54		4.0		5.2			
12-18%	4E	85		-		30		58		4.2		6.2			
12-18% SEV.ER.	6E	-		-		-		-		3.7		5.0			

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
0-12% >50 F. MAAT	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	YELLOW-POPLAR	90	WHITE OAK
12-20% >50 F. MAAT	2R	MODERATE	MODERATE	MODERATE	SLIGHT	MODERATE	WHITE OAK	80	BLACK WALNUT
							NORTHERN RED OAK	80	NORTHERN RED OAK
							BLACK WALNUT		GREEN ASH
									RED PINE
									SUGAR MAPLE
0-15% <50 F. MAAT	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	70	BLACK WALNUT
15-20% <50 F. MAAT	2R	MODERATE	MODERATE	MODERATE	SLIGHT	MODERATE	AMERICAN BASSWOOD		EASTERN WHITE PINE
							SUGAR MAPLE		RED PINE

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
>50 F. MAAT	EASTERN WHITE PINE		RED PINE		NORWAY SPRUCE		DOUGLAS-FIR			
	FORSYTHIA		SILKY DOGWOOD		AUTUMN-OLIVE		GRAY DOGWOOD			
<50 F. MAAT	WHITE SPRUCE		NORTHERN WHITE-CEDAR		EASTERN WHITE PINE		RED PINE			
	ORIENTAL ARBORVITAE	7	PEKING COTONEASTER	8	GRAY DOGWOOD	10	SILKY DOGWOOD	10		
	LILAC	10	AMUR MAPLE	15	MOCKORANGE	9				

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	POTENTIAL AS HABITAT FOR: WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-7%	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
7-12%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
12+%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

1 FROST ACTION EASILY OVERCOME BY EXTENDING FOOTINGS BELOW FROST LINE.

MLRA(S): 104, 108
GAP-TOT, 4-75
TYPIC HAPLUDOLLS, FINE-LOAMY, MIXED, MESIC

OSTRANDER SERIES

THE OSTRANDER SERIES CONSISTS OF DEEP, WELL-DRAINED SOILS FORMED IN LOAMY SEDIMENTS OVER GLACIAL TILL UNDER TALL GRASS PRAIRIE ON SUMMITS AND SIDE SLOPES OF UPLAND TILL PLAIN. TYPICALLY THEY HAVE VERY DARK-BROWN AND DARK-BROWN SURFACE LAYERS 16 INCHES THICK. THE UPPER 4 INCHES OF SUBSOIL IS BROWN SILT LOAM. THE LOWER 30 INCHES IS DARK YELLOWISH-BROWN AND YELLOWISH-BROWN LOAM AND SANDY CLAY LOAM. UNDERLYING MATERIAL IS YELLOWISH-BROWN LOAM. SLOPES RANGE FROM 0 TO 18 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-20	L, SIL	CL-ML, CL	A-4, A-6	0	100	98-100	90-95	70-90	25-40	5-15
0-20	SICL, CL	CL	A-6	0	100	98-100	90-95	70-90	30-40	10-20
20-50	SCL, L, SL	CL, SC	A-6	0-2	95-100	75-98	65-90	45-65	25-35	10-20
50-60	L	CL	A-6	0-1	95-100	90-98	80-95	50-75	25-40	10-20

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-20	0.6-2.0	0.20-0.24	5.6-7.3	-	LOW	LOW	LOW	.28	5-4	6
0-20	0.6-2.0	0.20-0.22	5.6-7.3	-	LOW	MODERATE	LOW	.28	5-4	6
20-50	0.6-2.0	0.17-0.19	5.1-7.3	-	LOW	LOW	LOW	.28		
50-60	0.6-2.0	0.17-0.19	6.6-7.8	-	LOW	LOW	LOW	.37		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-	-	B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-2%: MODERATE-SEEPAGE 2-7%: MODERATE-SLOPE,SEEPAGE 7+%: SEVERE-SEEPAGE
SANITARY LANDFILL (TRENCH)	0-15%: SLIGHT 15+%: MODERATE-SLOPE
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-15%: GOOD 15+%: FAIR-SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-FROST ACTION 8-15%: MODERATE-SLOPE,FROST ACTION 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-FROST ACTION 4-8%: MODERATE-SLOPE,FROST ACTION 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-FROST ACTION 8-15%: MODERATE-SLOPE,FROST ACTION 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	0-15%: FAIR-FROST ACTION 15+%: FAIR-SLOPE,FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	0-8% L,SIL: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE 0-8% CL,SICL: FAIR-TOO CLAYEY

WATER MANAGEMENT

POND RESERVOIR AREA	0-15%: FAVORABLE 15+%: SLOPE
EMBANKMENTS DIKES AND LEVEES	LOW STRENGTH
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	0-2%: FAVORABLE 6+%: SLOPE
TERRACES AND DIVERSIONS	0-15%: FAVORABLE 15+%: SLOPE
GRASSED WATERWAYS	0-8%: FAVORABLE 8+%: SLOPE,ERODES EASILY

REGIONAL INTERPRETATIONS

PASTURE AND HAYLAND	GROUP 1

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15%: SLIGHT 15+%: MODERATE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)		KENTUCKY BLUEGRASS (AUM)		CORN SILAGE (TONS)	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	1		110		33		80		4.5		6.7		3.5		15	
2-6%	2E		105		33		75		4.5		6.7		3.5		15	
6-12%	3E		95		30		70		4.3		6.3		3.3		14	
6-12% ERODED	3E		90		26		65		4.0		6.0		3.0		12	
12-18%	4E		90		-		65		4.0		6.0		3.0		12	
12-18% ERODED	4E		80		-		60		3.5		4.5		2.8		11	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS (A)

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
0-12%	EASTERN WHITE PINE	28	GREEN ASH	35	HACKBERRY	34	EASTERN COTTONWOOD	60
	AMERICAN ELM	36	SIBERIAN CRABAPPLE	18	AMUR MAPLE	23	GRAY DOGWOOD	12
	TATARIAN HONEYSUCKLE	11	LILAC	12	EASTERN REDCEDAR	19	NORTHERN WHITE-CEDAR	20

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	POTENTIAL AS HABITAT FOR: WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-6%	GOOD	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
6-18%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A 0-12%: WINDBREAK GROUP 1. 12+%: WINDBREAK GROUP 3-TOO STEEP FOR WINDBREAKS. MINNESOTA.

MLRA(S): 104
REV. GAP-TOT. 10-75
MOLLIC HAPLUDALFS. FINE-LOAMY. MIXED. MESIC

RACINE SERIES

THE RACINE SERIES CONSISTS OF WELL AND MODERATELY WELL DRAINED SOILS FORMED IN GLACIAL TILL ON UPLANDS. THE SURFACE LAYER IS VERY DARK BROWN SILT LOAM 8 INCHES THICK. THE SUBSURFACE LAYER IS DARK GRAYISH-BROWN SILT LOAM 4 INCHES THICK. THE UPPER SUBSOIL IS DARK YELLOWISH-BROWN CLAY LOAM. THE LOWER SUBSOIL IS DARK YELLOWISH-BROWN AND YELLOWISH-BROWN CLAY LOAM AND SANDY CLAY LOAM 28 INCHES THICK. THE UNDERLYING MATERIAL IS BROWN LOAM. SLOPES RANGE FROM 1 TO 25 PERCENT. MOST AREAS ARE IN CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-12	SIL	ML	A-4, A-6	0	95-100	95-100	90-100	55-85	30-40	5-14
12-18	SIL, CL	CL	A-6	0	95-100	95-100	90-100	55-85	30-40	10-20
18-46	CL, SCL	CL, SC, ML, SM	A-4, A-2, A-6	0-3	85-100	75-95	65-90	30-85	20-40	NP-15
46-65	L	ML, CL, SM, SC	A-4, A-6	0-3	85-100	80-95	70-90	35-75	20-40	3-20

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-12	0.6-2.0	0.22-0.24	5.1-7.3	-	LOW	LOW	MODERATE	.32	5-4	6
12-18	0.6-2.0	0.20-0.22	4.5-6.0	-	MODERATE	LOW	MODERATE	.32		
18-46	0.6-2.0	0.15-0.19	4.5-6.0	-	MODERATE	LOW	MODERATE	.32		
46-65	0.6-2.0	0.16-0.19	6.6-7.8	-	MODERATE	LOW	LOW	.32		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-PERCS SLOWLY, SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-2%: MODERATE-SEEPAGE 2-7%: MODERATE-SLOPE, SEEPAGE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH) [1]	0-15%: SLIGHT 15-25%: MODERATE-SLOPE
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL [1]	0-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

SOURCE MATERIAL

ROADFILL	0-15%: FAIR-FROST ACTION, SHRINK-SWELL 15-25%: FAIR-FROST ACTION, SHRINK-SWELL, SLOPE
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	0-8%: FAIR-THIN LAYER 8-15%: FAIR-THIN LAYER, SLOPE 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-6%: FAVORABLE 6+%: SLOPE
EMBANKMENTS DIKES AND LEVEES	SHRINK-SWELL
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	0-2%: FAVORABLE 2+%: SLOPE
TERRACES AND DIVERSIONS	0-12%: FAVORABLE 12+%: SLOPE
GRASSED WATERWAYS	0-2%: FAVORABLE 2+%: SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SLOPE, SHRINK-SWELL 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SLOPE, SHRINK-SWELL 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SLOPE, SHRINK-SWELL 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-FROST ACTION, SHRINK-SWELL 8-15%: MODERATE-SLOPE, SHRINK-SWELL, FROST ACTION 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

REGIONAL INTERPRETATIONS

PASTURE AND HAY	0-18%: GROUP 1 18+%: GROUP 2

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15%: SLIGHT 15-25%: MODERATE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		CORN SILAGE (TONS)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)		KENTUCKY BLUEGRASS (AUM)	
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	1	115		15		30		80		5.0		7.5		3.0	
2-6%	2E	110		15		30		80		5.0		7.5		3.0	
6-12%	3E	95		14		25		75		5.0		7.5		3.0	
6-12% ERODED	3E	90		13		25		75		4.5		6.7		3.0	
12-18%	4E	90		13		-		70		4.5		6.7		3.0	
12-18% ERODED	4E	85		12		-		70		4.0		6.0		2.5	
18+%	6E	-		-		-		-		4.0		6.0		2.5	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
0-12%	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SEVERE	AMERICAN BASSWOOD	68	WHITE SPRUCE
12+%	2R	MODERATE	MODERATE	SLIGHT	SLIGHT	SEVERE	NORTHERN RED OAK	65	EASTERN WHITE PINE
							BLACK WALNUT	60	BLACK WALNUT
							SUGAR MAPLE	60	GREEN ASH

WINDBREAKS (A)

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
0-12%	EASTERN REDCEDAR	19	NORTHERN WHITE-CEDAR	20	BLUE SPRUCE	22	EASTERN WHITE PINE	28
	EASTERN COTTONWOOD	60	GREEN ASH	35	HACKBERRY	34	SIBERIAN CRABAPPLE	18
	AMUR MAPLE	18	FLOWERING DOGWOOD	8	JAPANESE HONEYSUCKLE	9	LILAC	10

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-6%	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	POOR	POOR	GOOD	GOOD	POOR	-
6-12%	FAIR	GOOD	GOOD	GOOD	GOOD	GOOD	POOR	POOR	GOOD	GOOD	POOR	-
12+%	POOR	FAIR	GOOD	GOOD	GOOD	GOOD	POOR	POOR	FAIR	GOOD	POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

1 MATERIAL OF SUBSTRATUM IN PLACES IS CONSOLIDATED BELOW 5 FEET AND HAS SEEP ZONES. ALSO DIFFICULT TO EXCAVATE.

A WINDBREAK GROUP 1; 12+ PERCENT TOO STEEP.

MLRA(S): 90, 104, 105, 108
ELB, 2-74
TYPIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

RENOVA SERIES

THE RENOVA SERIES CONSISTS OF DEEP, WELL-DRAINED SOILS FORMED IN LOAMY SEDIMENTS OVER GLACIAL TILL UNDER DECIDUOUS FOREST ON UPLANDS. TYPICALLY THEY HAVE VERY DARK GRAY SILT LOAM SURFACE LAYERS 3 INCHES THICK; DARK GRAYISH-BROWN AND GRAYISH-BROWN SILT LOAM SUBSURFACE LAYERS 7 INCHES THICK; DARK YELLOWISH-BROWN SILTY CLAY LOAM UPPER SUBSOILS 9 INCHES THICK; YELLOWISH-BROWN AND LIGHT OLIVE-BROWN LOAM AND SANDY CLAY LOAM LOWER SUBSOILS 33 INCHES THICK; AND MOTTLED YELLOWISH-BROWN LOAM UNDERLYING MATERIAL. SLOPES RANGE FROM 1 TO 35 PERCENT. MOST AREAS ARE CROPPED.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-10	SIL, L	ML, CL	A-4	0	100	98-100	90-9	75-90	20-40	3-10
10-19	SICL, SIL, L	CL, ML	A-6	0	100	98-100	90-9	80-95	30-40	10-20
19-52	L, SCL, CL	CL, SC, CL-ML	A-4, A-6	0-2	95-100	85-95	65-8	45-65	20-35	5-15
52-60	L	CL	A-6	0-1	95-100	85-95	70-8	50-70	25-40	10-20

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-10	0.6-2.0	0.22-0.24	5.6-6.5	-	LOW	LOW	LOW	.32	4	6
10-19	0.2-2.0	0.20-0.22	4.5-6.0	-	LOW	LOW	MODERATE	.32		
19-52	0.2-2.0	0.17-0.19	4.5-7.3	-	LOW	LOW	MODERATE	.32		
52-60	0.2-2.0	0.17-0.19	7.4-7.8	-	LOW	LOW	LOW	.32		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-	-	B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	1-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-SLOPE,PERCS SLOWLY 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	1-2%: MODERATE-SEEPAGE 2-7%: MODERATE-SLOPE,SEEPAGE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	1-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE
SANITARY LANDFILL (AREA)	1-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	1-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

SOURCE MATERIAL

ROADFILL	1-15%: FAIR-FROST ACTION 15-25%: FAIR-SLOPE,FROST ACTION 25+%: POOR-SLOPE
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	1-8%: FAIR-THIN LAYER 8-15%: FAIR-SLOPE,THIN LAYER 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	1-15%: FAVORABLE 15+%: SLOPE
EMBANKMENTS DIKES AND LEVEES	LOW STRENGTH
EXCAVATED PONDS AQUIFIER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	
TERRACES AND DIVERSIONS	1-15%: FAVORABLE 15+%: SLOPE
GRASSED WATERWAYS	1-8%: FAVORABLE 8+%: SLOPE,ERODES EASILY

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	1-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	1-8%: MODERATE-FROST ACTION 8-15%: MODERATE-SLOPE,FROST ACTION 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS [2]	1-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	1-4%: MODERATE-FROST ACTION 4-8%: MODERATE-SLOPE,FROST ACTION 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	1-8%: MODERATE-FROST ACTION 8-15%: MODERATE-SLOPE,FROST ACTION 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

REGIONAL INTERPRETATIONS

PASTURE AND HAYLAND	1-18%: GROUP 1 18-25%: GROUP 2 25+%: GROUP 8

RECREATION

CAMP AREAS	1-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	1-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	1-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	1-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)		KENTUCKY BLUEGRASS (AUM)			
		NIRR	IRR[2]	NIRR	IRR[2]	NIRR	IRR[2]	NIRR	IRR[2]	NIRR	IRR[2]	NIRR	IRR[2]	NIRR	IRR[2]
0-2%	1	-	95	-	32	-	75	-	4.5	-	6.7	-	3.5	-		
2-6%	2E	-	95	-	32	-	70	-	4.5	-	6.7	-	3.5	-		
6-12%	3E	-	90	-	30	-	65	-	4.3	-	6.3	-	3.3	-		
6-12% ERODED	3E	-	85	-	26	-	60	-	4.0	-	6.0	-	3.0	-		
12-18%	4E	-	80	-	-	-	60	-	4.0	-	6.0	-	3.0	-		
18-25%	6E	-	-	-	-	-	-	-	3.0	-	4.5	-	2.5	-		
25-35%	7E	-	-	-	-	-	-	-	-	-	-	-	1.5	-		

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
0-12%	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	BLACK WALNUT	62	BLACK WALNUT
12+%	2R	MODERATE	MODERATE	SLIGHT	SLIGHT	MODERATE	AMERICAN BASSWOOD	69	NORTHERN RED OAK
							NORTHERN RED OAK	69	AMERICAN BASSWOOD
							EASTERN COTTONWOOD	92	SILVER MAPLE
							EASTERN WHITE PINE	64	WHITE OAK
							WHITE OAK	62	

WINDBREAKS (A)

CLASS-DETERMING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
2-12%	EASTERN WHITE PINE	28	GREEN ASH	35	HACKBERRY	34	EASTERN COTTONWOOD	60
	AMERICAN ELM	36	SIBERIAN CRABAPPLE	18	AMUR MAPLE	23	GRAY DOGWOOD	12
	TATARIAN HONEYSUCKLE	11	LILAC	12				

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	POTENTIAL AS HABITAT FOR: WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-6%	GOOD	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
6-18%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
18+%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE					
POTENTIAL PRODUCTION (LBS./AC. DRY WT):							
FAVORABLE YEARS							
NORMAL YEARS							
UNFAVORABLE YEARS							

FOOTNOTES

1 AREAS WITH MODERATELY SLOW PERMEABILITY HAVE SEVERE LIMITATIONS.

2 FOOTINGS BELOW FROST LEVEL

A 0-12%: WINDBREAK GROUP 1. 12+%: WINDBREAK GROUP 3-TOO STEEP FOR WINDBREAKS. MINNESOTA

MLRA(S): 95, 104, 105, 106
GAP-TOT, 3-75
TYPIC ARGIUDOLLS, FINE-LOAMY, MIXED, MESIC

ROCKTON SERIES

THE ROCKTON SERIES CONSISTS OF MODERATELY DEEP, WELL-DRAINED SOILS FORMED IN LOAMY SEDIMENTS AND LIMESTONE RESIDUUM UNDER PRAIRIE VEGETATION ON SUMMITS AND SIDESLOPES OF UPLANDS. TYPICALLY, THEY HAVE VERY DARK BROWN AND VERY DARK GRAYISH BROWN, LOAM SURFACE LAYERS 15 INCHES THICK. THE SUBSOIL IS DARK-BROWN AND DARK YELLOWISH-BROWN, FRIABLE LOAM AND SANDY CLAY LOAM IN UPPER 11 INCHES AND DARK YELLOWISH-BROWN, FIRM CLAY IN LOWER 5 INCHES. THE UNDERLYING MATERIAL IS FRACTURED LIMESTONE. SLOPES RANGE FROM 0 TO 25 PERCENT. MOST AREAS ARE USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-15	L	ML, CL-ML	A-4	0	90-100	90-100	85-95	50-75	25-35	5-10
15-26	L, SCL, CL	CL, SC	A-6, A-7	0	90-100	90-100	75-90	45-70	30-45	10-20
26-31	C, CL, SIC	CH, CL, MH	A-7	0-2	90-100	90-100	90-95	70-90	40-60	20-30
31	WB			0						

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-15	0.6-2.0	0.20-0.22	5.1-6.5	-	LOW	LOW	LOW	.28	4-3	6
15-26	0.6-2.0	0.17-0.19	5.1-6.5	-	MODERATE	LOW	LOW	.28		
26-31	0.6-2.0	0.10-0.14	5.6-7.3	-	HIGH	LOW	LOW	.28		
31										

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		20-40	RIPPABLE	-		B	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-DEPTH TO ROCK 7+%: SEVERE-DEPTH TO ROCK,SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-DEPTH TO ROCK
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: FAIR-THIN LAYER 8-15%: FAIR-THIN LAYER,SLOPE 15+%: POOR-SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-DEPTH TO ROCK 8-15%: MODERATE-DEPTH TO ROCK,SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-FROST ACTION 8-15%: MODERATE-FROST ACTION,SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	0-15%: FAIR-THIN LAYER 15+%: POOR-AREA RECLAIM
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	0-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA 2	DEPTH TO ROCK
EMBANKMENTS DIKES AND LEVEES	THIN LAYER
EXCAVATED PONDS AQUIFER FED	NO WATER,DEPTH TO ROCK
DRAINAGE	NOT NEEDED
IRRIGATION	0-6%: ROOTING DEPTH 6+%: SLOPE
TERRACES AND DIVERSIONS	0-1%: NOT NEEDED 1-12%: DEPTH TO ROCK 12+%: SLOPE,DEPTH TO ROCK
GRASSED WATERWAYS	0-1%: FAVORABLE 1-12%: DEPTH TO ROCK 12+%: DEPTH TO ROCK,SLOPE

REGIONAL INTERPRETATIONS

PASTURE AND HAYLAND	0-18%: GROUP 1 18+%: GROUP 2

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2%: MODERATE-DEPTH TO ROCK 2-6%: MODERATE-DEPTH TO ROCK,SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15%: SLIGHT 15+%: MODERATE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPA-BILITY	CORN (BU)		CORN SILAGE (TONS)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)		KENTUCKY BLUEGRASS (AUM)	
	NIRR	IRR[1]	NIRR	IRR[1]	NIRR	IRR[1]	NIRR	IRR[1]	NIRR	IRR[1]	NIRR	IRR[1]	NIRR	IRR[1]	NIRR	IRR[1]
0-2%	2S		95		14		28		70		4.0		5.6		3.0	
2-6%	2E		90		13		26		65		4.0		5.6		3.0	
6-12%	3E		75		9		22		57		3.5		4.9		2.7	
12-18%	4E		65		7		-		49		3.0		4.2		2.0	
18-25%	6E		-		-		-		-		2.5		3.7		1.7	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS (A)

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
0-12%	EASTERN REDCEDAR	18	NORTHERN WHITE-CEDAR	16	BLUE SPRUCE	22	EASTERN WHITE PINE	24
	GREEN ASH	28	HACKBERRY	25	AMERICAN ELM	28	SIBERIAN CRABAPPLE	15
	GRAY DOGWOOD	12	TATARIAN HONEYSUCKLE	11	LILAC	12		

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERBS.	HARDWD TREES	CONIFER PLANTS	SHRUBS	POTENTIAL AS HABITAT FOR: WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-12%	FAIR	GOOD	GOOD	GOOD	GOOD	-	POOR	POOR	GOOD	GOOD	V. POOR	-
12+%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE					
POTENTIAL PRODUCTION (LBS./AC. DRY WT):							
FAVORABLE YEARS							
NORMAL YEARS							
UNFAVORABLE YEARS							

FOOTNOTES

1 SEEPAGE IN BEDROCK MAY CAUSE POLLUTION TO GROUND WATER.
2 CAVERNOUS LIMESTONE BELOW CAN FORM SINKHOLES.
A 0-12%: WINDBREAK GROUP 5. 12+%: WINDBREAK GROUP 7 - TOO STEEP FOR WINDBREAKS.

MLRA(S): 104, 105, 108, 115
KEL, 9-73
TYPIC HAPLUDALFS, FINE-SILTY, MIXED, MESIC

SEATON SERIES

THE SEATON SERIES CONSISTS OF WELL DRAINED SOILS FORMED IN LOESS ON UPLANDS. THE SURFACE LAYER IS DARK-BROWN SILT LOAM 4 INCHES THICK. THE SUBSURFACE LAYER IS BROWN SILT LOAM 5 INCHES THICK. THE SUBSOIL IS YELLOWISH-BROWN AND BROWN SILT-LOAM 61 INCHES THICK. THE UNDERLYING MATERIAL IS MIXED LIGHT BROWNISH-GRAY AND BROWN SILT LOAM. SLOPES RANGE FROM 5 TO 45 PERCENT. THESE SOILS ARE USED AS CROPLAND, WOODLAND, AND PASTURE.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	SIL	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	24-33	6-16
9-70	SIL	CL	A-6, A-4	0	100	100	100	90-100	28-38	9-21
70-80	SIL, SI	CL, CL-ML	A-4, A-6	0	100	100	100	90-100	26-36	7-17

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-9	0.6-2.0	0.22-0.24	5.6-7.3	-	LOW	LOW	MODERATE	.32	5-4	6
9-70	0.6-2.0	0.20-0.22	5.1-6.5	-	LOW	LOW	MODERATE	.32		
70-80	0.6-2.0	0.20-0.22	5.6-8.4	-	LOW	LOW	MODERATE	.32		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	4-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	4-7%: MODERATE-SEEPAGE,SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	4-15%: SLIGHT 15-25%: MODERATE-SLOPE 25-70%: SEVERE-SLOPE
SANITARY LANDFILL (AREA)	4-8%: SLIGHT 8-15%: MODERATE-SLOPE 25+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	4-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	4-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	4-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	4-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-FROST ACTION
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	4-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	LOW STRENGTH
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	SLOPE
TERRACES AND DIVERSIONS	FAVORABLE
GRASSED WATERWAYS	FAVORABLE

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	4-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	4-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	4-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	4-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		WHEAT (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)			
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
4-7%	2E		101		35		46		70		4.6		6.6			
7-12% ERODED	3E		96		30		41		61		4.3		6.3			
7-12% SEV. ER.	4E		82		-		27		54		3.9		5.1			
12-18% ERODED	4E		84		-		28		56		4.0		5.2			
18-30%	6E		-		-		-		-		3.7		5.0			
30+%	7E		-		-		-		-		-		-			

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
4-12% >50 F. MAAT	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	YELLOW-POPLAR	90	WHITE OAK
12-35% >50 F. MAAT	2R	MODERATE	MODERATE	MODERATE	SLIGHT	MODERATE	WHITE OAK	90	BLACK WALNUT
35+% >50 F. MAAT	2R	SEVERE	SEVERE	SEVERE	SLIGHT	MODERATE	NORTHERN RED OAK BLACK WALNUT	80	NORTHERN RED OAK GREEN ASH RED PINE SUGAR MAPLE
4-15% <50 F. MAAT	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	70	BLACK WALNUT
15-35% <50 F. MAAT	2R	MODERATE	MODERATE	MODERATE	SLIGHT	MODERATE			RED PINE
35+% <50 F. MAAT	2R	SEVERE	SEVERE	SEVERE	SLIGHT	MODERATE			WHITE SPRUCE NORTHERN WHITE-CEDAR

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
4-18% >50 F. MAAT	EASTERN WHITE PINE		RED PINE		NORWAY SPRUCE		DOUGLAS-FIR	
	FORSYTHIA		SILKY DOGWOOD		AUTUMN-OLIVE		GRAY DOGWOOD	
4-18% <50 F. MAAT	WHITE SPRUCE		NORTHERN WHITE-CEDAR		EASTERN WHITE PINE		RED PINE	
	ORIENTAL ARBORVITAE	7	PEKING COTONEASTER	8	GRAY DOGWOOD	10	SILKY DOGWOOD	10
	LILAC	10	AMUR MAPLE	15	MOCKORANGE	9		

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	POTENTIAL AS HABITAT FOR: WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
4-7%	GOOD	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
7-12%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
12+%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSEN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

1 FROST ACTION EASILY OVERCOME BY EXTENDING FOOTINGS BELOW FROST LINE.

MN0104 SOIL SURVEY INTERPRETATIONS

MLRA(S): 104, 105 SKYBERG SERIES
REV. JPC, 5-78
UDOLLIC DERRAQUALFS, FINE-LOAMY, MIXED, MESIC

THE SKYBERG SERIES CONSISTS OF DEEP, SOMEWHAT POORLY-DRAINED SOILS FORMED IN A LOESS MANTLE OVER FIRM GLACIAL TILL UNDER OAK SAVANNAH ON UPLANDS. THE SURFACE LAYER IS VERY DARK GRAY SILT LOAM, 7 INCHES THICK. THE SUBSURFACE LAYER IS DARK GRAYISH-BROWN AND GRAYISH-BROWN SILT LOAM, 5 INCHES THICK. THE SUBSOIL IS GRAYISH-BROWN, MOTTLED SILTY CLAY LOAM IN UPPER 10 INCHES, AND YELLOWISH-BROWN MOTTLED LOAM IN LOWER 38 INCHES. THE UNDERLYING MATERIAL IS YELLOWISH-BROWN LOAM. SLOPES RANGE FROM 0 TO 2 PERCENT. MOST AREAS ARE CULTIVATED.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-12	SIL	CL-ML, CL	A-6, A-4	0	100	95-100	90-100	85-100	20-40	4-20
12-22	SIL, SICL	CL	A-6, A-7	0	100	95-100	90-100	85-100	35-45	15-25
22-60	L	CL, CL-ML	A-6, A-4	0-1	90-100	85-100	80-95	50-70	25-40	4-15
60-66	L	CL, CL-ML	A-6, A-4	0-1	90-100	85-100	80-95	50-70	25-40	4-15

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CONCRETE	EROSION FACTORS K	T	EROSION GROUP	WIND ERODI GROUP
0-12	0.6-2.0	0.22-0.24	5.6-6.5	-	MODERATE	HIGH	MODERATE	-	-	6	
12-22	0.6-2.0	0.18-0.20	4.5-5.5	-	MODERATE	HIGH	MODERATE	-			
22-60	0.06-0.6	0.14-0.19	5.1-7.3	-	MODERATE	HIGH	MODERATE	-			
60-66	0.06-0.6	0.13-0.19	7.4-7.8	-	MODERATE	HIGH	LOW	-			

FLOODING FREQUENCY	FLOODING DURATION	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYDRIC GRP	POTENTIAL FROST ACTION
NONE		1.0-3.0	PERCHED	APR-JUN	-		260		-		C	HIGH

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY, WETNESS	
SEWAGE LAGOON AREAS	SLIGHT	
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS	
SANITARY LANDFILL (AREA)	SEVERE-WETNESS	
DAILY COVER FOR LANDFILL	GOOD	

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	SEVERE-WETNESS
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION, LOW STRENGTH
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	MODERATE-WETNESS

SOURCE MATERIAL

ROADFILL	POOR-FROST ACTION, LOW STRENGTH
SAND	UNSUITED-EXCESS FINES
GRAVEL	UNSUITED-EXCESS FINES
TOPSOIL	FAIR-THIN LAYER

WATER MANAGEMENT

POND RESERVOIR AREA	FAVORABLE
EMBANKMENTS DIKES AND LEVEES	FAVORABLE
EXCAVATED PONDS AQUIFER FED	FAVORABLE
DRAINAGE	PERCS SLOWLY
IRRIGATION	PERCS SLOWLY
TERRACES AND DIVERSIONS	NOT NEEDED
GRASSED WATERWAYS	WETNESS

REGIONAL INTERPRETATIONS

PASTURE AND HAYLAND	CROP 1, MN

RECREATION

CAMP AREAS	SEVERE-WETNESS	PLAYGROUNDS	SEVERE-WETNESS
PICNIC AREAS	MODERATE-WETNESS	PATHS AND TRAILS	MODERATE-WETNESS

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY		CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)		KENTUCKY BLUEGRASS (AUM)	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
ALL	3w	-	100		35		70		4.5		6.0		3.0	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORC SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT.Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
ALL	20	SLIGHT	SLIGHT	SLIGHT	SLIGHT	SEVERE	AMERICAN BASSWOOD	68	BLACK WALNUT
							BLACK WALNUT	55	EASTERN COTTONWOOD
							EASTERN COTTONWOOD	86	AMERICAN BASSWOOD
							SUGAR MAPLE	60	EASTERN WHITE PINE

WINDBREAKS

CLASS-DETERMING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	NORTHERN WHITE-CEDAR	20	WHITE SPRUCE	22	EASTERN WHITE PINE	28	EASTERN COTTONWOOD	60
	SILVER MAPLE	45	GREEN ASH	35	COMMON HACKBERRY	34	TATARIAN HONEYSUCKLE	11
	SIBERIAN CRABAPPLE	18	LILAC	12				

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	GOOD	GOOD	GOOD	GOOD	FAIR	-	FAIR	FAIR	GOOD	GOOD	FAIR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPS)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A STONE LINE AT 22 INCHES AT CONTACT BETWEEN LOESS AND TILL. INCLUDES THIN COARSER-TEXTURED LAYERS.

E WINDBREAK GROUP 1.MN.

MLRA(S): 104, 105, 108 TAMA SERIES
JDH, 2-73
TYPIC ARGIUDOLLS, FINE-SILTY, MIXED, MESIC

THE TAMA SERIES CONSISTS OF WELL-DRAINED SOILS FORMED IN LOESS UNDER PRAIRIE VEGETATION ON UPLANDS. THE SURFACE LAYER IS VERY DARK BROWN SILTY CLAY LOAM 14 INCHES THICK. THE SUBSOIL IS VERY DARK GRAYISH-BROWN, BROWN, DARK YELLOWISH-BROWN AND YELLOWISH-BROWN, FRIABLE SILTY CLAY LOAM 31 INCHES THICK. THE SUBSTRATUM IS YELLOWISH-BROWN SILTY CLAY LOAM. SLOPES RANGE FROM 0 TO 20 PERCENT. MOST AREAS ARE CULTIVATED.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-14	SICL, SIL	ML, CL, OL	A-6, A-7	0	100	100	100	95-100	35-50	10-20
14-45	SICL	CL	A-7	0	100	100	100	95-100	40-50	15-25
45-60	SICL, SIL	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-14	0.6-2.0	0.22-0.24	5.1-5.5	-	MODERATE	MODERATE	MODERATE	.32	5	7
14-45	0.6-2.0	0.18-0.20	5.1-5.5	-	MODERATE	MODERATE	MODERATE	.43		
45-60	0.6-2.0	0.18-0.20	5.6-6.0	-	MODERATE	MODERATE	MODERATE	.43		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	HIGH

SANITARY FACILITIES (A)

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS [1]	0-2%: MODERATE-SEEPAGE,EXCESS HUMUS 2-7%: MODERATE-SLOPE,SEEPAGE,EXCESS HUMUS 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH) [1]	0-15%: MODERATE-TOO CLAYEY 15-25%: MODERATE-SLOPE,TOO CLAYEY
SANITARY LANDFILL (AREA) [1]	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: FAIR-TOO CLAYEY 8-15%: FAIR-SLOPE,TOO CLAYEY 15+%: POOR-SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS [2]	0-8%: MODERATE-LOW STRENGTH,SHRINK-SWELL 8-15%: MODERATE-SLOPE,LOW STRENGTH, SHRINK-SWELL 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-LOW STRENGTH,SHRINK-SWELL 8-15%: MODERATE-SLOPE,LOW STRENGTH, SHRINK-SWELL 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS [2]	0-4%: MODERATE-SHRINK-SWELL,LOW STRENGTH 4-8%: MODERATE-SLOPE,SHRINK-SWELL, LOW STRENGTH 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-15%: SEVERE-FROST ACTION,LOW STRENGTH 15+%: SEVERE-SLOPE,FROST ACTION,LOW STRENGTH
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	POOR-LOW STRENGTH,EXCESS HUMUS
SAND [3]	UNSUITED
GRAVEL [3]	UNSUITED
TOPSOIL	0-8% SICL: FAIR-TOO CLAYEY 0-8% SIL: FAIR-THIN LAYER 8-15% SICL: FAIR-TOO CLAYEY,SLOPE 8-15% SIL: FAIR-THIN LAYER,SLOPE 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	COMPRESSIBLE,LOW STRENGTH,ERODES EASILY
EXCAVATED PONDS AQUIFIER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	ERODES EASILY
TERRACES AND DIVERSIONS	FAVORABLE
GRASSED WATERWAYS	FAVORABLE

REGIONAL INTERPRETATIONS

RECREATION

CAMP AREAS	0-8% SICL: MODERATE-TOO CLAYEY 0-8% SIL: SLIGHT 8-15% SICL: MODERATE-TOO CLAYEY,SLOPE 8-15% SIL: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2% SICL: MODERATE-TOO CLAYEY 0-2% SIL: SLIGHT 2-6% SICL: MODERATE-TOO CLAYEY,SLOPE 2-6% SIL: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8% SICL: MODERATE-TOO CLAYEY 0-8% SIL: SLIGHT 8-15% SICL: MODERATE-TOO CLAYEY,SLOPE 8-15% SIL: MODERATE-SLOPE 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15% SICL: MODERATE-TOO CLAYEY 0-15% SIL: SLIGHT 15-25% SICL: MODERATE-TOO CLAYEY,SLOPE 15-25% SIL: MODERATE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)		KENTUCKY BLUEGRASS (AUM)			
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	1		127		49		100		5.4		8.8		4.2			
2-5%	2E		125		48		95		5.2		8.6		4.2			
5-9%	3E		120		46		90		5.0		8.3		4.0			
5-9% ERODED	3E		117		44		88		4.9		8.1		3.8			
9-14%	3E		111		42		83		4.7		7.8		3.7			
9-14% ERODED	3E		108		41		81		4.5		7.5		3.3			
14-18% ERODED	4E		93		35		70		3.9		6.5		3.0			

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	EASTERN WHITE PINE	32	DOUGLAS-FIR	25	SCOTCH PINE	28	EASTERN REDCEDAR	21
	RED PINE	27	BLUE SPRUCE	18	EUROPEAN LARCH		SILVER MAPLE	35
	NORWAY SPRUCE		GREEN ASH	36	EASTERN COTTONWOOD		RUSSIAN-OLIVE	

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERBS.	HARDWD TREES	CONIFER PLANTS	SHRUBS	POTENTIAL AS HABITAT FOR: WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-5%	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
5-15%	FAIR	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE					
POTENTIAL PRODUCTION (LBS./AC. DRY WT):							
FAVORABLE YEARS							
NORMAL YEARS							
UNFAVORABLE YEARS							

FOOTNOTES

1 MANY AREAS ARE UNDERLAIN BY A MORE SLOWLY PERMEABLE GLACIAL TILL AT DEPTHS GREATER THAN 6 TO 8 FEET.
2 FROST ACTION EASILY OVERCOME BY EXTENDING FOOTINGS BELOW FROST LEVEL.
3 SAND AND SMALL AMOUNTS OF GRAVEL MAY BE AT DEPTHS BELOW 6 FEET ON LOESS-COVERED STREAM BENCHES.
A CANGER OF POLLUTION OF GROUND WATER FOR BENCH PHASES DUE TO POROUS SUBSTRATUM.

MLRA(S): 103
REV. KRV,ELB, 12-75
TYPIC HAPLUDOLLS, FINE-LOAMY OVER SANDY OR SANDY-SKELETAL, MIXED, MESIC

WADENA SERIES

THE WADENA SERIES CONSISTS OF WELL DRAINED LOAMY SOILS MODERATELY DEEP OVER SAND AND GRAVEL. THE SURFACE LAYER IS BLACK AND VERY DARK LOAM 13 INCHES THICK. THE SUBSOIL IS DARK-BROWN AND DARK YELLOWISH-BROWN LOAM AND SANDY LOAM 17 INCHES THICK. THE UNDERLYING MATERIAL IS VARIGATED DARK YELLOWISH-BROWN, DARK BROWN, YELLOWISH BROWN, BROWN AND GRAYISH-BROWN SAND AND GRAVEL. SLOPES RANGE FROM 0 TO 12 PERCENT. THESE SOILS ARE MOSTLY USED FOR CROPLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-13	L	ML, CL, CL-ML	A-4	0	95-100	85-100	80-95	50-65	25-40	2-10
13-30	L, SL, SCL	SM, ML, CL, SC	A-4, A-6	0	95-100	85-100	80-95	40-60	25-40	5-12
30-50	SG	SP, SP-SM	A-1, A-3	0	80-95	70-95	40-80	2-10	-	NP

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-13	2.0-6.0	0.20-0.22	6.1-7.3	-	LOW	LOW	LOW	.24	4-3	5
13-30	2.0-6.0	0.12-0.14	6.1-7.3	-	LOW	LOW	LOW	.32		
30-50	>20	0.02-0.04	6.6-8.4	-	LOW	LOW	LOW	.10		

FLOODING			HIGH WATER TABLE			CEMENTED PAN		BEDROCK		SUBSIDENCE		HYD GRP	POTENTIAL FROST ACTION
FREQUENCY	DURATION	MONTHS	DEPTH (FT)	KIND	MONTHS	DEPTH (IN)	HARDNESS	DEPTH (IN)	HARDNESS	INIT. (IN)	TOTAL (IN)		
NONE			>6.0			-		>60		-		B	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE
DAILY COVER FOR LANDFILL	0-8%: FAIR-THIN LAYER 8-15%: FAIR-THIN LAYER,SLOPE

COMMUNITY DEVELOPMENT (A)

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE

SOURCE MATERIAL

ROADFILL	GOOD
SAND	GOOD
GRAVEL	FAIR-EXCESS FINES
TOPSOIL	0-8%: GOOD 8-15%: FAIR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEEPAGE
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	SEEPAGE,ROOTING DEPTH
TERRACES AND DIVERSIONS	ROOTING DEPTH
GRASSED WATERWAYS	ROOTING DEPTH

REGIONAL INTERPRETATIONS

PASTURE AND HAYLAND	GROUP 1

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE	PATHS AND TRAILS	SLIGHT

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		KENTUCKY BLUEGRASS (AUM)		BROMEGRASS-ALFALFA (AUM)			
		NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	2S	75		28		60		3.5		3.6		5.2			
2-6%	2E	70		26		55		3.25		3.4		4.8			
6-12%	3E	55		23		50		3.0		3.2		4.5			

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	EASTERN REDCEDAR	18	NORTHERN WHITE-CEDAR	16	WHITE SPRUCE	22	RED PINE	24
	GREEN ASH	28	HACKBERRY	25	BUR OAK	25	SIBERIAN CRABAPPLE	15
	GRAY DOGWOOD	12	TATARIAN HONEYSUCKLE	11	LILAC	12	EASTERN COTTONWOOD	50

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-6%	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
6-12%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE					
POTENTIAL PRODUCTION (LBS./AC. DRY WT):							
FAVORABLE YEARS							
NORMAL YEARS							
UNFAVORABLE YEARS							

FOOTNOTES

1 EXCESSIVE PERMEABILITY MAY CAUSE POLLUTION OF NEARBY STREAMS, LAKES AND WELLS.

A MINNESOTA WINDBREAK GROUP 5.

MLRA(S): 104, 105
CRC, 1-74
TYPIC HAPLUDOLLS, FINE-SILTY OVER SANDY OR SANDY-SKELETAL, MIXED, MESIC

WAUKEGAN SERIES

THE WAUKEGAN SERIES CONSISTS OF WELL-DRAINED SOILS FORMED IN LOESS OR SILTY ALLUVIUM UNDERLAIN BY SAND AND GRAVEL UNDER PRAIRIE VEGETATION ON OUTWASH PLAINS AND STREAM TERRACES. TYPICALLY THESE SOILS HAVE BLACK AND VERY DARK BROWN, SILT LOAM SURFACE LAYERS 15 INCHES THICK. THE SUBSOIL IS BROWN AND YELLOWISH-BROWN SILT LOAM IN UPPER 18 INCHES AND BROWN AND YELLOWISH-BROWN COARSE SAND AND GRAVEL IN LOWER 19 INCHES. THE UNDERLYING MATERIAL IS BROWN, YELLOWISH-BROWN AND GRAYISH-BROWN COARSE SAND AND GRAVEL. SLOPES RANGE FROM 0 TO 12%. MOST AREAS CULTIVATED.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-15	SIL	ML, CL	A-4	0	95-100	95-100	95-100	85-95	25-40	3-10
15-33	SIL	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	85-95	25-40	5-15
33-60	GR-COS	SP, SW, SP-SM	A-1	0-2	80-95	65-85	30-50	3-10	-	NP

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-15	0.6-2.0	0.22-0.24	5.6-7.3	-	LOW	LOW	LOW	.32	3	6
15-33	0.6-2.0	0.20-0.22	5.6-6.5	-	LOW	LOW	LOW	.43		
33-60	6.0-20	0.02-0.04	6.6-7.8	-	LOW	LOW	LOW	.10		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS [1]	0-8%: SLIGHT 8-12%: MODERATE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE
SANITARY LANDFILL (AREA)	0-8%: SEVERE-SEEPAGE 8-12%: SEVERE-SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	0-8%: GOOD 8-12%: MODERATE-SLOPE

COMMUNITY DEVELOPMENT

SHALLOW EXCAVATIONS [2]	SEVERE-CUTBANKS CAVE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-12%: MODERATE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-12%: MODERATE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-12%: MODERATE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	

SOURCE MATERIAL

ROADFILL	GOOD
SAND	GOOD
GRAVEL	FAIR-EXCESS FINES
TOPSOIL	0-8%: GOOD 8-12%: FAIR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEEPAGE
EXCAVATED PONDS AQUIFER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	0-2%: FAVORABLE 2+%: SLOPE,ERODES EASILY
TERRACES AND DIVERSIONS	0-2%: NOT NEEDED 2+%: FAVORABLE
GRASSED WATERWAYS	0-2%: NOT NEEDED 2+%: ERODES EASILY

REGIONAL INTERPRETATIONS

PASTURE AND HAY	GROUP 1

RECREATION

CAMP AREAS	0-8%: SLIGHT 8-12%: MODERATE-SLOPE	PLAYGROUNDS	0-2%: SLIGHT 2-6%: MODERATE-SLOPE 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: SLIGHT 8-12%: MODERATE-SLOPE	PATHS AND TRAILS	SLIGHT

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	CORN (BU)		SOYBEANS (BU)		OATS (BU)		GRASS-LEGUME HAY (TONS)		BROMEGRASS-ALFALFA (AUM)					
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-2%	2S		100		35		75		4.0		5.6					
2-6%	2E		95		30		75		4.0		5.6					
6-12%	3E		90		25		70		3.5		4.9					

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
							NONE		

WINDBREAKS (8)

CLASS-DETERMING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	EASTERN REDCEDAR	18	EASTERN COTTONWOOD	50	AMERICAN ELM	28	RED PINE	24
	NORTHERN WHITE-CEDAR	16	HACKBERRY	25	SIBERIAN CRABAPPLE	15	WHITE SPRUCE	22
	GREEN ASH	28	LILAC	12	AMERICAN PLUM	10	TATARIAN HONEYSUCKLE	11

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERBS.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-6%	GOOD	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
6-12%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A GENERALLY INSUFFICIENT WATER IN PROFILE FOR POTENTIAL FROST ACTION.
1 HAZARD OF POLLUTION.
2 UNSTABLE IN DEEPER EXCAVATIONS.
8 WINDBREAK GROUP 5.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES Whalen
STATE Minnesota
MLRA 105,104,195,103

Revised Draft GAP, JFC 6/72

The Whalen series consists of nearly level to very steep well drained soils formed in 20 to 40 inches of mixed loess, glacial drift, and limestone residuum over bedrock. In a representative profile, the surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil, about 15 inches thick, is brown loam in upper part grading to dark yellowish brown clay loam in lower part. The underlying material is bedrock. Native vegetation was forest. Whalen soils are associated with Racine, Renova, Rockton, and Winneshiek soils.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-4	Silt loam	ML	A-4		100	95-100	90-100	80-90	30-40	5-10	0.6-2.0	.22-.24	5.6-7.3	Moderate
4-12	Loam	ML or CL	A-6		98-100	95-100	80-95	75-90	30-40	10-15	0.6-2.0	.17-.19	5.1-6.5	Moderate
12-24	Clay loam	CL, CH or MH	A-7		90-95	80-95	80-90	60-75	40-60	20-30	0.2-0.6	.15-.19	5.1-7.8	High
24+	Rock													

Flooding None -
Hydrologic group: A
Depth to water table: More than 10 feet
Depth to bedrock: 20 to 40 inches
Corrosivity - uncoated steel:
Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair: bedrock 20 to 40 inches; mostly ML and CL materials; poor on slopes greater than 18 percent
Sand	Unsuited
Gravel	Unsuited
Topsoil	Fair: thin topsoil

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: bedrock at 20-40 inches; hazard of pollution to potential ground water in bedrock
Sewage Lagoons	Severe: bedrock at 20 to 40 inches; hazard of pollution to potential ground water in bedrock
Shallow Excavations	Severe: bedrock at 20 to 40 inches
Dwellings: With Basements	Severe: bedrock at 20 to 40 inches
Dwellings: Without Basements	Moderate: bedrock at 20 to 40 inches; severe on slopes more than 12 percent
Sanitary Landfill	Severe: bedrock at 20 to 40 inches
Local Roads and Streets	Moderate: bedrock at 20 to 40 inches; moderate shrink-swell potential Severe: slopes greater than 12 percent
Potential Frost Action	Low

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Bedrock at 20 to 40 inches; potential voids in rock to allow high seepage losses; moderate permeability; possible sites on more sloping areas
Embankments, Dikes, and Levees	Bedrock at 20 to 40 inches; has medium compressibility, shear strength and compressibility
Drainage of Cropland and Pasture	Not needed, naturally well drained
Irrigation	Moderate available water capacity; erosion hazard on sloping areas
Terraces and Diversions	Bedrock at 20 to 40 inches
Grassed Waterways	Need in small natural drainways to collect runoff; bedrock at 20 to 40 inches.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Slight: 0-6% slopes; moderate: 6-12% slopes; severe: above 12% slopes; slow runoff on the nearly level areas
Picnic Areas	Slight: 0-6% slopes; moderate: 6-12% slopes; severe: above 12% slopes
Playgrounds	Slight: 0-2% slopes; moderate: 2-6% slopes; severe: above 6% slopes
Paths and Trails	Slight: 0-18% slopes; moderate: over 18% slopes

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn Bu	Soybeans Bu	Oats Bu	Alfalfa-Brome Tons	Alfalfa-Brome AUM	Bluegrass Pasture AUM
0-2% slopes	IIs	2	.37	85	28	65	3.2	4.7	3.0
2-6% slopes	IIe	2	.37	80	24	60	3.2	4.7	3.0
6-12% slopes	IIIe	2	.37	65	--	45	3.0	4.5	2.5
12-18% slopes	IVe	2	.37	--	--	40	2.0	3.0	2.0
18-25% slopes	VIe	2	.37	--	--	--	2.0	3.0	2.0
25-35% slopes	VIIe	2	.37	--	--	--	---	---	1.5

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-6%slopes	Good	Good	Good	Good	Good	Very Poor	Poor	Good	Good	Very Poor
6-35%slopes	Fair	Fair	Fair	Fair	Fair	Very Poor	Poor	Fair	Fair	Very Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity: Important Trees	Potential Productivity: Site Index	Woodland Management Hazards: Erosion Hazard	Woodland Management Hazards: Equipment Limitations	Woodland Management Hazards: Seeding Mortality	Woodland Management Hazards: Plant Competition	Suitable Species: To Favor	Suitable Species: To Plant	Other
All	3d	Northern Red Oak	55-65	Slight to Moderate	Slight; Moderate on slopes more than 12%	Moderate	Slight to Moderate	Oak	Oak	
		Basswood	60-70						R. Pine	
		American Elm	55-65					Basswood	W. Pine	
		Black Walnut	50-65					B. Walnut		

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor
5	**Red and White Cedar, Spruce**	18, 25	**Fair**
	Pine, Green Ash	32, 32	**Fair**
	Hackberry, Basswood	30, --	**Fair**
	Russian Olive, Amur Maple, American Plum	30, 22, 18	**Good**
	Caragana, Honeysuckle, Lilac	12, 10-12, 12	**Good**

OTHER

FOR INTERIM USE

Subject to change on completion of coordination between MLRA's

USDA-SCS-LINCOLN, NEBR. 1973

APPENDIX D

MAMMALS OF SOUTHEASTERN MINNESOTA

MAMMALS: SOUTHEASTERN MINNESOTA

Common Name	Preferred Habitat
Common Mole	prairie, prefers sands and light loam soils
Cinerous Shrew	moist areas
Oppossum	hollow trees, brush piles, old buildings
White Tail Jack Rabbit	grasslands
Cottontail	brush and broken decidum
Woodchuck	edges of clearings
13 Lined Ground Squirrel	open pastures, edges of clearings
Eastern Chipmunk	deciduous brush
Red Squirrel	coniferous forests
Fox Squirrel	mature hardwood forest
Gray Squirrel	mature hardwood forest
Mississippi Valley Pocket Gopher	loose soils
Pocket Mouse	sandy soils, open areas
Beaver	aspen/willow forests, small streams or lakes
White-footed Mouse	grassland
Red Back Vole	damp deciduous forests
Meadow Mouse	lowland prairie
Prairie Vole	grasslands
Muskrat	cattail marshes, streams, lakes
Meadow Jumping Mouse	lowland prairie
Raccoon	oak forest & farmland, aquatic areas
Long-tailed Weasel	brush areas & along watercourses
Mink	along watercourses & lakes
Otter	streams, rivers, lakes, ponds
Striped Skunk	brush, forest, prairies
Badger	brush, forest, prairie
Red Fox	grasslands, forest
Gray Fox	brush, forest
Bobcat	wooded river bottom
White-tailed Deer	grasslands, brush forest

Source: Gunderson, H.L. and J.R. Beer. The Mammals of Minnesota. University of Minnesota Press, Minneapolis, Minnesota, 1953.

DESIGNATED ROADWAY CROSSINGS

Dakota County

1. U.S. Truck Highway 52/State Trunk Highway 56
2. County State Aid Highway 48
3. County State Aid Highway 62
4. County State Aid Highway 66
5. County State Aid Highwya 47
6. County State Aid Highway 85
7. U.S. Trunk Highway 61

Goodhue County

1. County State Aid Highway 17
2. State Trunk Highway 19
3. County State Aid Highway 8
4. County State Aid Highway 25
5. County State Aid Highway 1
6. County Road 56
7. County State Aid Highway 9
8. County State Aid Highway 8
9. County Road 50
10. U.S. Trunk Highway 52
11. State Trunk Highway 60
12. County State Aid Highway 10
13. County State Aid Highway 12
14. County State Aid Highway 11
15. County Road 43
16. County Road 54
17. County State Aid Highway 27

Olmsted County

1. County State Aid Highway 13
2. County State Aid Highway 5
3. County Road 113
4. County Road 105
5. County State Aid Highway 14
6. County Road 103
7. County State Aid Highway 4
8. County State Aid Highway 3
9. County Road 134
10. U.S. Trunk Highway 14
11. County State Aid Highway 34
12. County State Aid Highway 25
13. County Road 104
14. County Road 117
15. County Road 148

Olmsted County (Continued)

16. County State Aid Highway 8
17. County State Aid Highway 16
18. State Trunk Highway 30
19. Interstate 90
20. U.S. Trunk Highway 63
21. County Road 120
22. State Trunk Highway 50

Mower County

none

Fillmore County

1. Federal Aid Secondary Highway 29
2. Federal Aid Secondary Highway 4
3. County State Aid Highway 1
4. Federal Aid Secondary Highway 23 (?)
5. U.S. Trunk Highway 16
6. County State Aid Highway 12
7. County State Aid Highway 14
8. County State Aid Highway 1
9. State Trunk Highway 44

APPENDIX F

CAMPSITE AVAILABILITY

CAMPSITE AVAILABILITY
(Partial Listing)

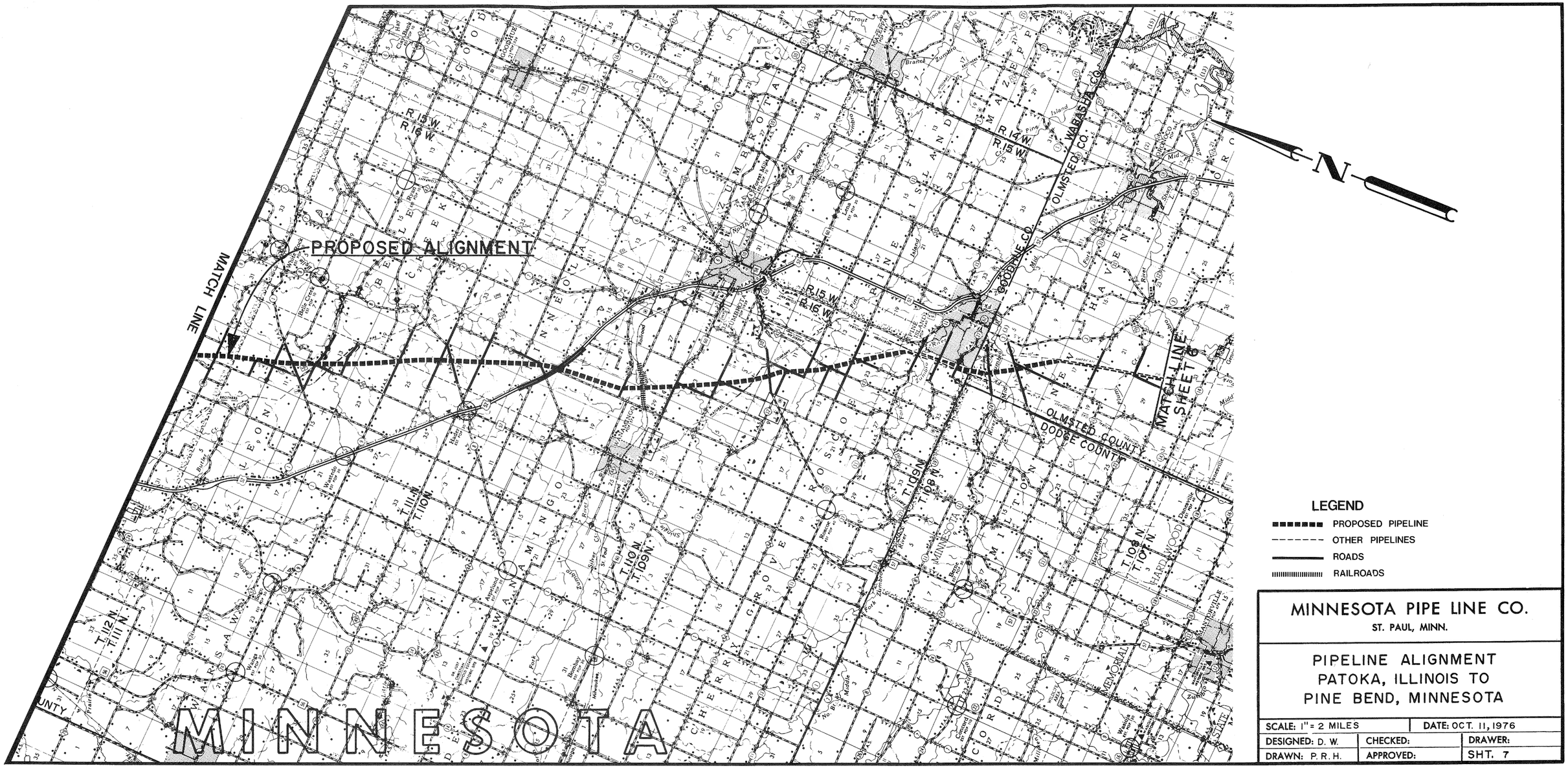
Community	Campground	Number of Sites
Coates	---	
Cannon Falls	KOA	100
New Trier	---	
Pine Island	Camp Wazionja	5
Rochester	KOA	60
	United's Serendipity	45
	Van's Trailer Ranch	50
Spring Valley	Five J's	30
Stewartville	---	---
Vermillion	---	---
Wanamingo	---	---
Zumbrota	Shades of Sherwood	100
	Zumbrota Covered Bridge Park	15
	TOTAL	390

Source: Minnesota Bureau of Economic Development, 1975

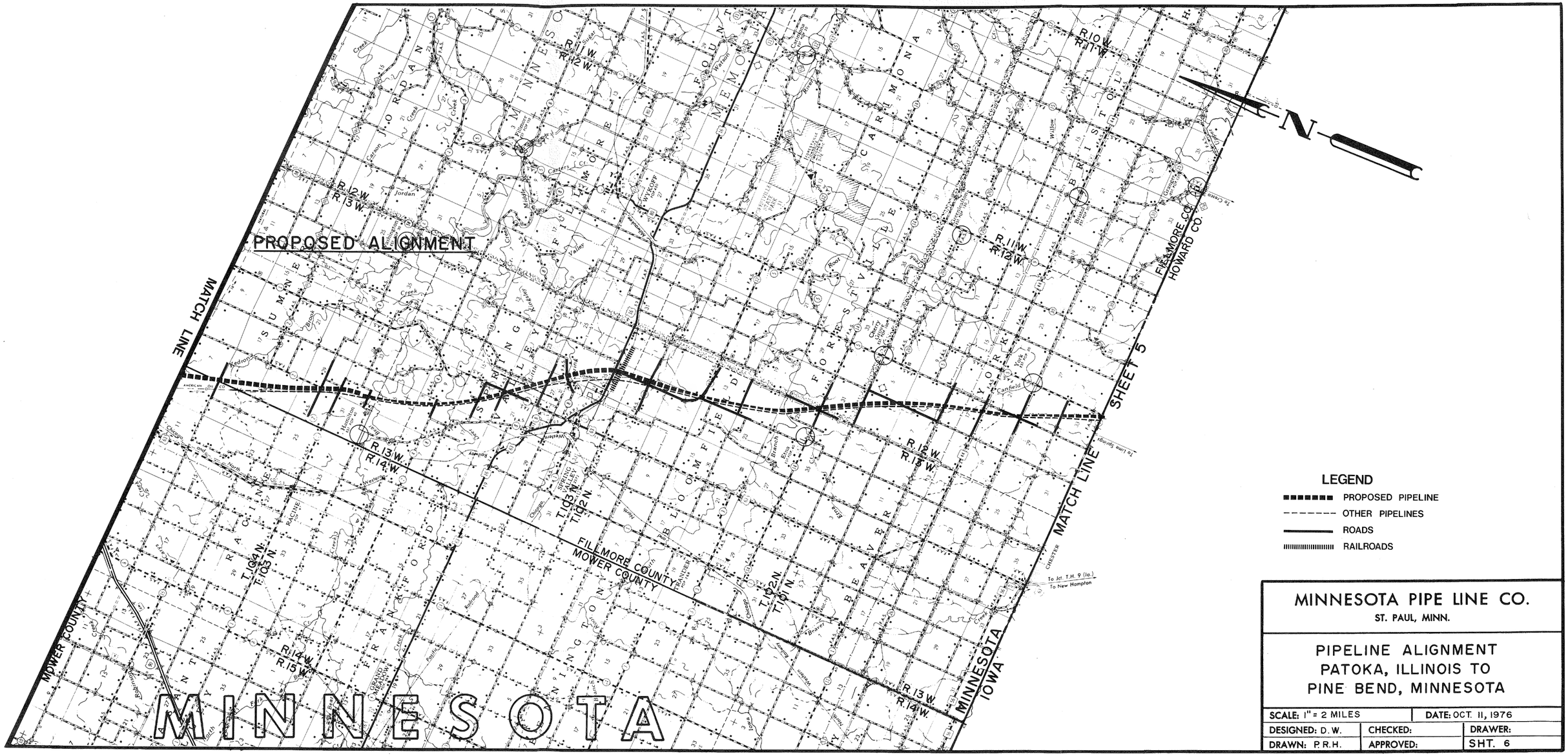
APPENDIX G

ROUTE MAPS

R.16 W.
R.17 W.
GOODHUE COUNTY
DAKOTA COUNTY
DAKOTA COUNTY
GOODHUE COUNTY
R.17 W.
R.18 W.
MATCH LINE
END PIPELINE
T.15 N.
T.14 N.
T.14 N.
T.13 N.
R.15 W.
R.16 W.
T.13 N.
T.12 N.
T.13 N.
STATE OF
LEGEND
PROPOSED PIPELINE
OTHER PIPELINES
ROADS
RAILROADS


PROPOSED ALIGNMENT
MATCH LINE
MATCH LINE SHEET 6
MINNESOTA
OLMSTED CO.
WABASHA CO.
GOODHUE CO.
DODGE COUNTY
R.16 W.
R.15 W.
R.14 W.
T.112 N.
T.111 N.
T.110 N.
T.109 N.
T.108 N.
T.107 N.
N
LEGEND
PROPOSED PIPELINE
OTHER PIPELINES
ROADS
RAILROADS
MINNESOTA PIPE LINE CO.
ST. PAUL, MINN.
PIPELINE ALIGNMENT
PATOKA, ILLINOIS TO
PINE BEND, MINNESOTA
SCALE: 1" = 2 MILES
DATE: OCT. 11, 1976
DESIGNED: D. W.
CHECKED:
DRAWER:
DRAWN: P. R. H.
APPROVED:
SHT. 7

STATE OF
MATCH LINE
MATCH LINE
OLMSTED COUNTY
FILLMORE COUNTY
OLMSTED COUNTY
DODGE COUNTY
OLMSTED COUNTY
ROCHESTER
R 13 W
R 14 W
R 14 W
R 15 W
R 15 W
R 16 W
T 108 N
T 107 N
T 106 N
T 105 N
T 104 N
LEGEND
PROPOSED PIPELINE
OTHER PIPELINES
ROADS
RAILROADS



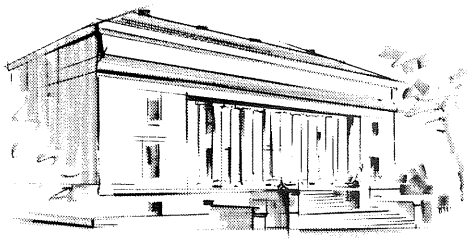
MINNESOTA PIPE LINE CO.
ST. PAUL, MINN.

PIPELINE ALIGNMENT
PATOKA, ILLINOIS TO
PINE BEND, MINNESOTA

SCALE: 1" = 2 MILES		DATE: OCT. 11, 1976
DESIGNED: D. W.	CHECKED:	DRAWER:
DRAWN: P. R. H.	APPROVED:	SHT. 6

APPENDIX H

LETTER FROM HISTORICAL SOCIETY



MINNESOTA HISTORICAL SOCIETY

690 Cedar Street, St. Paul, Minnesota 55101 • 612-296-2747

6 January 1977

Mr. Jeffrey F. Squires
NATIONAL BIOCENTRIC, INC.
2233 Hamline Avenue North
St. Paul, Minnesota 55113

Dear Mr. Squires:

RE: Proposed petroleum pipeline
Pine Bend, Minnesota to
Patoka, Illinois

Our records reveal that there are no known historic or prehistoric sites that will be affected by the proposed pipeline. In this regard, the pipeline crosses only one area that has been previously surveyed by a qualified archaeologist. This area includes portions of the S½, Sec. 26, T107, R15 (Kalmar Twp.), Olmsted County, on both sides of the intermittent stream indicated on county highway maps. In that survey the area in question was found not to contain any historic or prehistoric cultural resources.

Because the depth at which the pipeline is to be buried practically insures the complete destruction of any archaeological and historical materials that might be crossed, we believe that the pipeline route should be examined for heretofore unknown historic and archaeological materials. The historic material may be identified from documentary sources. The prehistoric sites can be discovered only by on-the-site examinations. In this regard, however, because of the considerably greater probability that unknown archaeological sites will be found within one thousand feet of any permanent body of water (extant or extinct), the survey need be conducted only in those qualifying areas. Any historic resources that are identified through documentary research and that might be affected should be examined in the field.

Thank you for your close attention to cultural resources in your planning process.

Sincerely,

Russell W. Fridley

Russell W. Fridley
State Historic Preservation Officer

RWF/fr

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APPENDIX I

LETTER FROM CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

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MINNESOTA
LINE CO
ST. PAUL MINN.

IN REPLY REFER TO
NCSCO-S

12 November 1976

Mr. Harry M. Weed
Vice President
Minnesota Pipeline Company
6483 85th Street South
Cottage Grove, Minnesota 55016

Dear Mr. Weed:

This is in response to your application for a Department of the Army permit for numerous oil pipeline river crossings at various locations in Minnesota and Iowa within the Corps of Engineers St. Paul District.

Our review of the proposed project, based on the information provided in the application and drawings describing a typical river or stream crossing, indicates that a Department of the Army permit is not required for those crossings following the described procedures.

Therefore, the St. Paul District Corps of Engineers has no objections to the proposed project provided that any variances to the described procedure be reported to this office. This notice of no objection applies only to those crossings meeting all criteria described in your application dated 8 October 1976. The described criteria included the following procedures; (a) Backfill material being used to cover the line will be the same material excavated and no additional new material will be introduced into the river; (b) Excavation shall be done in such a manner to minimize the creation of additional suspended solids. Excavated material from waterways (including adjacent wetland areas) will be stored in an upland site in a contained disposal area. Material shall be protected from weather and any erosion back into waterway will be prevented; (c) Excess material will be disposed of in an upland site; (d) Banks, as well as bottom contours, shall be restored to original condition as near as practicable. Any crossings not meeting these procedures could involve an activity under Department of the Army jurisdiction.

NCSCO-S 12 November 1976
Mr. Harry M. Weed

It is further requested that you maintain close coordination on this project with the Corps of Engineers, please provide us with any future new information as it becomes available. Mr. Frank Mazur[illegible] of my staff is available for contact at 612-725-7557.

Sincerely,

for WM. L. GOETZ
Chief, Construction-Operations
Division