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MINNESOTA FINAL ENVIRONMENTAL IMPACT STATEMENT(U) CORPS
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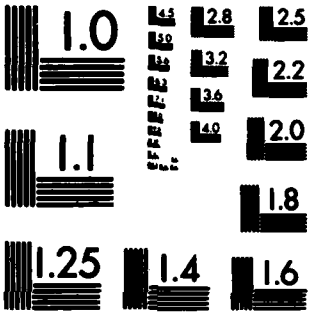

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The project would include channel modifications on a 46.2-mile reach of the Roseau River between the city of Roseau and the border with Canada in northwestern Minnesota. The major modifications would involve channel widening, mainly through one-bank excavation. In addition three levees would be constructed with material excavated from the channel, channel cutoffs would be installed at eight locations, and approximately 59 side-ditch inlet structures would be constructed to control erosion. Flood stages would be reduced on approximately 77,000 acres of the Roseau River floodplain. Agricultural drainage would be

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improved during flood periods, and there could be some increased land usage for agricultural purposes. The project could result in some localized erosion and sloughing along the river banks. In addition, excavation of riffle and cove areas and construction of isolated cutoffs would increase turbidity levels and stream temperatures and would reduce oxygen solubility which would adversely affect aquatic habitat. Any cultivation of previously uncultivated lands would effect a decrease in terrestrial vegetation and wildlife habitat in the project area, which would have a secondary adverse impact on recreation values.

FINAL
ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL
ROSEAU RIVER
ROSEAU AND KITTSON COUNTIES
MINNESOTA

U.S. ARMY ENGINEER DISTRICT, ST. PAUL
ST. PAUL, MINNESOTA

December 1976

FOREWORD

This final statement considers the environmental impacts associated with the flood damage reduction project proposed by the Corps of Engineers for the Roseau River in northwestern Minnesota. The flood and excess surface water problems in the Roseau River basin have been studied by State and Federal agencies as well as Canadian agencies since 1907. The Corps of Engineers was authorized by the Flood Control Act of 27 October 1965 (PL 89-298) to construct a flood control project on the Roseau River. The General Design Memorandum was completed in 1971. Since that time the proposed plan has been modified to incorporate mitigative measures to ameliorate potential adverse impacts. A part of the plan would be the payment to Canada of funds for mitigative works, determined during negotiations in the International Joint Commission, a permanent Canada-United States body which has been studying the impacts of the proposed project on the Roseau River basin.

A previous environmental impact statement concerning the proposed project on the Roseau River had been prepared and was filed with the Council on Environmental Quality in March 1972. However, the St. Paul District, Corps of Engineers, subsequently determined that this earlier document was inadequate and that another environmental impact statement would be prepared.

The subsequent draft environmental impact statement for flood control on the Roseau River was furnished to the public in July 1975. This statement examined identified alternatives, including the "proposed" plan of action, in light of the probable environmental, social and economic impacts which would result with the implementation of each of the solutions. The draft statement was presented to the public in an effort to gain their comments on the selected plan and the various presented alternatives. The final environmental impact statement includes all comments received on the document to date. Some comments have resulted in a modification of the proposed plan. Additional mitigative features for habitat losses have been incorporated into the plan and other possible measures are being discussed with the Minnesota Department of Natural Resources.

Initial construction funds for the project were appropriated by the U.S. Congress in 1971. It is anticipated that construction will start in Fiscal Year 1977 and will be completed in 1980, subject to availability of funds.

Coordination has been maintained with the International Joint Commission (IJC). The IJC plans to issue a complete report to both Governments in September 1976, following which final agreement will be reached regarding the project.

The remaining steps necessary to bring the proposed flood damage reduction project on the Roseau River into reality are as follows:

a. The final environmental impact statement will be reviewed by higher authorities within the Corps, such as the Corps of Engineers, North Central Division; the Office of the Chief of Engineers; and the Secretary of the Army.

b. The final environmental impact statement will be filed with the Council on Environmental Quality and will subsequently be issued to the public. There will then be a 30-day review period before construction can begin.

c. The International Joint Commission will submit its report to the Governments of the United States and Canada. Negotiations will follow to determine the payments to be made to Canada for mitigation works.

d. An agreement which will provide the schedule of payments to Canada will be signed following these negotiations, and not before the final environmental impact statement has been on file with the Council on Environmental Quality for at least 30 days.

e. Plans, specifications and cost estimates would be completed by the St. Paul District Engineer, bids would be invited, and a contract would be awarded.

f. The Roseau River Watershed District (the local sponsor) would obtain easements on lands needed for project right-of-way.

g. Initial payment would be made to Canada of funds for mitigative works, and further payments would be made on a continuing basis following the schedule of payments determined in the international agreement.

h. Upon completion of the project, local interests would start fulfilling their requirements for project operation and maintenance.

This final EIS was prepared to assure compliance with the requirements of the National Environmental Policy Act of 1969 (NEPA). It was prepared in accordance with the requirements of the Department of the Army, Engineers Regulation 1105-2-507 dated 15 April 1974 and Council for Environmental Quality (CEQ) guidelines dated 1 August 1973.

SUMMARY

FLOOD CONTROL
ROSEAU RIVER
ROSEAU AND KITTSON COUNTIES
MINNESOTA

( ) Draft Environmental Statement (X) Final Environmental Statement

Responsible Office: St. Paul District Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101
Telephone: 612-725-7505

1. Name of Action: (X) Administrative ( ) Legislative

2. Description of Action: The project would include channel modifications on a 46.2-mile reach of the Roseau River between the city of Roseau and the border with Canada in northwestern Minnesota. The major modifications would involve channel widening, mainly through one-bank excavation. In addition three levees would be constructed with material excavated from the channel, channel cutoffs would be installed at eight locations; and approximately 59 side-ditch inlet structures would be constructed to control erosion. Mitigative features have been incorporated into the project to ameliorate habitat losses and damage to prehistoric resources, and adverse effects in Canada.

3. a. Environmental Impacts: Flood stages would be reduced on approximately 77,000 acres of the Roseau River floodplain. Agricultural drainage would be improved during flood periods and, as flood waters could be removed earlier, crops could be planted earlier thus lengthening the effective growing season. This could also lead to some increased land usage for agricultural purposes. This would be a direct economic benefit for farmers.

b. Adverse Environmental Effects: The project could result in some localized erosion and sloughing along the river banks. In addition excavation of riffle and cove areas and construction of isolated cutoffs would increase turbidity levels and stream temperatures and would reduce oxygen solubility which would adversely effect aquatic habitat. Mitigative measures to ameliorate these effects have been incorporated into the project plans. Any cultivation of previously uncultivated lands would effect a decrease in terrestrial vegetation and wildlife habitat in the project area, which would have a secondary adverse impact on recreation values.

4. Alternatives to the Proposed Action: The nonstructural alternatives to the proposed plan include: (1) Base condition (no action); (2) flood warning, temporary and/or permanent evacuation of floodplain areas, and emergency protection and flood proofing (temporary barriers). Structural alternatives include: (3) reservoir storage; (4) channel modification; (5) levees; and (6) reservoir storage plus channel modifications.

5. a. A list of those Federal, State and local agencies and citizens and environmental groups who were furnished copies of the draft statement appears on page 88.

b. A list of those who furnished comments on the draft statement is found on page 91.

6. a. Draft Statement to CEQ: 12 September 1975

b. Final statement to CEQ:

FINAL
ENVIRONMENTAL IMPACT STATEMENT
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INTRODUCTION

The purpose of this statement is to assess the environmental impacts associated with the proposed Corps of Engineers, St. Paul District, flood control project on the Roseau River. This assessment has been drawn in part from an environmental impact assessment prepared by the Institute for Ecological Studies, University of North Dakota, Grand Forks, North Dakota (Reid et al.1974) under contract with the Corps of Engineers and from the Corps of Engineers Flood Control, Roseau River, Minnesota, General Design Memorandum, October 1971 (and supplement). The contracted assessment is on file in the St. Paul District Office.

1.000 PROJECT DESCRIPTION

1.100 Project Location

1.101 The Roseau River basin, comprising an area of about 2,057 square miles in northwestern Minnesota and south central Manitoba, Canada, is a part of the Hudson Bay drainage system. Approximately 60 percent of the basin is located in the United States. The international boundary is at mile 91.2[1] on the Roseau River channel. The project plan within the United States provides for channel improvement from river mile 93.5 to river mile 137.4 at the Roseau Dam, a distance of 43.9 channel miles. The project plan also includes remedial work along about a 10-mile reach in Canada, extending from the downstream end of an existing floodway (exhibit 1, page A-1).

1.200 Project Authorization

1.201 The Roseau River flood control project was authorized by the Flood Control Act approved 27 October 1965 (PL 89-298) to be constructed substantially as recommended by the Chief of Engineers in House Document No. 282, 89th Congress, 1st session.

1.300 Project Purpose

1.301 The proposed project is designed to provide varying levels of flood protection for reaches of the Roseau River from the city of Roseau to the Big Swamp area and to reduce the duration of flooding on some floodplain lands downstream from Big Swamp (paragraph 4.102). The project is designed to protect the city of Roseau from floods occurring with an estimated frequency of twice in 100 years. In the rural area from Roseau to Big Swamp, the project would provide protection from floods with an expected recurrence frequency of from 2 to 10 times in 100 years. The proposed project also provides for potential future drainage in the Canadian portions of the Pine and Sprague Creek basins, though no definite plans for such drainage have yet been developed (Sec. 3.003).

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[1] All river mile designations refer to the distance upstream from the mouth of the river (its confluence with the Red River of the North)

1.400 Description of Proposed Project

1.401 The features proposed for the flood control project would be constructed in the 46.2-mile reach measured along the Roseau River channel between the dam in the city of Roseau and the Canadian border. The project includes channel enlargement, channel cutoffs, levees, structures to connect existing ditches with the new channel, a new bridge and related utility relocations. The major features of the project are shown on exhibits 1 and 2, pages A-1 - A-4..

1.402 The channel capacity of the recommended plan would vary through the proposed project reaches. Channel capacities would range from a high of 9,500 cfs (cubic feet per second) in a 3 1/4-mile section, the upstream edge of which would be approximately 3 1/2 miles downstream of the Roseau Dam, to a low of 1,150 cfs, along a 4 3/4-mile section within Big Swamp. Downstream of the low velocity 4 3/4-mile section the channel capacities in Big Swamp would increase to 2,000 cfs and 2,400 cfs, respectively. Downstream of Big Swamp the channel capacity would be maintained at 3,250 cfs. The portion between Big Swamp and the Roseau Dam is divided into reaches with proposed channel capacities of 3,900 cfs, 5,750 cfs, 4,800 cfs, 9,500 cfs and 7,950 cfs (in order progressing upstream). Upstream of the dam until the end of the project the channel capacity would be maintained at 6,500 cfs.

1.403 The existing channel of the Roseau River would be modified (mainly through enlargement) throughout the project reach except for the last 2 1/4 miles upstream from the Canadian border. The modifications would consist primarily of increasing the bottom width of the channel from 48 to 120 feet (exhibit 2). Side slopes for the modified channel slopes would vary from 1 vertical on 2 1/2 horizontal to 1 vertical on 4 horizontal (exhibit 3). Some deepening of the existing channel would occur along the modified reach although in most areas this would be minimal (table 1). The estimated amount of material to be dredged would be approximately 7,152,000 cubic yards.

1.404 Where widening of the existing channel would occur, excavation would be limited to one side of the river where possible. Project plans call for approximately 80 percent of the total affected reach to be widened with one-bank excavation. Ninety-five percent of the channel widening itself would be accomplished with one-bank excavation. This type of excavation is shown in a typical section of the project on exhibit 3. The purpose of the one-bank excavation is to reduce to a minimum the adverse impacts of the project on the existing river setting. The one-bank excavation would preserve the trees and natural undergrowth along one side of the river and preserve the existing conditions along a portion of the river bottom. Where excavation is necessary on both sides of the channel, the excavated material would be deposited along both sides of the channel (exhibit 3).

1.405 The estimated amount of permanent project right-of-way is 1,300 acres. The estimated amount of temporary easement required for disposal of excavated material is 900 acres. Up to approximately 320 acres of brush and 760 acres of light timber would be cleared to accomodate excavation, levee construction, and disposal of excavated materials.

Table 1. Difference Between Existing and Proposed Channel Depths for the Roseau River.

Station[1] Distance from downstream end of project (x 100 feet)	Proposed[2] Depth (feet)	Station	Proposed Depth (feet)
0	-1.2	1200	Cutoff No. 5
50	0.0	1250	Cutoff No. 6
100	0.2	1300	0.8
150	Cutoff No. 3	1350	0.4
200	0.2	1400	0.2
250	0.0	1450	0.1
300*	-1.4	1500	0.7
350*	0.0	1550	-1.0
400*	-0.2	1600**	-0.7
450*	0.0	1650**	0.5
500*	0.4	1700**	0.4
550*	-0.6	1750**	Cutoff No.8
600*	0.3	1800**	Cutoff No.8
650*	1.2	1850**	Cutoff No.8
700*	0.1	1900**	-2.7
750*	1.2	1950	0.5
800*	0.4	2000	1.0
850*	1.3	2050	-0.2
900*	0.8	2100	0.7
950*	0.6	2150	1.6
1000*	0.3	2200	1.0
1050*	0.6	2250	1.3
1100	0.7	2300	-0.6
1150	1.5		

[1] Station 0 is at the downstream end of the proposed project approximately 2.3 miles upstream of the Canadian border.

[2] Distance between existing thalweg (line connecting deepest points of existing channel) and proposed depth. Negative values indicate existing channel is deeper than proposed channel by indicated value. Positive values indicate amount of proposed deepening.

* Approximate vicinity of Big Swamp

** Approximate vicinity of Roseau Lake

Source: United States. 1971. General Design Memorandum, Plate 3 (R2-R-5/3), Army Corps of Engineers, St. Paul District (extracted).

1.406 Except in the city of Roseau where space is limited, the excavated material (from 13 to 43 cubic yards per linear foot of channel) (table 2) would be distributed along the river in piles that would be uniformly shaped and set back from the edge of the completed channel at a distance varying from 20 to 90 feet, depending on foundation stability conditions (exhibit 3). Pile heights would be limited to 4, 6, or 8 feet depending on foundation conditions. Disposal piles would be graded for purposes of drainage and appearance and side slopes would be no steeper than 1 vertical on 3 horizontal. Riverward sides of the disposal piles would be seeded and/or planted with grasses, brush, and/or trees following construction to improve bank stability and provide wildlife cover.

1.407 There are three locations along the project where levees are required to contain the design discharge. These would be constructed with material excavated from the channel. The Kittson County levee would join an existing levee at the Canadian border (exhibit 2, page A-2). It would have a maximum height of 8 feet, a top width of 10 feet, side slopes of 1 vertical on 3 horizontal and 1 vertical on 5 horizontal and would be approximately 1.9 miles long. In the vicinity of Duxby (exhibit 2, page A-3) it was found to be more economical to construct a levee along the low south bank of the river along with enlarging the channel a moderate amount, rather than to widen the channel the full amount necessary to contain the design discharge. The Duxby levee generally would vary in height from 2 to 4 feet with a maximum height of 6 feet; it would have a variable top width dependent on the amount of excavated material available for disposal, with side slopes of 1 vertical on 3 horizontal and 1 vertical on 4 horizontal; it would be 5.8 miles long. In the area of cutoff 9, a continuous disposal bank having a minimum height varying between 2 and 4 feet would prevent design flows from reaching adjacent fields.

1.408 Channel cutoffs totaling approximately 5 miles in length would be installed at eight locations.[1] These cutoffs would bypass approximately 11 3/4 miles of existing channels (table 2). A typical section for a proposed channel cutoff is shown on exhibit 3. This shows the new channel with a disposal mound on each side. Locations of the cutoffs are shown on exhibit 2. Earth fill plugs would be placed at both upstream and downstream ends of 15 channel oxbows where new or previously excavated cutoffs would provide for channel straightening. The upstream channel plug would include a corrugated metal pipe culvert with flap gate for water inflow to the oxbows during high flow periods. A channel plug would also be installed in the main channel upstream from the mouth of Sprague Creek. The purpose of these plugs would be to control the water level in the abandoned loops and make them useful as wildlife habitat. Grassed bypass channels or wet channels with barriers are also being considered for cutoffs where existing fish habitat is substantial and would be desirable to preserve.

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[1] Although the proposed cutoffs are numbered from 1 to 10, originally authorized cutoffs numbered 2 and 4 have been deleted from the proposed project and cutoff no. 10 now consists of 2 sections.

Table 2. Physical Aspects of Channel Modifications in Minnesota Reach of Modified River Channel.

Location		Decrease in River Length Due to New Cutoffs			Magnitude of Channel Enlargement
River Mi.	Description	Length of Reach(mi)	Cutoff length(mi)	% of reach in cutoffs	Cu. yds./lin.ft
93.5	lower end of project	30.6	2.0	6	18
to 124.1	lower end of Roseau Lake	5.5	1.5	21	13
to 129.6	1/2 mi. below Sprague Crk.	2.9	1.0	35	28
to 132.5	5 mi. below Roseau Dam	4.9	0.4	7	43
to 137.4	Roseau Dam				

Note: The relative magnitude of channel enlargement was obtained by dividing the total excavation in each reach (exclusive of cutoff excavation) by the total length of each reach (exclusive of cutoff lengths.

Source: International Roseau River Engineering Board. 1975. "Joint Studies for Coordinated Water Use and Control, Roseau River Basin, Manitoba-Minnesota." Appendix F.

1.409 To control erosion, approximately 59 ditch inlet structures would be constructed where flow from existing ditches would enter the river over the modified channel banks. There are several different types of ditch inlet structures which would be used. The type selected would depend in each case on the size of the ditch, the drop between the ditch bottom and the river bottom, and whether of not the ditch is intersected by a levee. No ditch inlet construction is planned where existing ditches enter the river over undisturbed banks, except where required to protect bridge structures from erosion. In most cases, the type of inlet structure depends upon the size of the culvert closest to the channel. Minimum culvert size would be 24 inches.

1.410 In addition to the major project features mentioned above, there are a number of miscellaneous items that would be involved in project implementation. The hand railing on the dam in Roseau would be modified for removal during flood periods, with additional provisions made to keep people off of the dam when the railing was gone. One new roadway bridge would be required at the upstream end of cutoff 6 to provide access to a farmstead isolated by the cutoff. At a number of locations public utilities would have to be modified to accomodate the project.

1.500 Background of the Proposed Project

1.501 The Roseau River basin has had a long history of drainage programs, beginning in 1904 with the construction of the Badger Creek Ditch. In 1906 the Roseau River channel was deepened and straightened for several miles downstream from Roseau Lake, which reduced the lake's storage capacity. Between 1907 and 1920 an extensive ditch system was constructed both north and south of the Roseau River and the river itself was dredged from Roseau Lake to the Canadian border.

1.502 The capacities of the ditch systems and the river have never been sufficient to preclude frequent flooding. The flooding has been further increased in parts of the basin by a general lowering of the land surface that resulted from accidental fires and the intended burning off of the overlying peat in order to farm the mineral soils beneath.

1.503 The U.S. Geological Survey conducted a study of the Roseau River flood problem in 1933 for the International Joint Commission.[1] The study recommended restoration of Roseau Lake as a flood control lake. The Geological Survey further recommended use of Big Swamp north of the Roseau River for flood storage. This has been accomplished to some extent through development of the Roseau River Wildlife Management Area (WMA) by the Minnesota Department of Natural Resources.

1.504 Model studies conducted for the IJC indicated that if the original channel alignment and capacity conditions of the Roseau River had existed at the time of the 1948,1950 and 1960 floods, the peak discharges would have been about 10 to 25 percent lower at Caribou (about 3 river miles south of the international boundary) and would have been delayed by 5 to 10 days

1.505 The Roseau County Soil and Water Conservation District, formed in 1952 to implement conservation practices in cooperation with involved State and Federal agencies, has undertaken the construction improvement of approximately 110 miles of field ditches and 75 miles of public drainage ditches in addition to other conservation practices. (Roseau County Soil and Water Conservation District Annual Report, 1974).

1.506 Other soil and water conservation practices undertaken in the basin have consisted of reforestation for livestock shelter or wind erosion control and the construction of water conservation ponds and structures to prevent soil erosion from surface runoff. Prior to 1975, the Roseau County Soil and Water Conservation District sponsored the planting of approximately 11 miles of field windbreak, the reforestation of 879 acres, the planting of 386 acres of farmstead and feedlot windbreak, the construction of 382 water conservation ponds, and the construction of 41 grade stabilization structures.

1.507 A 1956-57 Soil Conservation Service (SCS) survey report[2] concerning drainage problems of the U.S. portion of the Roseau River basin concluded that the existing drainage ditches were in need of rehabilitation to improve their efficiency. An expansion of farm drainage was recommended on all farmland. However, this expansion could not take place unless outlet ditches tributary to the Roseau River were improved in both depth and capacity and additional ditches installed. Before these latter improvements could function effectively, it would be necessary for the capacity of the river to be increased to reduce the extent and duration of flooding and to provide adequate drainage.

1.508 According to the SCS, implementation of their drainage proposal would have resulted in land use changes for approximately 41,000 acres (about 20 percent of the 201,750 acres of Roseau County within the basin; most State, Federal and school lands have been deleted). The changes would have resulted from conversion of the "idle" land category to "crop well drained" category (see table 3).

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1 United States. September 1973. "Memorandum on Studies of Flood Relief Plans for Roseau River Valley, Expecially of a Suggested Two Rivers Auxiliary Channel." Geological Survey.

2 United States. 1956. "Survey Report on Major and Local Drainage for Roseau River in Roseau County, Minnesota." Soil Conservation Service.

TABLE 3. LAND USE[1] WITH AND WITHOUT SCS RECOMMENDED LOCAL AND REQUIRED MAJOR DRAINAGE IMPROVEMENT PROGRAM
Roseau River - Minnesota

		Without Program						With Program					
					Crop[3]								
Area	Area Acres	Other[2]	Pasture	Wood-land	Interme-diately Drained	Poorly Drained	Idle[4]	Other	Pasture	Wood-land	Crop Well Drained	Idle
I	84,370	17,636	2,344	292	7,324	31,580	25,194	17,987	-	1,172	54,372	10,839
III[5]	112,836	8,426	10,615	1,967	45,432	16,814	29,582	9,094	-	742	98,138	4,862
IV	4,544	293	-	-	568	2,112	1,571	293	-	-	3,153	1,098
Total	201,750	26,355	12,959	2,259	53,324	50,506	56,347	27,374	-	1,914	155,663	16,799

[1] Projected from land use samples

[2] Other includes roads, farmsteads, non-farmland, land not needing drainage

[3] Cropland divided into lands intermediately drained and lands poorly drained

[4] Includes idle and idle wetlands
56,347 acres - 16,799 = 39,548 acres
idle wetland to be improved

[5] Includes Area III and 4,900 acres of Area II in original (SCS) report which would benefit by drainage improvement

Areas I & II - contiguous segments constituting eastern portion of project area; area II lies north of area I. Both areas lie between the watershed boundary on the east and the east boundary of area III on the west; and between the international border to the north and a line sloping southeasterly from Roseau and generally south of Hay Creek

Area III - and irregularly shaped section extending northward to the international boundary and southward to the town of Badger. At its greatest length it extends from the east boundary of Area IV to the town of Roseau.

Area IV - lies just east of the Kittson County/Roseau County line and south of the Roseau River. It extends 9 miles east from the county line and is 1/2 - 3 1/2 miles wide.

Source: United States. 1964. Survey Report for Flood Control, Roseau River, Minnesota. Appendix C. Corps of Engineers, St. Paul District

1.509 The estimated average annual agricultural benefits of the SCS proposal, based on long-term projected prices in 1956, were $3,430,000. These estimated benefits assumed proper installation and maintenance of both local and major drainage improvements, that 90 percent of the project would be completed in 15 years, and that a 15-year level of flood protection would be provided by the Corps channel modification project. See exhibit 31 for a more detailed summary of the SCS proposal.

1.510 The Roseau River Watershed District was established on 13 September 1965 as the successor to the Roseau River Drainage and Conservancy District which had been in existence since 13 August 1920. The objectives of the District are, generally, to control flood waters, provide improved drainage facilities, conserve water supply for domestic, industrial, recreational and other public purposes, control soil erosion and siltation of water courses, and regulate modifications made by owners of riparian lands to preserve beneficial public use of streams and drains. The District has taxing authority and is otherwise legally constituted to cooperate with State and Federal government agencies in sponsoring projects within the District. In recent years, the District has undertaken the improvement of several legal drainage ditches in the basin.

1.511 The Minnesota State Statutes provide for establishment of public drainage facilities under three categories: county ditches, State ditches, and judicial ditches. Under these statutes the prime responsibility for establishment or denial of a public drainage ditch has been vested in the Board of County Commissioners or the local District Courts. In 1973, the Minnesota Legislature enacted an important addition to the old drainage statutes under a new subdivision 6 to Minnesota Statutes 106.021. This subdivision provides for the promulgation by the Commission of Natural Resources of a list of criteria relating to social, economic, and environmental impact of any proposed drainage system. These criteria are to be considered by the county boards or the courts when establishing or improving drainage systems. The criteria to be assessed include:

1. Economic analysis of private and public benefits and costs.

2. An analysis of present and anticipated agricultural land acreage available and in use within the county.

3. An analysis of flooding characteristics of land involved.

4. An analysis of alternatives involved for conservation, allocation, and development of the drainage waters.

5. An analysis of water quality effects.

6. An analysis of fish and wildlife effects.

7. An analysis of shallow groundwater availability, distribution and use.

8. An overall environmental impact analysis of the above.(State of Minnesota, "Session Laws of Minnesota," 1973).

However, due to the considerable opposition to the proposed regulations the matter was referred back to the legislature for further consideration. The legislation passed essentially gave control over drainage in the area back to local interests.

1.600 Existing Projects

1.610 Roseau Dam. The Roseau Dam, at the city of Roseau, is a concrete overflow structure with a crest length of 79.5 feet. The crest of the dam is about 7 feet above the channel bottom, and the storage behind the dam is small so there are no significant hydrologic effects, although some flooding is experienced in the city of Roseau during spring flood events due to minor backwater effects of the dam.

1.620 Hayes Lake Dam The Hayes Lake Dam is an earth dam located on the North Fork of the Roseau River about 20 miles southeast of Roseau. The lake created by the dam is about 187 acres in area and has a volume of 1,640 acre-feet at normal pool elevation 1167.0. The contributing drainage area at the dam is 148 square miles, and a fixed crest concrete spillway provides outlet capacity for a 100-year frequency flood of 4,100 cfs. An emergency-type spillway provides additional capacity for greater floods. The impoundment created by dam primarily serves water related recreational purposes at the Hayes Lake State Park and is not operated primarily for other purposes. The dam has little hydrologic effect on high or low streamflow.

1.630 Wildlife Impoundments. The Roseau River Wildlife Management Area (WMA) impoundments, located north of the Roseau River and west of Pine Creek, were constructed by the Minnesota Department of Natural Resources (DNR) to furnish food and cover for ducks, upland game, muskrats, and mink. The project consists of three earth dikes which create three pools impounding water diverted from Pine Creek and part of the surface waters flowing over the project area. Water flows through the three pools by means of overflow sections in the dikes; and outflow from the system returns to the Roseau River upstream of Caribou. The three pools by means of overflow sections in the dikes; and outflow from the system returns to the Roseau River upstream of Caribou. The three pools at their normal elevations cover a total of about 10,600 acres, to an average depth of about 1.5 feet. Since the pool levels are artificially maintained, it is likely that they have contributed to the Roseau River's winter low flow supply since their construction in 1953.

1.640 Channel Modifications The principal natural drains are Hay Creek, Sprague (Mud) Creek, Pine Creek, and Badger Creek. Most of these natural drains have been modified and incorporated as part of a legal drainage organization. The channels of these tributaries, both natural and modified, have inadequate capacity and depth to provide good drainage for their watersheds, and lack of maintenance of some of these channels aggravates the situation. In 1950, the Roseau River flooded the land for over 2 miles on each side of the river from the city of Roseau to the west line of Roseau County. Various degrees of flooding occur annually. Until the capacity of major drainage outlets is increased, channel modifications on tributaries will remain ineffective during high flows.

1.650 Pine Creek Diversion. The diversion, which was created for the purpose of supplying water to the three wildlife pools in the Roseau River WMA, became operational in 1953 following recommendations of the IJC. The diversion dam in Pine Creek consists of an earth dike across the present creek channel with an 18-inch, gate-controlled culvert through the dike to permit low flows to pass down the natural channel of Pine Creek, if desirable or necessary. At the point of diversion, Pine Creek has a drainage area of about 50 square miles. Operating plans provide for diverting flows up to 450 cfs into the Roseau River WMA. The Pine Creek Diversion system reduces flows in the natural channel, while increasing flows along the diversion channel route. The diversion channel is designed for a maximum flow of 600 cfs, which has about a once-in-15-year recurrence interval. Streamflow records show that high discharges frequently occur in Pine Creek during the months of March and April, when there is still a possibility that the Pine Creek Diversion channel may be obstructed with ice and snow. In such a case high streamflows might cause erosion of the diversion works or the downstream channel.

1.660 Drains. In its natural state a large part of Roseau County was poorly drained. As mentioned, an extensive, but not fully effective, ditch system was initiated about 1900. Cost of this ditch system was defrayed by bonds which, under general State laws, became county obligations. The extent of the ditch system is shown in exhibit 4 . Early drainage projects drained the lands best suited to agriculture, however drainage of swamp areas was included in the early program with the result that, even after ditching, much of this land could not be farmed profitably. Improvements of some ditches have been made in recent years.

1.670 Road Networks. Road networks and bridges could affect flood flows in the basin. Most of the smaller roads are built on a square mile grid basis. Larger highways cut through the basin in various directions and are generally oriented along section lines. The roads are of the typical prairie type. They are built well above the surrounding ground with ditches on either side, and culverts or bridges at selected locations to permit surface runoff with minimum disruption. However, local drainage patterns are inevitably altered somewhat by the roads; and water backup is likely to occur at culverts in the spring for various reasons. Hence, water contributing to floods is likely to be delayed by most road systems, while the eventual land drainage after flood subsidence may be more effective due to a more extensive ditch network.

1.700 Mitigative Measures

1.710 General. The project described in this EIS has been significantly modified from the authorized project, both in its design and manner of construction, to lessen adverse environmental effects. Modifications to the authorized project were made to a large extent using a mitigation concept that involved the use of one-bank excavation and disposal of dredge material during construction. This allowed decisions to be made regarding the least environmentally damaging manner in which to accomplish the flood reduction purposes of the project. The analysis was made using data contained in the University of North Dakota Environmental Impact Assessment Report, USGS topographic maps and aerial photographs of the section of the Roseau River which would be directly altered by the project.

1.711 The proposed project includes provisions for remedial works in Canada to offset possible adverse effects on Canadian interests. The extent of these works and their estimated cost will be the subject of negotiations between the United States and Canada based upon a report and recommendations furnished by the International Joint Commission (IJC). A report prepared by the International Roseau River Engineering Board by direction of the IJC was submitted to the IJC in September, 1975. The Board investigations were intended to enable the Commission to make a final and complete report on the questions regarding control and use of waters in the Roseau River basin which were originally referred to the IJC by the Governments of Canada and the United States in 1929 under Article IX of the Boundary Waters Treaty. Upon completion of negotiations, necessary funds will be furnished to the Canadian government for completing construction of these mitigative works.

1.712 Factors that were evaluated in arriving at a decision regarding what would be done in a specific reach of the river to reduce potential adverse environmental impacts of the authorized project included the following: the location of archaeological sites; the type, quality and extent of habitat adjoining the river; the amount of river shading being provided by streamside vegetation; the constraints placed upon dredge disposal by Canadian interests (i.e. placement must not result in increased flooding in Canada); the interest

expressed by the Minnesota DNR regarding dredge disposal locations that could be developed for wildlife impoundments; the physical capability of the equipment which would be accomplishing the work; the degree of access to a particular site available to this equipment; the engineering constraints of the project area (primarily foundation conditions); and the additional construction costs involved.

1.713 The initial attempt to modify the authorized plan to reduce or preclude adverse environmental impacts was formulated with only historical, archaeological and biological parameters taken into account. The first priority was given to archaeological sites since the notion of a resource being nonrenewable is particularly appropriate in this instance. A total of 16 sites have been located in the project area. The initial and final excavation and disposal plan was developed in a manner which would avoid disturbance of any of the officially recorded sites. Two sites which were not previously recorded were situated in a manner which necessitated their disturbance if the project were to accomplish its purposes. These particular sites were field inspected and tested by the Minnesota State Archaeologist from the University of Minnesota. The results of this survey are discussed in section 2.530.

1.714 The biological factors involved in developing the modified plan were many and varied. The one-bank excavation concept has the potential for substantially reducing the magnitude of adverse effects on the riverine environment for the following reasons:

1. Channel excavation from approximately the centerline of the river to one side retains a portion of the existing aquatic habitat in the river. This would reduce the adverse effects associated with complete removal of the channel bottom, however the biological carrying capacity of the river would still be reduced, at least for a period following project construction.

2. The retention of streamside vegetation on one bank has several beneficial biological effects in addition to the smaller amount of natural vegetation which would be removed than with both-bank excavation. Increases in maximum water temperatures and daily fluctuations often associated with stream channelization can be reduced with the preservation of streamside vegetation which provides shade, particularly from the afternoon sun. Relatively large blocks of contiguous habitat types which provide a natural access to the river can be preserved. The energy supplied to the aquatic system by the terrestrial community (allochtonous or introduced material) would be partially retained. The stream edge habitat, important to certain species, would be partially preserved.

1.715 In certain reaches of the river these biological factors conflicted with each other. For example, a heavily grazed woodlot, with relatively little value to wildlife productivity, might be located so that the vegetation provided shade for the river while, in the same area, a diverse community, with a much higher value for wildlife occupied the opposite bank. In this instance, the more diverse habitat was generally given higher priority.

1.716 The additional factors mentioned in paragraph 1.712 were then integrated into this "optimum" biological and archaeological plan. Relatively few conflicts developed. These included minor changes, which were expected, due to the location of various structures along the river (gaging stations, homes, farm buildings, etc.). A trade-off was made in the area of project cutoffs as related to the cost of construction. Since the largest amount of dredge material for a given length of river would be generated in the construction of cutoffs, these areas are also the most expensive when applying the one-bank excavation/disposal concept. This results from the large amount of double handling required in the disposal of this quantity of material. A decision was therefore made, for the most part, to use "normal" construction procedures through the cutoff areas and to apply the funds available for project modifications to those reaches not involved with cutoffs. However the number of cutoffs was reduced for biological and/or archaeological reasons.

1.717 The reach extending from the State Aid Road 1 (Trunk Highway 310) bridge upstream to the terminus of the project in Roseau presented particular problems for the following reasons:

1. This area is more heavily populated, with most structures situated near the river on the left (south) bank.

2. The major portion of the streamside vegetation is located on the right (north) bank.

3. There are problems with equipment access which conflict with the "optimum" biological and archaeological plan.

4. This reach contains the majority of areas generating engineering problems related to the poor foundation quality of the soils.

5. There are reaches which require channel width enlargement which have farm buildings on one bank, close enough to the river so that the enlargement would be required to take place on the opposite bank unless the buildings were moved.

The vegetation along this reach is characterized by grazed (some very heavily grazed) woodlots. The agricultural use of the adjacent land is also more intense than that of reaches farther downstream. It was therefore in this reach of the project where the greatest departures from the "optimum" biological plan occurred.

1.720 Mitigative Features. In addition to one-bank excavation and disposal of dredge material, other mitigation features have been incorporated into the project plan which were not included in the authorized project.

1.721 The plan includes modification of the originally proposed cutoffs numbered 1 and 10 and the elimination of the originally proposed cutoffs numbered 2 and 4 because of archaeological and/or biological considerations. Channel plugs of semicompacted fill would be installed at both upstream and downstream ends of five new cutoffs[1] and nine existing cutoffs. Most of these cutoffs are located within the Big Swamp area. The upstream plug would contain a flap gated culvert to permit flow into the cutoff during high flow periods. The downstream plug would have a top elevation of 0.5 foot below the top of adjacent banks to permit flushing during high flow periods. These features were added to the project for waterfowl management purposes on the recommendation of the Minnesota DNR. Although flap gated culverts are presently planned, future evaluations may result in a change to some other type of control structure that would increase the value of these areas for fish as well as waterfowl. Other structures being considered include grassed flood bypass channels or wet channels with barriers to shunt water through cutoffs where fish habitat is substantial.

1.722 The channel modifications through the Big Swamp area would entail widening in lieu of deepening so that only limited future drainage in the area would be feasible, periodic flooding of the marsh and Roseau WMA would continue, and flood peaks in downstream areas would be only slightly diminished.

1.723 The extent to which normal and low river stages would be lowered by the channel excavation has not been precisely evaluated and it may be necessary to construct low weirs in the channel in the Big Swamp area to maintain adequate fish habitat during low flow periods. These conditions would be monitored by the Minnesota DNR. A study to determine standing crops and locations of fish populations in the channelized section of the Roseau River would be conducted prior to and following construction. Information on population changes resulting from the project would be evaluated to determine the necessity (and location) of the low channel weirs to mitigate habitat losses for fish, especially northern pike.

1.724 Future impoundments in the Roseau Lake area are regarded as a possibility by the Minnesota DNR. Under existing conditions the Roseau River traverses the southwest corner of the lake and the lake bed is drained to the river by a judicial ditch system. However, the lake bed is at a low elevation with respect to flood stages and several thousand acres of the lake bed are frequently flooded. Under project conditions the main channel would be realigned through the center of the lake, and flood stages would be reduced approximately 2 feet which would result in a diminished height of periodic flooding and a diminished duration of flooding.

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[1] Cutoff 10 consists of two cutoffs.

1.725 In recognition that wildlife interests may eventually initiate plans for a wildlife impoundment in the northeast quadrant of Roseau Lake, the Corps plans (at the suggestion of Minnesota DNR) to place excavated material along the north side of the new channel upstream from the junction with Pine Creek in order to facilitate such future development. This future construction by wildlife interests, if undertaken, would consist of constructing a dike along the east side of Pine Creek within the lake bed plus water control structures. The flood control plan would also allow for a possible future impoundment at the mouth of Badger Creek by placing a continuous dredge material bank along the south side of the Roseau River from the mouth of Badger Creek to the west limit of section 22 (a distance of approximately 2 miles). This is also at the suggestion of the Minnesota DNR.

1.726 Planning of dredged material deposition in the Roseau Lake and Badger Creek areas was initiated with the idea that future construction of such an impoundment would be accomplished by wildlife interests. It has also been proposed that the Corps construct the structural features of a waterfowl impoundment at either of these sites or at a similar area to offset riparian vegetation and wildlife habitat losses incurred by the proposed project. Coordination with the DNR is being maintained to resolve this problem area.

1.727 To ameliorate riparian vegetation and habitat losses the riverward sides of the disposal piles would be seeded and/or planted with grasses, brush, and/or trees following construction.

1.728 In recognition of the existing high-value potholes both north and south of the Roseau River in the Big Swamp area, studies would be conducted before and after construction to determine whether the Corps project has adversely affected these waterfowl areas. Since foundation conditions are not very stable, the use of bench marks would not be the most accurate method of determining "before" and "after" conditions. Thus aerial photography is being investigated as the possible method of study. If the potholes are adversely affected, structural corrections would be sought as a design deficiency.

1.729 The Corps has an agreement with the Minnesota DNR to do a study of lands disturbed during channel construction.

1.730 Mitigation of Impacts in Canada. The project plan provides for a payment to Canada for mitigating works in Manitoba necessitated by the increase in flows expected at the international boundary. Proposed projects in Canada include rehabilitation of the Gardenton Floodway, channel enlargement between Gardenton and Stuartburn, a flood diversion to the Red River of the North downstream of Dominion City, modifications to the Dominion City water treatment plant, and extension of existing bridges to accomodate the increase in peak flood flows. In addition, the payments would include operation and maintenance costs for the proposed mitigation works over the 50-year project life. This would be performed by Canadian interests but would be funded by the United States, the cost being part of the channel modification project.

1.800 Economics. The proposed project has an estimated benefit-cost ratio of 1.5. Table 4, below summarizes the economic data compiled by the Corps.

Table 4. Costs and Benefits of Proposed Roseau River Project

	Last Presented to Congress (Oct 1975)	Current Estimate (Oct 1976)
Estimated Federal Cost (Total)	$13,800,000	$15,200,000 [A]
Estimated non-Federal Cost (Total)	425,000	470,000 [A]
Cash contribution	none	none
Other costs	(425,000)	(470,000)

BENEFIT-COST ANALYSIS

	Current Estimate (3 1/4%-Oct 1976)	Percent of Benefits
Benefits (Average Annual)	$1,012,000[A]	
Flood Control	(916,300)	90
Agricultural	407,200	
Rural Property	220,100	
Urban Property	264,400	
Road and Bridge	24,600	
Wildlife [B]	(0)	
Redevelopment Benefits (increased employment)	(95,000)	10
Charges (Average Annual)	676,800	
Federal	(625,500)	
Interest	494,000 [C]	
Amortization	125,100 [C]	
Maintenance [B]	6,400 [A]	
Non-Federal	(51,300)	
Interest	15,300 [D]	
Amortization	3,900 [D]	
Maintenance [B]	32,100 [A]	
Benefit-Cost Ratio	1.5	

[A] Higher price levels.
[B] Mitigation features have been included in the project plan.
[C] Increase in Federal investment.
[D] Increase in non-Federal investment.

2.000 ENVIRONMENTAL SETTING WITHOUT THE PROJECT

2.100 Physical Environment

2.110 Description and Location of Roseau River Basin. The Roseau River basin, 2,057 square miles in area, is located in northwestern Minnesota and south central Manitoba, Canada (exhibit 1). The basin is a part of the Hudson Bay drainage system. Approximately 60 percent of the basin is in the United States and about 85 percent of that is in Roseau County, Minnesota. The basin also includes small parts of Beltrami, Kittson, Lake of the Woods and Marshall Counties. The upper portion of the watershed is fan-shaped while the remaining portion is long and narrow. The basin is about 110 miles in total length but its maximum width does not exceed 30 miles.

2.120 Description of Roseau River and Its Tributaries. The Roseau River follows a general northwesterly course over its entire 180-mile length. It crosses the U.S. Canadian border at about the midpoint of its course and enters the Red River of the North about 15 miles downstream from the intersection of the latter stream with the border. In its natural state the Roseau River was characterized by a somewhat tortuous alignment over its entire length. However, the river between Roseau Lake and the border has been straightened by previous channel modifications (House Document No. 282, 89th Congress, 1st session).

2.121 Along its course within the United States below Malung (about river mile 145, the Roseau River is flanked by broad and relatively flat plains. Similar conditions also exist in Canada downstream from the border to the vicinity of Stuartburn Post Office (mile 64.3). Below this point, commencing at about mile 60, a valley forms which is more or less continuous to the mouth of the stream. Although narrow and shallow at the point of origin, the valley increases in size to a width of about 500 feet and a depth of 40 feet at the mouth of the stream (House Document No. 282, 89th Congress, 1st session).

2.122 Principal tributaries of the Roseau River are the South Fork, Hay Creek, Sprague (Mud) Creek and Pine Creek. All enter the Roseau River within the United States. Sprague and Pine Creeks, however, originate and primarily drain areas in Canada. The tributaries, in the order named, enter the Roseau River at river miles 145.5, 138.3, 133.5 and 125.8. Their characteristics differ little from those of the Roseau River except for steeper average gradients. Stream flow data for the Roseau River basin are presented in exhibit 5 .

2.123 The Roseau River exhibits a wide range of stream gradients. Above the city of Roseau the gradient of the Roseau River is about 17 feet per mile. Downstream, through Roseau Lake and Big Swamp, the gradient flattens markedly. The minimum gradient of the entire stream, about 0.2 foot per mile, occurs in Big Swamp. The maximum gradient, about 48 feet per mile, is in the vicinity of river mile 47 in the "Roseau River Rapids" (Canada). Below river mile 47 the river gradient

flattens abruptly and decreases to a little over 1 foot per mile near the mouth of the stream.

2.124 Roseau Lake and Big Swamp are important features of the Roseau River basin. Roseau Lake was originally a shallow, permanent body of water. Due to the construction of lateral ditches and channel enlargement downstream from the lake, it now contains surface water only during flood periods. As a result, much of the lake bed is now farmed in non-flood years. During flood periods the lake has been known to have a surface area of up to 40 square miles. The Roseau Lake area, under existing conditions, serves as a natural retarding basin which regulates runoff from upstream areas.

2.125 Big Swamp occupies the major part of the Roseau River basin between river mile 115 (about 10 miles west of the outlet of Roseau Lake) and river mile 100 (about 9 miles upstream from the international border). The land in this area slopes gently to the southwest. Before initial ditch construction, that portion of Big Swamp lying north of the Roseau River drained into the river while the area south of the stream drained away from the Roseau River. Even now, during flood periods, part of the discharge which over-tops the south bank of the Roseau River, within the Big Swamp reach, flows overland and through ditches into the several branches of the Two Rivers basin despite control structures in ditches leading into the Roseau River.

2.130 Topography of the Roseau River Basin. The Roseau River basin and bordering areas are characterized by gently sloping terrain. Elevations in the basin range from a maximum of about 1250 [1] in the headwaters to about 780 at the mouth. About 50 percent of the entire basin lies between elevations 1100 and 1000. The tributary area in the fan above Roseau Lake exhibits appreciably steeper slopes than the remainder of the basin. The flatness of the topography is accentuated by the fact that about 50 percent of the area in the watershed within the United States is under cultivation. The remainder of the land is swampland covered with dense growth of brush and aspen, or State-owned land allowed to remain as wildlife habitat.

2.140 Flooding Characteristics. Flooding of the Roseau River is almost an annual event. Most spring floods begin after the second week in April. The usual flood is caused by a combination of heavy winter snowfall and rapid spring melting, but occasional summer storms have also caused flooding. The condition of the soil is an important factor affecting the degree of flooding. High soil moisture or frozen soil conditions prior to heavy rains and/or snowmelt result in greater runoff. The floods usually occur along the reach extending from the city of Roseau to a point near the border. The floods are affected by the retarding action of a temporary storage in Roseau Lake and Big Swamp during flood periods, which may reduce peak flows substantially. This effect is evident from the discharge data at Roseau Lake and at Ross in table 5 below.

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[1] All elevations are feet above mean sea level.

Table 5. 1919, 1950, and 1966 Flood Peaks at Roseau Lake, Ross and Caribou, Minnesota - Existing Current Conditions.

Location	1919 Flood Peak Discharge cfs	1919 Flood Date of Peak	1950 Flood Peak Discharge cfs	1950 Flood Date of Peak	1966 Flood Peak Discharge cfs	1966 Flood Date of Peak
Roseau Lake (inflow)*	13,700	July	8,650		6,000	16 April
Ross	3,800	7 July	6,210	12 May	4,670	21 April
Caribou(at)	2,890	13 July				
Caribou(near)			4,120	19 May	3,120	28 April

* Computed

Source: United States, 1971. "Flood Control, Roseau River, Minnesota, General Design Memorandum." U.S. Army Corps of Engineers, St. Paul District.

2.141 Due to the retarding effects of Roseau Lake and Big Swamp, and because the land is of low relief, flood crests take between 3 and 4 weeks to pass from Roseau to the Canadian border.

2.142 The largest portion of the economic flood losses in the basin occur to the agricultural sector. The severity is related to the duration of inundation, preventing or delaying plowing and planting in the spring or damaging crops in the summer. Flooding also causes more permanent damage. Bank erosion and consequent bridge structure damage is a common result of increased water velocity. Flood flows of record are shown in table 5, above, and average monthly and daily flows are recorded in table 6, page 25.

2.143 The city of Roseau and approximately 87,000 acres of farmland downstream of Roseau lie within the floodplain of the Roseau River, exclusive of the 38,000 acres within Big Swamp. Fourteen damaging floods have occurred since 1919. Estimated average annual flood damages in 1970 amounted to about $617,700. Average annual flood damages in the area in 2024 are projected to be about 1.7 times those in 1970.

2.150 Climate. The climate of the basin is characterized by wide temperature variations, moderate to heavy winter snow, and summer rainfall generally ample for crop growth (U.S. Congress, 1965). Average annual temperature in the basin is about 37 F. The extremes range from a high of 107 F to a low of -52 F. The frost-free period extends from about 20 May through the end of August and averages 102 days. Annual precipitation averages 20 inches and has varied from a low of 11.74 inches at Caribou to a maximum of 26.62 inches at Roseau. Normally, 70 percent of the annual precipitation occurs during the frost-free period. Rainfall in the area is heaviest during June and July. Annual actual evapotranspiration at Roseau approximately equals annual precipitation during years of normal precipitation.

2.151 Annual snowfall averages about 35 inches. The maximum recorded depth of snowfall occurring in the vicinity in any one calendar year, 77 inches, was observed at Warroad, Minnesota, in 1935. Continuous low winter temperatures in the region afford little opportunity for snow-melt prior to the spring thaw period.

2.152 Storms affecting the Roseau River basin generally travel southeast and occur both as snow and rain. Winter snowstorms are frequently accompanied by high winds which create blizzard conditions, disrupting travel and communication facilities and occasionally endangering life and property.

2.160 Geologic History of the Roseau River Basin. The entire surface of the Roseau River basin is the result of geological action that has occurred since about 11,000 years ago. Immediately prior to that time the last major Pleistocene ice sheet was rapidly melting and the terminus retreating northward, leaving behind a mantle of glacial till and outwash. Because the regional slope is to the north, water from the melting ice and precipitation runoff became ponded between the higher land to the south and the retreating ice dam to the north which resulted in the formation of glacial Lake Agassiz, the largest ice-dammed lake in the world. Lake Agassiz expanded in area as the ice continued to retreat, but as lower drainage outlets were uncovered the lake level dropped. Occasional readvances of the ice sheet raised the lake to earlier levels. At first the lake drained southward, later it drained eastward through ancestral Lake Superior. Finally it drained northward, leaving in its wake remnant lakes (Lake of the Woods, Lake Winnipeg and Lake Manitoba) in a lake plain for the most part flat and underlain by clays and silts. Deposits of silts and clays characterize the deeper parts of the former lake and are an important sediment in the Roseau River basin. In shallower parts of the lake, wave action eroded the shores and the tops of the submerged hills, leaving behind a pavement of larger boulders that were too heavy to be

moved. Much of the western part of the Roseau River basin is characterized by wave-planed till strewn with boulders (exhibit 6).

2.161 As the Lake Agassiz level fluctuated, numerous shores alternately became submerged and exposed. Today ridges of sand and gravel mark the former positions of these shorelines. Other ridges are interpreted to have formed as offshore sand bars and spits. An excellent example of such a ridge extends between Greenbush and Badger and beyond.

2.162 Until vegetation became fixed on the newly exposed lake bed, wind action undoubtedly was an important geologic force. Sand ridges, most of which date from this time, are found scattered throughout the Roseau River basin. These and other dunes probably became active again between 2,000 and 6,000 years ago when the climate was warmer and dryer than now. Wind erosion further tended to level the land in most places. The most recent period of active wind erosion occurred during the 1930's due to a dry period compounded by the use of farming practices which were not designed to prevent wind erosion.

2.163 The Roseau River first formed as Lake Agassiz drained from the basin. Since that time there has been little vertical erosion by the river. Instead, the river has migrated laterally, cutting across the bottom of the flat lake plain, abandoning old channels and creating new ones in the process.

2.164 The end product of all these geological events is a rather level plain broken occasionally by beach ridges and, of course, by the channel of the river itself. Underlying much of the basin's surface are thick sequences of lake silts and clays, especially north and west of Roseau (in the project area). Farther west, especially between Ross and Duxby and in the vicinity of Caribou, the surface is underlain by wave-planed till. Because of the relative impermeability of the sediments, particularly the clays, the water table is normally high. As a result, peat, a common surface sediment in localized depressions, may be as much as 20 feet thick. In general, areas of peat in the Roseau River basin are underlain by clay and silt.

2.170 Soils and Sediments. The entire Roseau River watershed lies within the plain of former glacial Lake Agassiz. Thinly bedded silts and clays form the foundation for most of the soils within the project area. These relatively impermeable sediments have prevented water from infiltrating to lower levels. The resulting high water table has produced vast areas of peat and gleyed silts and clays.

2.171 The soils of the Roseau River drainage basin include the following:

Arveson	Grimstad	Poppleton
Barnett	Gudrid	Potamo
Baudette	Hiwood	Salol
Bearden	Kittson	Sioux
Chilgren	Mahnomen	Spooner
Enstrom	Malung	Tanberg

Fargo	Maple	Taylor
Faunce	McDougald	Ulen
Foxhome	Nereson	Wildwood

Each of these series is described in McMiller et al., 1942, and U.S. Department of Agriculture, 1926, 1939.

2.172 In addition to these true soils, alluvium and especially peat are important sediment deposits. Alluvium is generally the dominant sediment throughout the Roseau River channel. It ranges in thickness from scattered patches on the floodplain to extensive accumulations representing channel cut and fill sequences. Aside from this sediment the dominant soil types found along the channel are peats and clays (exhibit 7). These soils are developed in a surface sediment, and the channel modification project would commonly extend to greater depths into different underlying sediment types. The primary surface sediment in the project area is usually either lake clays and silts or wave-washed glacial till.

2.180 Bank Stability. Materials that would be excavated in the project are highly variable. Most important is the lacustrine clay which underlies the surface in the eastern part of the basin. The clay deposit is up to 50 feet thick in the area between river miles 125 and 132. This clay unit is characteristically dark gray with a high water content in this particular reach of river. Banks of the river, and especially man-made slopes adjacent to the channel, in areas underlain by this type of clay are particularly susceptible to mass movement (slumping and flowing). This bank instability is presently evidenced by numerous slump blocks and destruction of bridge approaches and supports. The western three-fourths of the project area, from river mile 125 downstream, is characterized by glacial till with some patches of clay and silt; the banks in this section are much more stable.

2.200 Hydrologic Environment

2.210 Groundwater. The base of groundwater flow in the Roseau River basin is Precambrian granite which lies about 600 feet below ground level in the western portion of the basin and 300 feet below ground level in the eastern portion. Overlying the granite in the western half of the watershed is a series of shales and sandstones. Thick deposits of glacial drift materials overlie the sedimentary rocks in the western portion of the watershed and the granite in the eastern portion. The thickness of the drift material ranges from less than 100 feet in the eastern part of the watershed to 300 feet in the western part.

2.211 The Sandilands upland (in the Canadian portions of the Pine and Sprague Creek watersheds) and Beltrami Island are the two major areas of rapid groundwater recharge in the basin. The central corridor of the watershed, i.e. along the river, is primarily an area of

groundwater discharge, mainly in the large areas of peat deposits in the lowlands in the middle of the basin.

2.212 Generally high water levels throughout the watershed indicate that the groundwater reservoir is essentially full. Water movement in the groundwater reservoir is very slow, however, due to low hydraulic gradients within the general area. Groundwater flow into and out of the basin is considered small, and natural water losses are high. Most precipitation runs off to local low areas (swamplands) or infiltrates into the soil and returns to the atmosphere by evapotranspiration. Some precipitation reaches streams as overland runoff. Only a small portion reaches the groundwater reservoir by infiltration, and this is largely in areas of surficial sand deposits.

2.213 At the base of both the Sandilands and Beltrami recharge areas, artesian flows are frequently experienced. Pine Creek and other small drainage systems west of Pine Creek are major collectors of groundwater flow moving in a general southwesterly direction from the Sandilands uplands. Similarly, the Roseau River, Roseau River South Fork, and Hay Creek are the primary collectors of northerly flowing groundwater originating in the Beltrami Island area. The groundwater converges on the Roseau Lake segment of the central corridor from both the south and north recharge areas. The groundwater supply to the Big Swamp portion of the central corridor is primarily from the north. It is likely that a portion of the southwesterly subsurface flow actually bypasses the Roseau River and moves on into the Two Rivers basin. Another significant groundwater movement is easterly and originates somewhere west of the Red River. This source is a supply for low flows along most of the Roseau River in Canada.

2.214 Water yields in the watershed are low - about 1 inch during a year of normal precipitation. The total estimated yield in the Minnesota part of the basin ranges from about 294,000 acre-feet for wet years to about 43,000 acre-feet for dry years. Moderate supplies of groundwater for domestic and small industrial and community supplies are available at most places in the watershed.

2.215 Groundwater development is confined largely to a 470-square mile agricultural area around Roseau and provides about 45.5 mgy (million gallons per year) for domestic use and 103.1 mgy for stock watering. In addition, two active municipal wells in Roseau provide about 41.2 mgy for industrial and commercial use and about 27.5 mgy for domestic use and are adequate for present needs. Roseau is the only urban site in the basin and the only location of known municipal wells.

2.216 Surface water is not used for municipal purposes in the U.S. portion of the watershed and only a very small amount is used for watering stock. Most wells are between 50 and 150 feet deep, and yields are generally less than 20 gpm (gallons per minute). Some wells of this type yield more than 100 gpm. Natural flows range from less than 1 gpm to more than 50 gpm, but most flows are less than 10 gpm. Well drillers report a few areas where "dry holes" existed below the water table. "Dry holes" result where no material of sufficient

permeability to yield water to wells are penetrated even though these materials are completely saturated. No widespread decline in water levels has occurred in the watershed. Groundwater is available over a large area, and yields are adequate for anticipated needs. Most of the water pumped is being diverted from evapotranspiration losses in the low areas of the basin, and the pumping causes no significant change in surface water levels.

2.220 Surface Water. The Roseau River generally attains its highest peaks in April and May from runoff caused by snowmelt, sometimes augmented by rainfall. The peaks diminish thereafter, except during periods of increased runoff following heavy or prolonged rains. The mean annual runoff is 2.5 inches at Ross and 2.9 inches at Caribou. The minimum annual runoff of 0.3 inches in 1934 and the maximum annual runoff of 8.1 inches in 1950 were recorded at the Ross gaging station. Runoff is affected by the large natural storage in Roseau Lake, slow discharge from the swamps, and high rates of evapotranspiration in the swamps. Table 6 lists stream flow data for the Roseau River and major tributaries.

Table 6. **Monthly Mean Flows, Minimum and Maximum Daily Flows, for Period of Record**

Hydrometric Station	Discharge (CFS)												Min. Daily	Max. Daily	Records
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.			
Roseau River Near Gardenton	19.9	11.6	61.5	1020	1180	795	505	210	160	174	120	38.0	0	3610 (May 1970)	1915-12 1962-
Roseau River Near Dominion City	20.8	15.3	55.7	983	1054	657	441	172	177	190	169	53.1	0	8110 (May 1950)	1913-
Roseau River Near Caribou	31.4	25.3	123	806	933	594	393	146	158	177	114	46.4	0.8	4020 (May 1950)	1917-
Sprague Creek Near Sprague Man.	2.9	1.6	20.2	173	165	109	53.0	25.0	45.4	36.6	22.8	4.9	0	1960 (Sept. 1942)	1928-
Pine Cr. Diver. Near Piney	5.4	4.7	15.8	860	69.8	45.2	21.1	12.0	15.3	20.5	14.7	8.0	0.2	627 (April 1967)	1958-

Source: International Roseau River Engineering Board. 1975. "Joint Studies for Co-ordinated Water Use and Control in the Roseau River Basin," Appendix B.

2.221 The natural storage of the Roseau River has a very pronounced effect on the streamflows. Because of the retarding effect of Roseau Lake, the discharge hydrographs at Ross are characterized by a delay in timing, diminished peaks, and extended high flow over a longer period of time when compared to upstream hydrographs. Substantial natural storage is also provided in the Big Swamp area. The Roseau River flood flows are thus additionally delayed, reduced, and extended over a longer period of time because of the retarding effect of Big Swamp. Further, because of the low divide between the basins of the Roseau River and Two Rivers in Big Swamp, a part of the flood flows of the Roseau River excapes southerly into the Two Rivers basin. Drainage ditches constructed in this portion of the swamp permit water to flow in either direction. Table 5 gives the peaks and dates of peaks for the discharges of the 1919, 1950, and 1966 floods at Roseau Lake, Ross and Caribou with existing conditions (Pine Creek diverted). The reduction in flows due to Roseau Lake and Big Swamp are evident.

2.222 Low Flow. Table 7, below, summarizes the results of low flow regime analysis. Because the period of record differed for each of the gaging stations, the discharge values shown on the table are not directly additive. All available records were used to compute average discharge values. However, when flows at adjacent stations were compared, only flows for years common to each station were used. Only 2 low flow months were analyzed. November represents a normal low flow month, whereas February represents an extreme low flow month.

Table 7. Low Flows of the Roseau River

Station or Area	Period of Record	Drainage Area mi^2	November Aug Flow cfs	November cfs sq.mi.	February Aug Flow cfs	February cfs sq.mi.
Roseau River near Roseau*	1929-70	622	25.4	0.057	4.49	0.007
Sprague Creek near Sprague	6 yrs. in 1929-40 1941-70	169	22.1	0.131	1.69	0.010
Pine Creek near Pine Creek	8 yrs. in 1929-40 1941-53	75	18.2	0.243	6.89	0.092
Local area Roseau near Ross	1941-53	354.1	14.1	0.040	1.06	0.003
Roseau River near Ross	1929-70	1220	89.8	0.074	12.33	0.010
Local area Ross to Caribou	17 yrs. in 1929-70	349.7	7.34	0.021	0.57	0.002
Flooded area Roseau to Ross	--	52.1	2.07	0.040	0.156	0.003
Flooded Area Ross to Caribou	--	101.7	2.13	0.021	0.17	0.002

*U.S.G.S. station is located on Roseau River below South Fork near Malung; drainage area of 573 sq.mi.

Source: United States, 1973a. Memorandum Roseau River Basin, Manitoba and Minnesota "Low Flow Regime." Army Corps of Engineers, St. Paul District.

2.223 As mentioned (2.214), water yield in the watershed is low. The greatest seasonal yield generally occurs in the spring and early summer months. The severe winter temperatures preclude any appreciable melting of accumulated snow cover; and minimum seasonal yields occur from November through March.

2.224 It is believed that the flood storage in Roseau Lake and Big Swamp do not contribute much to low flows in the Roseau River during late summer and winter. The water table in Roseau Lake and Big Swamp is at or near the surface throughout much of the normal low-flow period, since most of the peatlands flanking the river are groundwater discharge areas. The wildlife pools in the United States have a storage and surcharge effect that lessen groundwater depletion. In addition, the groundwater and surface water regimes are basically unaltered in the tributary basins.

2.225 Under present conditions, strips of land 1 to 3 miles wide along either side of the Roseau River represent the only part of Big Swamp with direct runoff contribution. As mentioned, south of the river the major part of the swamp drains southwesterly into the Two Rivers basin. The swamp is well ditched, and much of the excess surface water drains fairly well once the flood levels in the river have receded. After spring floods have receded, however, the water table in the peat soils of the swamp remains at or near the surface, and scattered pools of surface water persist.

2.226 Low Flow Duration. Once-in-ten-years, 7-day low flows in the Roseau River range from 0.1 cfs near Malung, to 1.7 cfs at Ross, to 8.2 cfs near Caribou.

2.227 Base Flow. Base flow for Pine Creek is generally more than 5 cfs, whereas base flow from the South Fork of the Roseau River is less than 5 cfs. The significance of the groundwater movement from the Sandilands recharge area in Manitoba is reflected in the contribution this area makes to low flows in the Roseau River. Much of the flow from the Sandilands reaches the Roseau River between streamflow gaging stations at Ross and Caribou. The drainage area between these points is 383 square miles, about two-thirds of which is north of the Roseau River. Pine Creek, upstream of the diversion channel, occupies 65 square miles of this area. The yield at Pine Creek averages about 0.075 cfs per square mile during February, the month of most extreme low flow. This is 7 to 10 times the yield of the next most productive tributary to the Roseau River. The Pine Creek Diversion conveys much of the Pine Creek flows into the three large wildlife pools maintained by the Minnesota DNR in Big Swamp between the international boundary and the Roseau River. These pools collect almost all drainage from the north side of the river between the gaging stations at Ross and Caribou. The pools are interconnected and discharge into the Roseau River at several locations.

2.300 Water Quality

2.310 Surface Water. Water samples from the Roseau River have been collected and analyzed since 1966 by the USGS (stations: below Roseau 1972-75; Ross 1966-68; below State Ditch 51 1972-75) and from 1967-68 by the Minnesota Pollution Control Agency (MPCA) (stations: Malung and Caribou). In addition, samples were collected at 13 stations along a 43.7-mile reach of the Roseau River by the Institute for Ecological Studies (IES), University of North Dakota in 1973 as a part of the Environmental Impact Assessment of Roseau River. A description of the IES sampling sites is shown in exhibit 8, and summaries of the water quality data are presented in exhibits 9 and 10. Concentrations reported as average values are often difficult to interpret, since inconsistent low or high results greatly affect the average value. For this reason the range amd median[1] value are given whenever possible.

2.311 The Roseau River has been classified as a 2B stream by the MPCA (WPC-25). Standards for this water quality classification are shown in exhibit 11. The major ion chemistry of the Roseau River varies with the seasons and with discharge. Examination of individual samples indicates that winter is a period of high ionic concentration, as reflected by high specific conductance, while spring and summer are characterized by lower concentrations. In winter, when the soil and many smaller tributaries are frozen, the Roseau River water is essentially groundwater and thus exhibits a chemistry similar to that of the groundwater in the area (exhibit 12). In the spring the snowmelt water dilutes this winter base-flow of groundwater and lowers the specific conductance of the river water. The chemistry of the water in summer and fall depends on the frequency and intensity of rainfall in the watershed; during dry periods the water becomes more concentrated, reflecting the groundwater origin of base-flow, while after storms the river water is diluted by rain and surface water. This inverse relationship between discharge and major-ion concentration is a phenomenon commonly observed in streams (Toler, 1965; Johnson, et al., 1969; Hynes, 1970).

2.312 Nutrient concentrations in the Roseau River also vary seasonally and with discharge; however, in addition, they appear to be affected by the Roseau municipal sewage settling ponds and possibly by agricultural fertilizers used in the watershed. On 13 August 1973 the concentration of total phosphorus exhibited a fourfold increase from 184 parts per billion (ppb) at station R6, just upstream from the city of Roseau, to 602 ppb at station R5, 5 miles downstream, and just below the sewage settling ponds. (See exhibit 8 for locations of sampling stations.) The total phosphorus concentration then declined progressively at sampling points downstream, reflecting dilution by tributary streams with low phosphorus concentration. In addition, the contribution of

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[1] Median indicates that half of the samples have a value greater than the median and half less than the median.

nutrients to the river by the settling ponds is demonstrated by the very high nitrite concentration in the river at station R5 on 20 July 1973. Nitrite is a common indicator of organic pollution (U.S. Public Health Service, 1962).

2.313 In addition, the USGS sampling stations below Roseau and below State Ditch 51 (downstream from Caribou had the highest phosphorus concentrations along the river while stations at Roseau and Caribou exhibited the only violations of fecal coliform standards.

2.314 In rapid, highly turbid water, plant growth is limited because of reduced light penetration and the physical action of the current resulting in a low biological uptake of nutrients. In areas of stagnant water, such as oxbow lakes or water behind impoundments, high nutrient concentrations (especially nitrogen and phosphorus) can foster substantial algal growth. An example of this exists in the oxbow at station R11. This area behaves like a small lake with algal blooms accompanied by high chlorophyll concentrations. Nutrient concentrations are reduced to very low levels by biological uptake followed by death and sedimentation of the organic matter. This process is reflected in the oxbow sediment, a black, fine, organic biopel with few clays. During periods of low flow, stretches of the river exhibit a reduction in turbulence and turbidity, allowing algae and other aquatic plants to proliferate. Such was the case on 20 July 1973, at station R4, when blankets of duckweed species (Lemna minor, Spirodela polythiza, Wolffia columbiana) and high chlorophyll concentrations were observed.

2.315 Additional major sources of nitrogen and phosphorus are agricultural fertilizers and rainwater. These sources probably account for the observed seasonal fluctuations in the nutrient concentrations of the river. High nitrate concentrations in rain water are not uncommon (Hynes, 1970) and have been observed in northern Minnesota (Wright, 1974). This nitrogen, along with that originating from fertilizers, can find its way into the river via surface runoff and/or groundwater. Fertilizers can also contribute phosphorus to the river (Benoit, 1973).

2.316 The MPCA has identified two point sources of pollution along the U.S. portion of the Roseau River.[1] The Wannaska Creamery Association at Wannaska discharges 200 GPD (gallons per day) of creamery waste water, 1,000 GPD of locker plant waste water and 5,000 GPD of cooling water to the south Fork of the Roseau River. Final effluent standards have been established for the company and became effective 16 September 1974 (table 8). To date, however, it is unknown to what extent the creamery is meeting its discharge permit conditions because there has been no monitoring in this reach of the river in recent years (table 9).

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[1] State of Minnesota. Jan 1975. Water Quality Management Basin Plan, Red River of the North Basin. MPCA, Division of Water Quality.

Table 8. Point Discharge Requirements and Needs [1]

	Dischargers	
	Wannaska Creamery Association	Roseau
NPDES Required Final Effluent Limits		
Flow (MGD)	NA[2]	0.500
BOD (mg/l)	5*, 25**	25**
TSS (mg/l)	5*, 30**	30**
Fecal Coliform (MPN/100 ml)	200	200
Temp. (^{o}F)	60	
NPDES Dates		
Issued	5/6/74	9/1/74
Final Compliance	9/16/74	9/1/74
Expiration	4/30/77	5/31/77
Treatment Needs	Need a new treatment facility	Adequate treatment
Other Planning Considerations	Begin construction by 6/15/74; operational by 9/15/74	No future needs anticipated

[1] After MPCA, Jan. 1975

[2] Not Applicable

* Continuous, requires tertiary treatment

** Seasonal, effluent stored and discharged only during periods of adequate streamflow, such as during spring runoff and during autumn.

Table 9. Point Dischargers, Existing Conditions[1]

	Receiving Water	
	South Fork Roseau River	Hay Creek
River Mile	86	36
Discharge Description	Wannaska Creamery Association	Roseau
Present Treatment System	Not Known	Primary and Secondary Ponds
Present Average Effluent		
Flow (MGD)	NR[2]	NR
BOD (mg/1)	NR	19
TSS (mg/1)	NR	26
Fecal Coliform (MPN/100 ml)	NR	150
Discussion of Problems	Nature of problems not known	Treatment is adequate

[1] After MPCA, Jan. 1975

[2] Not Reported

2.317 Roseau's waste treatment facility was constructed in 1973 and consists of two primary ponds of 39.5 acres each and a secondary pond of 31.0 acres. Discharge to the Roseau River is via a drainage ditch and Hay Creek. Permit requirements and effluent characteristics are listed in tables 8 and 9. The Roseau waste treatment system serves the Roseau Farmers Coop Creamery, Polaris Industries, Independent School District No. 682, Roseau Area Community Hospital, Sheltering Oaks Nursing Home, Eventide Nursing Home, Roseau Children's Hospital and Land O'Lakes. According to the MPCA report, Roseau's pond system appears to be adequate for the community's needs. The levels of biological oxygen demand (BOD), total suspended solids (TSS), and fecal coliforms are well within the controlled discharge standards.

2.318 According to the MPCA report, it is assumed that the small unsewered communities on the river have properly constructed and maintained septic tanks that provide adequate waste disposal and that no sewer or treatment systems will be required.

2.319 In general, the water quality of the Roseau River during the period from 1966 to 1975 met the objectives listed in exhibit 11 . However, the parameters of dissolved oxygen, turbidity, and fecal coliform objectives have been exceeded during that period, even after the September 1974 compliance dates for the two point sources in the watershed. Most violations have occurred during the winter (January-March) and in June and July.

2.320 Groundwater[1]. There are no continuing groundwater quality testing programs in effect at the present time, and water quality information is limited. However, based on data supplied by well owners and well drillers in the area, the quality of groundwater can be summarized in general statements. The groundwater is suitable for domestic and stock use at most places although the water is very hard, largely between 200 to 400 ppm up to a maximum hardness of 930 ppm.

2.321 Dissolved solids concentrations are largely between 200 and 500 ppm, but sometimes as high as 1,800 ppm. Iron content is high, largely between 0.3 and 1.5 ppm up to a maximum of 4.1 ppm. Most well owners report "rusty" water. Water temperatures range from 39 to 40 F.

2.322 Dominant ions are calcium, sulfate, and bicarbonate. The deeper wells generally have a higher concentration of sulfate and total dissolved solids. Chloride ion concentrations are low, generally less than 10 ppm, except in a few shallow wells near a source of contamination, where concentrations of 50 ppm are reported. Exhibit 12 tabulates further groundwater characteristics obtained from six wells in the area.

2.330 Sediment Yield. There are no sediment sampling stations on the Roseau River located in the United States. However, a Canadian sediment sampling program initiated in 1972 obtained data at Gardenton and at Dominion City, Manitoba. The Gardenton station is located close to the boundary between the upper (U.S.) and middle (Canadian) regions of the watershed, and essentially represents the runoff and sediment yield from the United States portion of the drainage area. Canadian studies have analysed three periods of runoff to determine sediment yields from the middle and upper reaches of the watershed. The three periods were from August to November in 1972, April to October 1973, and April to June 1974. These three periods represented three different flow conditions: low, normal, and high, respectively.

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[1] IJC Report, Appendix B.

2.331 Analysis of the existing data resulted in the following conclusions:

1. The Roseau River can be classified as a low sediment producing stream

2. During low flow periods, the suspended sediment yield rate for the upper region (U.S. portion) was the lowest for the watershed (about 25 to 35 percent of the average sediment yield from the whole watershed).

3. During high flow periods, the suspended sediment yield rate for the upper region increases and approaches the average sediment yield from the whole watershed.

4. During low flow periods, most of the sediment load is produced by channel erosion, while during high flow periods most of the sediment load results from sheet erosion on the watershed.

2.400 Biological Environment

2.410 Terrestrial Vegetation. The vegetation of the Roseau River watershed falls into several dominant community types. These types inhabit distinct regions within the watershed (exhibit 13).

2.411 The region of the drainage basin west of Duxby is dominated by sedge-, grass- and cattail-supporting peatlands. These peatlands probably developed under lush bluestem prairies characterized by big bluestem (Andropogon gerardi) and little bluestem (A. scoparius), Indian grass (Sorghastrum nutans) and switchgrass (Panicum virgatum); however, most of this type has long since been disturbed by drainage attempts, mowing, grazing and other agricultural practices, and the area is now a treeless fen.

2.412 The vegetation of the central area of the drainage basin (from Duxby east to the eastern boundary and from Sprague Creek south to several miles south of Roseau) is characterized by interspersed aspen, bur oak and grassland community types. Oak communities were perhaps once more widespread; now, however, only a few are present on the high ground near the river. Small aspen communities are still plentiful in this region of the watershed, although these forested areas are a diminishing constituent of the natural vegetation of the drainage basin. Few, if any, of the grasslands of this area are native. Most of these lands have been plowed and now support introduced species of grasses and legumes.

2.413 Large forested peatlands occur north of an imaginary line 4 miles south of and parallel to the U.S.-Canadian border. The dominant elements of this type are tamarack (Larix laricina) and black spruce (Picea mariana). Large stands of this type once covered much of the territory north of the Great Northern Railroad between Roseau and Warroad. Fires eliminated the southern parts of this great swamp forest. These parts now support introduced grasses and legumes.

2.414 The narrow belt of remaining "floodplain" forest consists of mixed hardwoods including black ash (Fraxinus nigra), green ash (F. pennsylvanica), bur oak (Quercus macrocarpa), basswood (Tilia americana), box elder (Acer negundo), balsam poplar (Populus balsamifera) and quaking aspen (P. tremuloides). As with the other forest community types in the watershed, much of this mixed forest has succumbed to modern agricultural practices.

2.415 Based on a study of 42 sample plots, vegetation in the area may be tentatively divided into the following community types:

a. Black Ash - Basswood Community
b. Aspen - Balsam Poplar Community
c. Bur Oak - Green Ash Community
d. Green Ash - Elm Community
e. Jack Pine Community
f. Tamarack Community
g. Grassland Community
h. Altered Fen

Analysis of the community types, the physical and chemical characteristics of vegetation, mensuration data, and study procedures are detailed in exhibits 14 and 15.

2.420 Aquatic Organisms. Plankton, fish and bottom sediment samples were collected at the various stations along the 43.9-mile stretch of the Roseau River at which water samples were taken (see paragraph 2.310). Detailed data on the following information are presented in the environmental assessment prepared by the Institute for Ecological Studies[1], on file in the St. Paul District Office, Corps of Engineers.

2.421 Plankton. Plankton counts varied from station to station, but two samples were distinctive in that no zooplankton were present. These samples were collected at sites R1 and R13, characterized by riffle areas and higher current velocities, perhaps explaining the apparent lack of zooplankton. Large numbers of species were recorded at sample sites R3 and R7 which probably reflects the pool-like conditions of the channel at these locations. Professor Alan J. Brook of the University of Minnesota (personal communication, 1973) has stated that pools and dammed areas in rivers tend to foster more lacustrine planktonic algal species. The species found at R3 and R7, as compared with those at other sites, were similar to those found in lake communities. At R6, Daphnia was somewhat abundant, and a virtual

[1] Environmental Impact Assessment of the Roseau River, Minnesota, Flood Control Project, Research Report Number 6. Institute for Ecological Studies, University of North Dakota, Grand Forks, North Dakota, March 1974.

Volvox "bloom" existed. This site is situated above a dam in the city of Roseau. The water at this point is quieter and the turbidity lower than at other sites. Volvox was not found at any other station. Mougeotia and Spirogyra, both periphytic (attached) algae, were collected in faster flowing waters (e.g., R1, R7 and R13), probably having been scoured from their attached positions along the river's edge by the faster currents.

2.422 Fish. Based on limited sein samples and on an electrofishing survey conducted by the Minnesota DNR during the 1971 spring runoff period (Huber, 1971), the IES assessment concluded that the Roseau River downstream from the city of Roseau contained a significant fish population. These two sampling efforts collected only 151 fish of 10 different species. The success of the DNR sampling effort was, however, limited because of high water conditions which reduced the efficiency of their electrofishing equipment. However, information can be inferred from an accident which occurred in August 1970, in which an insecticide dumping resulted in a fish kill that extended for a 3 1/2-mile stretch below Roseau. At least 5,000 fish were killed of which 90 percent were northern pike (up to 8 pounds with an average weight of 2 to 3 pounds and 10 percent were walleyes, suckers and other species (Bonnema, 1970).

2.423 The large, shallow impoundments of the Roseau River WMA, located on the Pine Creek Diversion, provide spawning areas for northern pike. The Minnesota Division of Game and Fish has a northern pike spawning, rearing, and winter rescue operation in and adjacent to the large pools in the Roseau River WMA. Between 50,000 and 100,000 northern pike, weighing from 1 to 4 pounds each, are trapped there annually in the fall for transplanting in suitable State waters. The Minnesota DNR has determined that adult northern pike enter the pools to spawn during spring high water conditions in the river. In addition, the Minnesota DNR feels that the natural oxbows and channel cutoffs currently existing along the river provide, to an undetermined extent, spawning, and feeding areas. Because of limited habitat in the Roseau River upstream from the city of Roseau, this portion of the river is not considered a significant fishery area.

2.424 The Hayes Lake impoundment, completed in 1973, provides the possibility for a lake sport fishery in the basin. Catfish fingerlings have been stocked on an experimental basis, however much of the impoundment lacks adequate depth and the maintenance of a significant sports fishery is uncertain.

2.425 A more recent and intensive fish survey of the Roseau River from the Canadian border to Malung was conducted by the Minnesota DNR in September 1975. This stretch of river was divided into five sections (exhibit 16). Each section was electrofished for periods from 0.23 to 1.83 hours (survey data contained in exhibit 16 - (19). Because of the unequal fishing effort expended on the five sections, actual catches of fish were converted to "catch per unit of effort (CPE), in this case, "catch per hour". Game fish populations were highest from the downstream sections with the reach upstream and through Big Swamp (Section IV) exhibiting the highest CPE. The two upstream sections (I & II) exhibited more diverse species composition, with more non-game species and lower CPE values. Total CPE values appeared to be correlated with the composition of bottom material and numbers of oxbows and old cutoffs. Bottom material from sections III through V was composed of large sized particles while substrate from sections I & II was silt and sand. Sections III through V also contained many more oxbows and channel cutoffs than did the upper two sections. It is also interesting to note that Section IV which had a CPE of 690 fish was estimated to have been 100-percent channelized in the original channel.

2.426 Although no population estimates can be obtained from these samples, it is evident that at least the downstream sections of the Roseau River contain a significant fishery resource. Further fishery studies are being considered to form the basis for the design of structural fishery mitigative measures.

2.427 Benthos. A study of the distribution of benthic invertebrates, based on total numbers and occurrence at sampling sites, revealed nematodes, alderflies, and stoneflies to be rare, caddisflies, crustaceans, beetles and clams to be of intermediate abundance, mayflies and dipteran larvae to be common, leeches to be intermediate-to-rare, and obligachaetes and snails to be intermediate-to-common. A discussion of sampling methodology and sampling error is found in the environmental assessment on file in the St. Paul District Office, Corps of Engineers.

2.428 The benthic sample analysed from site R1 (exhibits 20 and 21) contained both a large number of total individuals (478) and a large number of species (10) when compared with other sites. The total numbers of organisms collected in the areas formerly disturbed by channelization (R9, R2, R12, R11, R10, R8, and R13) were one-half to one-ninth the number collected at station R1, a riffle area that potentially could offer many more microhabitats than a purely silted channel bottom.

2.429 The paucity of benthic taxa (three) collected at R11 may reflect a lack of habitat diversity at that site, even though the second largest total number of individuals (258) was found there. However, the presence of only one taxa at R4, a site somewhat removed from the disturbed area, suggests sampling error may have been inherent in the survey.

2.430 Wildlife Resources. Terrestrial vertebrates were studied at fourteen sites (exhibit 22) representative of the plant communities in the project area.

2.431 **Birds.** Breeding bird species diversity found in the various censused habitats is summarized in exhibit 23. The greatest diversity (33) existed in habitats closest to the river, i.e. in Bur Oak-Green Ash and Green Ash-Elm communities. Species diversity was lowest in Grassland (14) and in the dry Shortgrass Marsh (12).

2.432 Sixty-two bird species were believed to be breeding in the census areas during the time period of the environmental assessment study, and most of these were common or abundant in one or more habitat type. Ninety-nine additional species have been recorded at times other than when censuses were being conducted. The environmental impact assessment did not assess the importance of the project area in harboring wintering or migrating birds. The study was conducted under drought conditions such that the fauna of the census areas may have deviated significantly from that of normal or wet years.

2.433 The Bur Oak-Green Ash and Green Ash-Elm woodland communities along the Roseau River harbor the greatest variety of breeding birds of any of the habitat types studied. None of those breeding birds identified are considered endangered on a national or State basis. Three species of waterfowl (mallard, common goldeneye, and hooded merganser) were regularly observed along the river throughout the breeding season and are believed to be common breeding birds in the vicinity of the river.

2.434 The grasslands and hayfields are probably most important in providing habitat for sharp-tailed grouse (nesting and summer feeding) and other typical open country species such as bobolink and grasshopper sparrow. Birds characteristic of native prairies were not observed.

2.435 Aspen woodlands are typical of the prairie-forest ecotone of Minnesota. These woodlands provided breeding habitat for a good variety of birds (average 26 species per trail), but no species considered endangered were encountered. These woodlands are of importance for winter survival of sharp-tailed grouse. Ruffed grouse populations vary greatly and were probably at the bottom of a population fluctuation during the time of the assessment.

2.436 The drained bog (altered fen) censused contained an unusual combination of open country (e.g. killdeer and western meadowlark) and bog (e.g. woodcock, common snipe, Traill's flycatcher) bird species. There was only one species considered a rare breeding bird in Minnesota (Wilson's warbler). This bog contained two upland game species, i.e. woodcock and common snipe. These two species breed in northern Minnesota, primarily in bog habitats and are declining in numbers in proportion to bog destruction.

2.437 The Short-grass site was almost completely dry due to drought conditions. For this reason it resembled an upland grassland and species typical of both upland (e.g. bobolink and western meadowlark) and marsh habitat types (e.g. short-billed marsh wren and sharp-tailed

sparrow) were found. The Short-grass Marsh harbored several species considered rare or in very limited distribution nationwide. Short-billed marsh wrens, though widespread, are rare to uncommon throughout most of the country although they are sometimes abundant in grassy marshes as they were here. Sharp-tailed sparrows are considered rare nationwide, with rather restricted ranges. They are very rare in Minnesota, marshes of the Roseau River area being one of only a few known breeding areas in the State. Approximately three pairs of mallards bred in the Short-grass Marsh, which is considered good mallard breeding density based on the area sampled.

2.438 Twenty-eight species of birds were found breeding in the mixed habitat of the lowland wood edge. No species considered rare in Minnesota were noted except for the sharp-tailed sparrow which, as mentioned above, has an extremely limited breeding range in the State. This area contained one sharp-tailed grouse dancing ground frequented by 11 males.

2.439 Big Swamp, a natural bog area on the southwestern border of the Roseau River WMA, was visited on several occasions although the bog was not thoroughly censused because of its impenetrability. This area has a breeding population of approximately 50 pairs of sandhill cranes. These birds have a very limited breeding range in Minnesota and the continental United States. In addition, the bog sustains a large breeding population of woodcock and common snipe. This type of bog typically sustains many species of birds uncommon in Minnesota including such boreal forms as Canada warbler, Connecticut warbler and brown-capped chickadee.

2.440 Mammals

2.441 Fur Bearers. Seven local trappers known to trap in the Roseau River WMA and on the southwest edge of Big Swamp were contacted and interviewed concerning their take from this area during 1972-73. Their take indicated that the minimum economic value of the bog area lies somewhere between $3,000 and $5,000 per year at current fur prices. The take from Big Swamp comprised 30 to 50 percent of their total take.

2.442 Deer and Moose. Interviews with local game management personnel revealed that no big game surveys have been conducted along the Roseau River. Incidental sightings of moose and deer were frequent and signs in the form of droppings and tracks were very common. Browse conditions also indicated that the scattered stands of trees and wet boggy areas along the river are heavily used and support high populations of both deer and moose.

2.443 Although no quantitative surveys were available, subjective evaluation by the environmental assessment study team indicated that the deer population in this area was as high or higher than in any other part of the northwest corner of the State (estimated at 20 per square mile). The moose population was estimated at 1-2 per square mile, also one of the highest densities in the State.

2.444 Small Mammals. Relative abundance of small mammals in the principal habitat types is indicated in exhibit 24. The greatest diversity of species was in the grassland, Bur Oak-Green Ash and Green Ash-Elm communities, while the marsh and altered fen had the lowest. The lowland Bur Oak-Green Ash and Green Ash-Elm communities had the highest density of small mammals, and Aspen-Balsam Poplar forest the lowest.

2.445 Mammal populations can fluctuate widely from year to year, and from one region to the next. However, these data are at least comparable to other published figures (Iverson et al., 1967), and emphasize the importance of the Green Ash-Elm and Bur Oak-Green Ash communities to this component of the biota.

2.500 Historical and Archaeological Records

2.510 Prehistoric Occupation of the Roseau River Area Prehistoric occupation of the Roseau River project area was not possible until after approximately 7000 B.C. Prior to that time the area was below the waters of glacial Lake Agassiz (see 2.160). From about 9500 B.C. until after 7500 B.C. the huge glacial lake stood at an intermediate level bounded by what is now known as the Campbell Beach. This beach is a gravel ridge up to 20 feet high and 500 feet wide. It runs northward along the Red River Valley until it turns to the east south of the Canadian border. The town of Roseau is just north of the beach ridge and the Roseau River flood control project is located along a stretch of river flowing across the lake bottom deposits of the Campbell Stage of Lake Agassiz.

2.511 As the glacial lake receeded from the Campbell Beach area the Roseau River originated as a drainage channel. Sometime after 7000 B.C. the Roseau region of the lake had drained, prairie grassland vegetation began to invade the lake bottom plain, and the area was available for occupation by human beings and other terrestrial mammals.

2.512 Since that time the Campbell and other beach ridges have been preferred locations for settlements, short-term encampments, and other kinds of cultural activities. The earliest known prehistoric remains from the area are associated with archaic hunters and gatherers who occupied the region for thousands of years until approximately 1000 B.C. These peoples made intensive use of a wide variety of local plant and animal food resources. Their population was not dense and their sites would not be abundant. Little is known about the early inhabitants since their sites do not leave obvious surface indications, and there has never been systematic exploration for these sites. One

such site on the Campbell Beach ridge not far from Roseau, was a tool manufacturing site containing abundant remains of manufacturing processes, but virtually no finished tools. This suggests the possibility that some food procurement sites and food processing and habitation sites may be located off the glacial lake beach ridges. Since riverine and lacustrine food resources were being utilized, the river banks and the shores of lakes are among the probable site areas. There is some confirmation of these suggestions in the private collections of local residents.

2.513 There are some substantial gaps in present knowledge of the prehistory of the Roseau River basin; such that the next solid information available is dated from about 600 A.D. to 1000 A.D. or later. During these years a widespread pattern of burial mound construction appeared all along the Campbell Beach ridge, from Lake Traverse, up the Red River Valley and into Manitoba. This pattern, known as the Arvilla Complex, consisted of linear and circular mounds which contained tools and ornaments with the burials. Most of the research on the Arvilla Complex was carried out 30 to 40 years ago and concentrated on the burial practices. Therefore, little is known about the habitation sites of the people who built the mounds.

2.520 History of Recent Settlement of Roseau River Area. Apparently the first Europeans to enter the Roseau Valley were Frenchmen associated with the French-Canadian trader and explorer Pierre Gaultier de Varennes, Sieur de la Verendrye, who established Fort Saint Charles on Magnusson's Island in Lake of the Woods in 1732. By the middle of the nineteenth century the Hudson's Bay Company began to push its fur trading activities to the region around the Roseau River. Records of the Hudson's Bay Company indicate that the western portion of the valley was cut by the Roseau River which ran through a marsh 10 miles long. A post was established on the now dry Roseau Lake, where the river entered the lake, but it was abandoned in 1851.

2.521 Concentrated settlement of the Roseau Valley was well underway by the late 1800's. In 1895 Roseau County was organized and Roseau became the county seat. By 1894 the tide of migration had shifted farther to the west and in 1895 the townsite of Badger was established.

2.522 For some years development of the county was hindered by the lack of adequate transportation facilities. In 1900, however, the Canadian National Railways built a line around the south shore of Lake of the Woods, through the Warroad Valley and across the northwestern section of Roseau County. This and other circumstances led to the expansion of the Great Northern Railway into Roseau County in 1908 (Chapin, 1943).

2.530 Cultural Resources (Archaeological). Present knowledge of the settlement history of the Roseau River basin suggests the possibility of the existence of prehistoric and historic sites in the project area. The Natural Register of Historic Places (see 9.006) lists no sites in the project area, however little research has ever been done specifically along the river. At the start of Corps involvement with cultural resource identification in the area, these were three known sites recorded in the archaeological files of the Minnesota State Archaeologist.

2.531 An archaeological survey was conducted by the environmental assessment team in June, 1973. The survey concentrated on the locations of proposed cutoffs and levee construction, and was almost exclusively a surface collecting activity. Four sites were identified. Since that time modifications have been made in project plans with changes in the locations of some proposed cutoffs and levees. A detailed survey was carried out in 1975 to investigate the new locations and to evaluate some sites where impact was anticipated. Results of this work indicated that 2 prehistoric and one historic site would be adversely affected by the proposed actions. In response to these circumstances, project plans have been changed slightly and construction specifications will be established so that adverse impacts will be avoided at two of the sites. The third site is located along the right-of-way of a proposed levee. During the summer of 1976 an archaeological contractor conducted intensive subsurface testing at the site to determine its eligibility for the National Register of Historic Places, and to recommend mitigation if warranted. As a result of this field work the Principal Investigator has determined that the site does not qualify for the National Register, that no alternation of project plans shall be required in the site area, and that no additional archaeological work is necessary at the site.

2.600 Socioeconomic Environment

2.610 Land Use. During the late 1960's, an extensive study of Minnesota land use was made by the University of Minnesota in cooperation with the executive and legislative branches of the State government (University of Minnesota, 1969). Each 40-acre tract of land was classified as to dominant land use. In all, nine categories were considered. "Cultivated" was defined as land which had recently been tilled or harvested mechanically, "Pasture and Open" as non-forested land not used for any identifiable purpose, "Forested" as an area that contained a scattering of trees whose crowns cover at least 10 percent of the land area, and "Marsh" as non-forested, shallow, permanently wet, vegetated areas. Grazing land and farm land not under cultivation at the time of the study was placed under the category of "Pasture and Open." Based on this study, approximately 50 percent of the basin is classified as agricultural land. The major areas of nonagricultural land are the headwater regions of the main stems and south branch of the Roseau River which are predominantly forested and the extensive marsh areas along the international border. Since completion of this survey there have been no significant changes in land use.

2.611 Exhibit 25 shows the land types in the Roseau River Watershed identified in the IES assessment. Approximately one-third of the U.S. portion of the basin is forested (approximately 240,000 acres). Beltrami Island State Forest contains approximately 108,000 acres of this forested area, and much of the remaining forested land is owned and administered by the Minnesota DNR. While these forested areas are a valuable basin resource as wildlife habitat and for scenic and recreational purposes, commercial sale of timber is of limited economic significance. There are scattered holdings of privately owned land managed for forestry purposes but none by commercial interests. The State's management objectives with respect to the State-owned land apparently are to achieve a maximum yield of forest products, to provide recreational opportunities for the public, and to provide wildlife habitat.

2.612 Wildlife - particularly waterfowl, sharp-tailed and ruffed grouse, moose, and deer - is a major resource of the Roseau River basin. The basin contains extensive marsh areas as well as open water in ditches, natural water courses and potholes in areas of burned out peat lands. Timbered habitat, while greatly diminished from natural conditions, is extensive and supports substantial populations of upland birds and mammals. The natural habitat of the basin is augmented by the habitat provided in the Roseau River (WMA) operated by the Minnesota DNR. There are 62,000 acres of wildlife habitat in the area and three waterfowl impoundments having a total area of 10,000 acres at normal pool levels. At present, about 150,000 acres, or 20 percent of the watershed, is considered excellent wildlife habitat.

2.613 Farm practices in the basin consist of growing small grains, notably, flax, barley, oats and wheat, raising livestock, and producing dairy products. Grass seed has also been a significant cash crop in recent years.

2.614 Table 10, below, gives a breakdown of farm land use in Roseau and Kittson Counties.

Table 10. Farm Land Use in Roseau and Kittson Counties

	Roseau County	Kittson County
Total Approximate Land Area	1,072,768 acres	718,976 acres
Total Land in Farm Use	558,296	554,575
Land in Farms According to Use		
Total Cropland	408,022	436,902
Harvested Cropland	209,165	266,457
Cropland Used only for Pasture or Grazing	43,058	21,082
All Other Cropland	155,799	149,363
Woodland (including woodland pasture)	83,739	57,801
All Other Farm Land	66,535	49,872

Source: United States, 1969. Census of Agriculture, Minnesota, Department of Commerce.

2.615 Although agriculture is important in the region, the number of farms has been steadily declining. Despite the decline of individual farms in Roseau County, the percent of land under cultivation has remained fairly constant:

Table 11 Farms and Farmland in Roseau County -- 1959 & 1970

	1959	1970
Number of farms	1,700	1,261
Percent of land that is farmland	50.8%	49.7%

Source: U.S. Department of Agriculture Statistical Reporting Services June, 1969; October, 1972

2.615 Projections based on present trends suggest that by 1985, there will be 20 to 50 percent fewer farms in the watershed. The decline in farm population is expected to result in either abandonment of farms or a two to four fold increase in the size of farms throughout the basin (Borchert and Carrol, 1971). Present trends, as indicated in the above table, suggest that farm consolidation is the normal course in depopulation for this area.

2.616 The survey report completed in 1957 by the U.S. Soil Conservation Service (SCS) concluded that insufficient capacity of the Roseau River and insufficient land drainage have reduced agricultural production in the area because of the consequent delays in spring planting and the acreage of cropland or potential cropland kept out of production by flooding.

2.620 Water and Land Resource Management. An important feature of the trend in land use in the project area has been the substantial reduction in wetlands and forests to provide more acres for crops. The Minnesota Land Management Information System Study (Orning and Maki, 1972) analyzed the trends in land use for Region 1 of Minnesota which, among other counties, includes Roseau, Kittson and Marshall counties. Based on changes in land use for 40-acre parcels, it was found that drainage to increase crop production has significantly decreased the pre-settlement marshes and forests in Region 1. Agriculturally related water and land resources management has been accomplished by individual farm operators, the Roseau River Watershed District, and the Roseau County Soil and Water Conservation District. Principal management practices have been drainage and soil and water conservation measures.

2.621 The portion of the floodplain devoted to agriculture is served by an extensive system of public and private drainage ditches and natural tributaries of the Roseau River. Drainage of nearly all of the floodplain above Big Swamp is dependent upon the effective functioning of the public drainage ditches (exhibit 4).

2.622 Improvement and maintenance of the public ditch system established by the District Court and County Boards over the past several decades constitute the major agricultural drainage measures undertaken in recent years. In addition, on-farm ditches serving one or a group of farm operators have been constructed.

2.623 Current restraints on the drainage of lands by recent Federal legislation, notably the Reuss Amendment to the Agricultural Appropriation Act and Public Law 87-732, are expected to limit future public drainage improvements in the basin to maintenance of established ditches, supplemented by private on-farm ditching. Recent State legislation has essentially given control of drainage in the area back to local interests.

2.630 Economy. In the five-county area, Roseau, Kittson and Marshall Counties and, to a lesser degree, Lake of the Woods County, are heavily dependent on agriculture. However, much of the agricultural land in the impact area is marginal. Whereas the value of farm products sold per acre was $60.60 for Minnesota in 1969, similar figures for the counties in the impact area were as follows: Roseau, $20.15; Beltrami, $20.28; Kittson, $22.81; Lake of the Woods, $14.30; and Marshall, $24.65.

2.631 Although agriculture plays an important role in the economy of the watershed, it ranked second in terms of employment in Roseau County according to U.S. Census figures for 1970. Manufacturing of both durable and non-durable goods accounted for over 23 percent of the employed persons in Roseau County. Service industries - professional, entertainment, business and personal - employed nearly 25 percent of the workers in the county. In comparison, agriculture and related activities employed only 19.1 percent. In 1950, 63.2 percent of the employed persons in Roseau County worked in agriculture. By 1960 less than half the workers (48.7 percent) were in farming and in 1970 the number in agriculture had dropped to less than one-fourth. Projections suggest that this downward trend will continue.

2.632 The watershed could properly be categorized as predominately agricultural 20 years ago; today manufacturing (Polaris Snowmobile) and service industries overshadow agriculture in terms of employment. This increase in non-farm employment and growth of the city of Roseau as a community center, providing area residents with medical, educational and trade facilities, has altered the complexion of the area. The existence of non-agricultural forms of employment has slowed the movement off the farm, enabling marginal farmers to supplement their income through part-time work. It is estimated that by 1985 only 10 percent of all farmers in the impact area will be farming full-time (Borchert and Carroll, 1971).

2.633 The number of retail establishments in each of the five counties in the watershed and in Minnesota declined between 1948 and 1967, but the decline for Minnesota and for Lake of the Woods County was not as sharp as was the decline for the other four counties. Although the counties in the impact area and Minnesota experienced declines in the number of retail establishments, retail sales increased, although not as rapidly in the five counties as in the State of Minnesota as a whole.

2.634 Between 1950 and 1970, the civilian labor force declined in Roseau, Kittson, Lake of the Woods and Marshall Counties whereas gains in the civilian labor force were registered by Beltrami County and by the State. With the single exception of Marshall County in 1960, each of the five counties experienced higher rates of unemployment than did the State in each of the last 3 census years. The data probably understate the employment problem in the area since the lack of job opportunities has encouraged young people to migrate from the area to seek jobs.

2.635 The unemployment rate has steadily increased in Roseau County since 1950 and in 1971 was double the average unemployment rate for the State (5.5 percent). The percentage of Roseau residents having income below the poverty level in 1974 was 18.2, again well above the State average (10.5 percent). A high proportion of those with below poverty income were in the "over 65" age category. Census figures indicate that 42.3 percent of residents "65 and over" have poverty status, compared with 26.7 percent of persons "65 and over" throughout the State (U.S. Census, 1970).

2.636 In-migration is low in the watershed and although a new pattern of non-farm settlement oriented towards amenity areas is emerging in the State, this apparently will have little effect on the project area. A possible reason for continued low in-migration may be the geographic remoteness of the region from industrial centers (Borchert and Carroll, 1971).

2.640 Population Density. The river basin defines a sparsely populated area and projections suggest the declining population trends will continue (exhibits 26 - 28). Each of the five counties in the watershed, except Beltrami, suffered falls in population between 1930 and 1970. During the same time period, the State of Minnesota registered a significant increase in population.

2.641 The specific cause of the decreasing population in the Roseau River watershed is the outflux of people from rural areas to more urban centers, net outmigration from 1960 to 1970 being about 20 percent (Borchert and Carroll, 1971). Yet, not all movement has been out of the watershed. Accompanying the steady decline in farm population has been a slow (below 20 percent) growth in the non-farm population of the area. From 1960 to 1970 the city of Roseau experienced a growth in population of 17 percent and the area surrounding it also experienced population gains. Estimates suggest that the town's population will increase by 32 percent from 1970 to 1985 (Gustafson, 1973).

2.642 With the exception of farm residences and rural churches few man-made facilities are located outside of the city of Roseau.

2.650 Personal Income. Personal income is one of the primary indicators employed by economists and others to assess the economic well-being of an area. Personal income includes the income received by residents from business establishments, Federal, State and local governments, households, institutions and foreign countries.

2.651 Total personal income increased substantially between 1950 and 1971 in each of the five counties as well as in the State as a whole (exhibit 29). None of the counties matched the 268.2 percent increase in total personal income registered by the State between those years. However, due to population declines in four of the five counties, the per-capita gains in personal income for those four counties were greater than the gains in per-capita personal income for Beltrami County and for Minnesota during the 1950-1971 period.

2.652 The rapid increase in per-capita income for all but Beltrami County in the impact area represents a catching-up from relatively low per-capita personal incomes in 1950 (exhibit 30). The per-capita personal income for each of those four counties has been approaching the per-capita personal income figures for the State and for the United States.

2.660 Recreation. Hunting is an important sport in the watershed Game species include white-tailed deer, moose, bear, sharp-tailed grouse, ruffed grouse, woodcock, snowshoe hare, and waterfowl. Area residents tend to hunt outside of the river basin, in Lake of the Woods County for instance, so that the bulk of the hunting within the watershed is done by Minnesotans from more urban areas (farmers, personal communications, 1973).

2.661 While fishing in the Roseau River is important to visitors from outside the watershed, it is a marginal activity for area residents. The river is regarded by many residents as too polluted or as having too high or too low a water level (area residents, personal communications, 1973).

2.662 Recreational activities associated with the wildlife resources of the watershed are important to both residents and visitors in the area. In 1969, a survey of public use of the Roseau River WMA (Bares et al., 1973) indicated the following breakdown of activities in person-day estimates:

Table 12. Public Use of Roseau River Wildlife Management Area (1969)

Waterfowl hunters	7,000 person-days
Deer hunters	500
Upland game hunters	300
Fishermen	7,000
Picnickers	400
Boy Scouts	200
Birdwatchers	200
Students	100
Miscellaneous sightseers	3,000
Trappers	100
Rifle and trap shooters	200
Boaters	500
Snowmobilers	500
TOTAL	20,000 person-days

2.663 While waterfowl hunting and other game hunting and fishing constitute the major uses of the management area, the increasing importance of non-game species as recreational resources is indicated by the large number of birdwatchers, picnickers, students and other non-hunter users of the area.

2.664 Throughout the State, recreational activity is projected to increase at a much faster rate than population increases and there is a need for additional recreational facilities (Minnesota DNR, 1974). However, with the exception of Hayes Lake, this area of northwestern Minnesota is not mentioned in terms of potential recreational use in the "Project 80" Report, a study of the State's objectives in outdoor recreation (Minnesota DNR, 1971).

2.670 Aesthetic and Human Interest. The wooded terrain and topographical relief of portions of the watershed constitute natural amenities of aesthetic and human interest. Such amenities are increasingly important in settlement patterns; many people consider environmental assets in determining where they will live (Gustafson, 1973). Preservation of scenic views, wilderness features and wildlife has high priority in the State of Minnesota, according to the Citizens Advisory Committee of the Minnesota Environmental Quality Council (1972). The Roseau River basin contains natural areas that may well be highly valued in the future.

3.000 RELATIONSHIP OF THE PROPOSED ACTION TO FUTURE LAND USE

3.001 Approximately 50 percent of the Roseau River basin is agricultural land and approximately 33 percent of the U.S. portion of the basin is forested. At the present time about 20 percent of the watershed is considered excellent wildlife habitat (See 2.612).

3.002 Studies to determine the suitability of land for additional drainage and agricultural production in the Canadian portions of the Pine and Sprague Creek basins have indicated that potential exists for the future conversion of Canadian lands to agricultural production by constructing additional drainage works. It is anticipated that approximately 30,000 acres of additional land could be drained in the Canadian portion of the Pine Creek basin and 50,000 acres in the Canadian portion of the Sprague Creek basin. Because of this potential, the authorized project for channel works in Roseau County was modified to include an incremental width to handle additional flows which would result from this added drainage.

3.003 Although no definite plans have been developed, either in Canada or the United States for the above mentioned potential drainage, channel modifications were included in the project at this time because it might not be economically or engineeringly feasible at a later date to include channel modifications necessary to accommodate the increased flows resulting from future drainage. Providing for this potential drainage in the proposed project would also directly benefit flood control in Roseau County.

3.004 The 1957 SCS proposal for land drainage is not part of the current channel modification program, nor has it been authorized by Congress. However, completion of the proposed Corps channel modification project could stimulate rehabilitation efforts on the ditch system since an improved high flow outlet (capacity) would be available. On-farm ditching may also be increased as a result of the project, although the proposed project would not increase or extend the hydraulic efficienty of drainage ditches during low flow peroids (see 4.105). Improved drainage from the ditches would stimulate more intensive agricultural development in areas protected by the project. Expansion of agriculture into undeveloped areas and/or into areas that were previously developed but later abandoned because existing ditches were ineffective, would reduce the amount and dispersion of existing habitat to the detriment of wildlife populations in the basin. (See exhibit 31.)

3.005 Unrestricted drainage is however, presently contrary to Minnesota DNR policy (see 1.511). In addition, Federal legislation (notably, the Reuss Amendment to the Agriculture Appropriation Act and Public Law 87-732) is expected to limit Federal assistance to future drainage improvements in the basin to maintenance of established ditches supplemented by private on-farm ditching. Maintenance clean-out and restoration of the existing functional drainage system is one plan for agricultural improvement that could be consistent with current State policy. However, if the present drainage policy in the basin were to be altered, and additional drainage works were to be undertaken beyond those identified in the EIS, the effects on the Roseau River flood flows would result in lower than design levels of flood protection.

3.006 Agricultural drainage downstream from Big Swamp would not be significantly affected by the flood control project except that the duration of snowmelt flooding would be somewhat reduced, and this could permit drainage systems to become effective earlier in the spring. Also, construction of the Kittson County Dike would diminish the degree of flooding along the south bank of the river within the affected area.

3.007 Wild rice is among the potential future crops of the basin requiring extensive water management. The State of Minnesota has experienced a phenomenal growth in acreage devoted to this crop since 1968 and it is grown on "bog" land similar to that in the Roseau River basin below the city of Roseau. Because of the prevailing practice of growing grass seed on this type of land, domestic wild rice production has not developed in the basin. The potential for this crop remains, particularly if water control measures are improved. Should this crop be grown in the basin in future years, however, a substantial water withdrawal requirement would exist during the 3 to 4-month growing season prior to harvesting in August. The total irrigation requirement for flooding fields during this period in adjacent basins is 22 inches minus the available natural rainfall during the period.

3.008 The proposed project is expected to enhance the present agricultural uses of the area by reducing flood damages and by providing improved outlet (volume) for existing drainage systems during flood periods. An estimated 2,400 acres would be required for the project of which at least 760 acres are vegetated by forest communities and another 320 acres support "brushland" types. Vegetation on the remaining area is marsh, altered fen, and agricultural.

3.009 While diminished flooding and improved drainage could be beneficial to the future of forestry, economic considerations would probably direct future land use toward agriculture. The potential forestry market would probably be low, as the likely species in the affected area are currently in oversupply in the State. The significant existing forestry resources of the basin are located in the headwaters region of the basin which is generally well drained, and problems related to water resources are minimal in this area. In the central portion of the basin, which is extensively cultivated, the original forest vegetation has been removed so that no water resources modification would alter the situation. In the poorly drained portion of the basin in the vicinity of Roseau Lake and Big Swamp, the existing vegetation is limited to aquatic and water-tolerant species such as tamarack trees, marsh bluebell, silverweed, and cattail. For the present land use as wetland-related wildlife habitat, maintenance of marsh conditions is essential.

3.010 Some of the privately-owned lands presently contain brushy, wooded areas that provide good habitat for deer, moose, and ruffed and sharp-tailed grouse. A portion of this habitat would be destroyed after the modifications are completed and the existing agricultural drainage improved or restored to original effectiveness.

3.011 Future land use as related to the proposed project is of concern because it may adversely affect the project's hydrologic design and degree of protection. The design is based on the conditions of land use, drainage networks and runoff which currently exist in the United States portion of the Roseau River basin (with provision for possible developmental Canadian drainage).

3.012 Two principal constraints were recognized in the project's hydrologic design:

1. No increase in flows into the Two Rivers basin would be permitted. (There is a nearly non-existent basin boundary in the Big Swamp area which permits flows from the Roseau River basin to cross into the Two Rivers basin during flood periods.)

2. Only moderate increases in flow would be permitted at the International boundary. (These adverse effects have been studied by the International Joint Commission, whose report will be the basis for negotiations with Canada to determine payments to be made to Canada for mitigation works. This will result in a signed International agreement which will fix a payment schedule based on this aspect of the project's hydrologic design.)

3.013 Given these constraints, the final design capacity of the project was determined from analysis of hydrologic data for the Roseau River basin, based on observed flow records from the period for which U.S. Geological Survey data are available. Project formulation was based on an economic analysis of benefits versus costs to determine an optimum channel size for reduction of flood damages in the city of Roseau and the agricultural area between Roseau and the Canadian border.

3.014 Thus, a factor which is basic in the project design is the assumption that runoff characteristics of the basin will not measureably change during the life of the project. This assumption includes the expectation that the capability of existing wetlands in the basin to retard the rate of runoff from snowmelt and rainstorms will remain substantially unchanged throughout the life of the project.

3.014 Examples of construction of major drainage facilities in the Roseau River basin, which could increase flood stages in the completed project beyond those provided for in the design, are:

1. Ditching which alters the timing of runoff from an area so as to result in coincidental, and thus higher, peak stages on the river.

2. Ditching which drains lands that in pre-ditching conditions were either undrained or poorly drained, and thus contributed little to the flood stages on the river.

3.015 The extension of existing drainage ditches or the construction of new drains into areas not now drained is, therefore, of particular concern. The land use change which could accompany such activity could have a significant adverse impact on the flood control project if it would increase runoff potential or alter the timing of runoff.

4.000 ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT

4.100 Impacts on Topography and Land Use

4.101 By straightening, deepening, and widening the channel at established sites along the river downstream from the city of Roseau, flood waters would be carried away from Roseau faster, and flooding would be significantly reduced.

4.102 Approximately 87,000 acres of land lie within the floodplain of the Roseau River below Roseau, exclusive of the 38,000 acres within Big Swamp. The proposed flood control plan would reduce flood stages in approximately 55,000 acres of Roseau River floodplain above Big Swamp and would decrease the frequency and duration of flooding on an additional 22,000 acres of floodplain below Big Swamp.

4.103 Within Big Swamp and the reach of river downstream to the lower limit of the project, little or no reduction in peak flood heights would be realized from the project because of the restraints in the design discussed in section 1. Upstream from Big Swamp the degree of protection afforded by the project would vary from 10-year to 50-year frequency.

4.104 The efficiency of the private ditches on agricultural lands would also be enhanced by the improved performance of public ditches and natural tributaries flowing to the main channel. The flood control plan includes the construction of 59 structures (mostly on the excavated bank) to accommodate flow from the drainage ditches to the slightly deeper modified river channel without causing excessive scour. Agricultural drainage downstream from Big Swamp would not be significantly affected by the flood control project except that the duration of snowmelt flooding would be somewhat reduced which could permit drainage systems to become effective earlier in the spring. Also, construction of the Kittson County Dike would diminish the degree of flooding along the south bank of the river within the affected area.

4.105 With a much wider channel available as an outlet, the trend could be to improve existing drainage ditches and increase the number of on-farm ditches in an effort to decrease the duration of floodwater inundation. This would increase the time the land would be available for agricultural purposes. Most of the lands adjacent to the channel are already ditched (see exhibit 4), but most of these ditches are not now operating at their full potential. They are not maintained free of vegetation, and other flow obstructions, and their outlets to the channel are at points well above the existing channel bottom. If the ditch outlets were located closer to the river channel bottom the ditches could be extended further from the channel and still maintain their effectiveness (by having a slope adequate to maintain a flow; hydraulic efficiency of the ditch, i.e. channel roughness, would then be the controlling factor). Thus the potential for more efficient and more extended drainage already exists in the project area, although the present system apparently approximates economically feasible drainage during low-flow periods. While the increased capacity of the channel would hasten the removal of floodwaters from adjacent lands, it would have only a limited effect on the efficiency of drainage ditches during low flow periods.

As the channel would not be deepened significantly (and thus ditch outlets could not be lowered significantly more than is presently possible), the proposed project would not make it feasible to extend the ditches to lands further away from the river than is now possible.

4.106 Increased land usage could possibly lead to increased soil erosion and slightly increased concentrations of various pollutants, such as animal wastes, pesticides, and nutrients in the water, to the detriment of existing water quality.

4.200 Engineering Considerations

4.210 Foundation Conditions. The materials to be excavated for the modifications of the Roseau River are highly variable.

4.211 Problems with removal of sediment between mile 124.0 and mile 124.7 (exhibits 1 and 2) appear to be minimal, as the sediments are mostly clay till and lacustrine clay characterized by low moisture contents and low plastic and liquid limits. In the western portion of the basin the sediment is mainly glacial till, consisting of clay with an admixture of silt, sand and gravel, and a thin covering of river alluvium. From mile 124.7 eastward to mile 131.7 the excavated sediment would pose more serious problems. This area is mainly underlain by lacustrine clays characterized by high moisture content, high liquid limits and occasionally high void ratios. The presence of this potentially weak sediment, both in the dredge material piles and beneath the excavation, presents serious engineering problems.

4.212 It is in the area from mile 124.7 to mile 131.7 that most problems with foundation failure are likely to be encountered. From mile 131.7 eastward, the foundation sediments are more stable but highly variable, being combinations of fluvial sand, highly plastic clay and lake-washed till. Field observations indicate some evidence of slumping in this area. Therefore, the proposed removal of vegetation could cause problems from mile 131.7 to the dam in Roseau (mile 137.4). The instability in this area is not anticipated to be nearly as severe as from mile 124.7 to mile 131.7

4.213 The bank stability analysis presented in the Design Memorandum[1] for the project indicated that the safety factors against slumping in the area around Bridge #8, 5 1/2 miles north of Roseau, were less than those normally accepted for earth slopes and embankments, and indicated that some slumping could occur between mile 124.7 and the upstream end of the project. The prime factor involved in slumping is the proximity of the dredge disposal piles to the top of the channel cut. This is due to the fact that the piles induce additional loading on the channel slopes.

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[1] United States. 1971. "Flood Control, Roseau River, Minnesota," General Design Memorandum. U.S. Army Corps of Engineers, St. Paul District.

4.214 The present project design requires that the dredge disposal site be at least 20 to 92 feet landward from the top of the channel cut in the upstream portions of the project. This requirement is necessary to insure that minimum safety factors be maintained. To increase the safety factors above the minimum values would require that the piles be shifted further landward. Such a shift would result, however, in both increased construction costs and increased right-of-way requirements for the project.

4.215 Such an enlargement in the right-of-way and removal of vegetation would increase the adverse impact of the project upon both the agricultural and wildlife communities located adjacent to the channel. For these reasons dredge disposal piles would be located only far enough It is anticipated that such a procedure would result in some slumping at isolated locations along the upstream one-fourth of the project. The frequency of such slides would, however, be relatively low. In the few areas where structures are located in potential failure zones, care would be taken to insure that dredge disposal piles would not affect the stability of the structures.

4.216 The foundation material deposits in the upstream one-fourth of the proposed project are characteristically the type of deposits which are susceptible to slumping. It is likely that some mass slumping of the excavated channel slopes would occur along the 12 miles of channel excavated upstream of mile 125 (approximately mile 124.7). It is anticipated that most would occur between mile 124.7 and mile 131.7. Typically, such slumps result in movement of a portion of the river bank into the channel. The majority of slides of this type would occur during or shortly after construction; however, localized erosion could trigger such movements throughout the life of the project.

4.217 The effect of such slides upon functioning of the channel would depend on the volume of material displaced from the bank. In the more severe slides, the channel could be partially filled, requiring excavation with draglines to restore the channel section. In addition, such slides would cause subsidence or loss of land adjacent to the channel. In anticipation of such movements varying amounts of land adjacent to the channel have been included in the permanent right-of-way for the project.

4.218 The impact of bank instability depends heavily upon the frequency of occurrence of slumping. Based on observation of four similar projects in the Red River Valley, it may be concluded that mass slumping would occur periodically at the Roseau project but that the channel could be maintained without undue cost.

4.220 Erosion. Reduced bank stability may result in localized sloughing or erosion of the channel slope and also in isolated occurrences of deepseated movements that would result in slumping of the river bank.

4.221 The proposed channel widening would require excavation of at least one of the existing channel banks and the attendant removal of vegetation from the channel slopes. Temporary and localized erosion of the excavated slope would result from surface runoff in the period between excavation and re-establishment of a vegetation cover of grasses on the channel slopes. Observations of similar projects in northeastern Minnesota and eastern North Dakota indicate that this time period generally ranges from 1 to 3 years. Following construction in a particular reach of the project, the area would be planted and/or seeded to native grasses and brush or trees. Selection of vegetation for reestablishing ground cover would be coordinated with the Minnesota DNR to insure maximum wildlife value consistent with engineering objectives.

4.222 Erosion from surface runoff would cause shallow gullies to form along the excavated slopes and some bank material to be deposited in the river. It is anticipated that this erosion, which would occur throughout the project, would not significantly affect the adjacent land or operation of the project.

4.223 A second type of erosion, of a potentially more serious nature, would occur due to the action of the flowing water at the toe (base) of the cut slope. Although the channel has been designed to maintain the velocity of flow below erodible levels, it is anticipated that some erosion of the channel slopes would occur at various locations along the channel.

4.224 This second type of erosion results from natural meandering of the river flow on one side of the channel or the other. The higher velocity caused by the concentration of flow can often create local sloughing of the channel bank resulting in a vertical, or near vertical, face. Such erosion is currently occurring on the existing river banks in the project area. This type of erosion is common to channel projects and may be expected along the channel slopes of the Roseau River project.

4.225 The frequency of such erosion is difficult to predict because natural factors, such as fallen timber and sandbars can contribute significantly to its occurrence. Observation of such erosion at other projects indicates that sloughing of the channel bank decreases significantly once vegetation is established, and this erosion and sloughing almost never affect operation of the channel or extend beyond the project right-of-way. The danger in such sloughing is that it can precipitate slumping of the channel bank if the foundation materials beneath the channel banks are unusually weak.

4.300 Impacts on Hydrologic Characteristics

4.310 General. The proposed flood control project would reduce the amount of flooding on approximately 55,000 acres of agricultural land along the Roseau River in Minnesota between the city of Roseau and Big Swamp. Within Big Swamp and along the reach of river downstream to the Canadian border, little or no reduction in peak flood heights would be realized from the project since the modified channel has been designed to minimize the increase in magnitude of flood peaks at the international border. In addition, continued flooding of Big Swamp is necessary to maintain wildlife in the area and to insure that the natural flood overflows into the Two Rivers Basin remain unchanged (see paragraph 2.125).

4.311 Because the water levels during most floods would be reduced only about 2.5 inches in the area of Big Swamp and downstream (table 13), the natural floodplain storage of Big Swamp and the downstream area would continue to attenuate the flood peaks as they pass through this area. Upstream from Big Swamp the degree of protection afforded by the project would vary as follows:

From Big Swamp upstream through Roseau Lake	10-year frequency
Roseau Lake to the Roseau Dam	10-year frequency increasing to 50-year frequency
Roseau Dam to upstream limit of city of Roseau	50-year frequency decreasing to 30-year frequency

4.312 Stage reductions to be afforded by the project at various locations are shown in the table below:

Table 13. Reduction in Peak Flood Stages from Channel Modification

Location	Reduction in Peak Flood Stages for Indicated Frequencies - Stage Reductions in Feet			
	2-Year	5-Year	10-Year	50-Year
Roseau, Center St. Bridge	4.0	5.0	5.2	4.0
Roseau, Headwater of Dam	5.0	6.0	6.0	4.4
Roseau, Tailwater of Dam	5.7	6.2	6.2	4.0
Minnesota Highway 310	3.0	2.7	2.3	1.3
Roseau Lake	1.6	1.6	1.6	1.5
Big Swamp, Mile 105	0.6	0.2	0.2	0.2

Source: United States. 1971. "Flood Control, Roseau River, Minnesota, General Design Memorandum". U.S. Army Corps of Engineers, St. Paul District.

4.313 During periods of high flow there is an escape of water into the Two Rivers basin from Big Swamp. An investigation was conducted to determine the effect on project conditions of blocking the escape of these flows by modifications to County Road 7 on the south edge of Big Swamp. This blockage of flows would adversely impact wildlife habitat south of County Road 7. In addition, for proposed conditions with channel modifications and blockage of flows into the Two Rivers basin, flood stages in Big Swamp would be increased slightly and discharges at Caribou and into Canada would be increased substantially which would require additional mitigating works in Canada. For this reason, the IJC report (Canada: E-16) recommends that future improvements to County Road 7 and alterations to the size of drainage openings in the disposal banks immediately south of the road should not be permitted unless the capacity to permit existing overflow to the Two Rivers basin is guaranteed.

4.320 Canadian Flow Conditions. The proposed straightening and enlargement of the Roseau River channel downstream of the city of Roseau would increase peak flood flows entering Canada and would cause the flood crests to reach downstream areas sooner. These considerations have been evaluated, and monies for the construction of flood control structures designed to mitigate these effects are included in the proposed project (see section 1.711).

4.330 Low Flow Conditions. To more fully assess the impacts of the proposed project on low flow conditions in the Roseau River, an analysis was made utilizing data for the low flow months of November and February. In the analysis, the drainage area affected by the channel modifications was assumed to be that flooded during the 1950 flood or about 132.7 square miles (85,000 acres) and expanded to 153.8 square miles to include fringe areas. The normal contribution to low flow from this flooded area is approximately 4.2 cfs and 0.33 cfs in November and February, respectively. These flows represent 4.2 and 2.4 percent of the November (97.1 cfs) and February (13.53 cfs) average flow at Caribou. Therefore, although the flooded area represents about 9.8 percent of the total area at Caribou, the low flow contribution from the flooded area represents only about 2 to 4 percent of the low flow runoff at Caribou.

4.331 At the extreme, should the flood control works eliminate low flow contributions within its area of influence, it could be deduced that low flows at Caribou might be reduced by only approximately 2 to 4 percent. Zero flow has been recorded at both the Ross and Caribou gaging stations.

4.332 The amount of overbank flooding would be reduced along the Roseau River due to increased capacity of the channel and levees along certain reaches. The increased channel capacity would facilitate a more rapid depletion of the water stored during floods. Although it is not felt that storage in Roseau Lake and Big Swamp makes a significant contribution to low flows in the Roseau River during late summer and winter, the earlier removal of the surcharge effect of this stored water coupled with the drop in river stage to a level slightly lower than presently exists, could advance the withdrawal of water from groundwater supplies. This advancement, however, is not likely to be very pronounced.

4.333 In addition, the wildlife management pools north of the river have a storage and surcharge effect that would dampen advancements in groundwater depletion, and the groundwater and surface water regimes in the tributary basins would be basically unaltered.

4.334 The significance of the potential reduction in low flow conditions in the Roseau River would depend to a large extent upon the long-term precipitation trends in the watershed. During years with ample precipitation and adequate recharge, a small reduction in base flow would not be significant. During dry years, however, even a small reduction in base flow over that normally occurring under such conditions would seriously impact on aquatic systems in the watershed, and would contribute to drier fields and watering sites. Even with existing conditions, however, channel flow has decreased to zero at times. If improvements to existing ditches and construction of additional on-farm drainage systems are allowed, this could exacerbate the low flow reduction that would be directly attributable to the proposed channel modifications.

4.340 Sediment Loadings. During the construction of the channel works, a temporary increase in the sediment load is to be expected. After construction is completed, high flow velocities, the lack of natural streambank vegetation, and a channel free of natural flow impediments might prolong these increased levels of sediment loading to the detriment of water quality, fisheries, water supply and recreation (Reid, et al). This might require periodic dredging in downstream reaches. In addition, higher flood stages in the rapids reach of the Roseau River in Canada would increase long-term erosion and sediment loading. However, the flood control project would reduce flood stages in approximately 55,000 acres of Roseau River floodplain above Big Swamp and would decrease the frequency and duration of flooding on an additional 22,000 acres of floodplain below Big Swamp. The net deposition of sediments and addition of nutrients associated with surface runoff could therefore be expected to decrease.

4.400 Impacts on Water Quality.

4.401 The Roseau River is currently classified as a 2B stream and is subject to the water quality standards listed in exhibit 11. The proposed project would impact on water quality of the river in several areas where standards have been established. These areas are turbidity, temperature, and dissolved oxygen. These effects would be both direct and indirect, short-term and long-term.

4.410 Turbidity. A temporary and significant increase in turbidity would occur during construction activities. Excavation would cause silt and clay to be introduced into the water, making it more turbid than present levels under most conditions. Until the new banks become stabilized by vegetation, there would continue to be greater movement of sediment into the channel than presently occurs. To reduce this impact, grasses, brush, and trees would be planted on the excavated area following construction activities. Even with plantings, turbidity may be increased over existing conditions for several years following construction.

4.411 In addition to turbidity resulting from construction activities and from surface erosion following construction, turbidity may be increased due to channel scour as the modified reaches of the river establish a new channel within the excavated channel. This effect should be relatively short-term.

4.412 Because of the increased turbidity, aquatic organisms would be adversely impacted (4.550). It may also be necessary for a period of time to provide more extensive treatment of the river water in downstream areas in Canada where it is used for domestic consumption.

4.420 Water Temperature. The proposed project could also result in modifications to existing water temperatures. Clearing of riparian vegetation would cause water temperatures to respond more quickly to changes in ambient air temperatures, especially during low flow conditions (Brown, 1972). This would result from increased insolation during the day and increased reradiation during the night. Seasonal as well as diurnal temperature fluctuations would be greater due to these effects. In addition, stream temperatures would also be affected because the average water depth would be reduced with a wider channel.

4.421 Temperature changes resulting from the removal of riparian vegetation should be relatively minor and are not expected to result in violations of State temperature standards for a class 2B stream, i.e. 86° F maximum daily temperature or 5° F above the natural monthly average based on maximum daily temperatures. The effects of riparian vegetation on stream temperatures were considered in selecting reaches for one-bank excavation (paragraph 1.404). Proposed revegetation plantings would tend to reduce this impact, although they would need time to grow to sufficient heights and they would not be planted as close to the channel as many woodlands presently occur.

4.422 The effects of reduced water depths and turbulence on stream temperatures would probably be greater than those resulting from removal of vegetation but should be relatively short-term. As the river develops a new low flow channel within the modified channel, this effect would be reduced.

4.430 Dissolved Oxygen. With increased temperatures the solubility of oxygen in water decreases. For example, at an altitude of 1,000 feet and a temperature of 10° C (50° F), oxygen saturation is 10.91 mg/l while at 12° C (53.6° F) oxygen saturation is 10.43 mg/l. Increased stream temperatures would tend to reduce naturally occurring oxygen concentrations while lower temperatures would tend to increase oxygen concentrations. Reduced turbulence that would occur as a result of the proposed modifications would also tend to reduce oxygen concentrations through a reduction in the contact of air and water.

4.431 In addition to direct effects on dissolved oxygen (DO), increases in stream temperatures would cause an increase in the physiological (respiration) rates of aquatic organisms. This would result in an increase in oxygen consumption and could cause a decrease in stream oxygen concentrations if the increased demand was not fully compensated for by turbulent mixing and photosynthesis.[1]

4.432 Dissolved oxygen may also be reduced, to a greater extent than presently occurs, in reaches receiving oxygen demanding substances, i.e., sewage effluents. Although the biological oxygen demand (BOD) of the discharges would not be increased, they could be acted upon to a greater extent by organisms in the modified stream because of slightly higher temperatures and consequently higher respiration rates.

4.433 Based on the MPCA report (paragraph 2.316) discharges from Roseau and the Wannaska Creamery should not result in significant effects because of the established standards (and times of discharge) they are required to meet. However, water quality data below Caribou indicate that dissolved oxygen concentrations below those established for the river could become more frequent.

4.434 Should future fishery studies (see 1.723) result in post-construction modifications in an attempt to mitigate fishery losses, such as artificial riffles and low head dams, dissolved oxygen concentrations greater than just after project construction would result through increasing turbulent mixing in the stream.

4.440 Nutrients. Surface runoff from the watershed contains nutrients (fertilizer residues, etc.) which enter the aquatic system. Nutrients usually identified as potentially causing eutrophication are nitrates and phosphates. Nitrates are leached from the soil fairly readily while phosphates are subject to less leaching loss, but are carried on eroded particles (Hynes, 1970).

4.441 As a result of reduced flooding and shorter contact time between water and soil in the watershed that would occur with the proposed project, nutrient additions to the river, directly resulting from the increased channel capacity, would probably be reduced. Indirect effects of the project, however, such as land use changes and intensified agricultural practices, could actually increase inputs to the river during certain periods. Effects of the enrichment of the aquatic system would be reflected mainly in stagnant water areas such as existing oxbows and those created by the channel modifications.

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1 Photosynthesis is not usually a significant source of DO in flowing reaches of streams.

4.500 Impacts on Aquatic Resources.

4.501 The ability of a particular environment to support a wide range of organisms is directly related to the diversity (interspersion) of the habitat types within that environment. The quality of the riverine environment is dependent upon a wide range of physical and chemical factors and their infinite combinations of interaction. These interactions result in a continuum of more or less discrete habitats that provide the conditions necessary for the support of a diverse assemblage of plants and animals. Important factors that influence the quality of the riverine system are temperature, geology, gradient, land use, and riparian vegetation.

4.502 The major action of the proposed project, that of dredging and straightening the river, would have two immediate effects. It would (1) destroy some organisms immediately, such as clams and benthic invertebrates, and (2) more important, it would increase the uniformity of habitat along the reach of the river subjected to the construction activities (Hynes, 1970). Significant negative environmental impacts of channel modifications are also related to drainage of wetlands, cutting of bottom-land forests, cutting off oxbows and meanders, alteration of water tables and stream recharge, erosion and sedimentation, and associated channel maintenance (A.D. Little, 1973). 1973).

4.503 Modifications associated with this project would cause a significant loss of existing aquatic and terrestrial habitat and deterioration of the aesthetic qualities of this reach of the river. Present plans to plug five of the eight channel cutoffs to be constructed and to plug 11 additional old cutoffs or oxbows are under review from a fish and wildlife standpoint. Isolation of these newly constructed and old cutoffs from the main channel would, except during high flow periods, reduce the current in these areas to zero and would essentially result in the creation of a pond-type environment. Plants and animals associated with the existing lotic (running water) environment would be replaced by biota more characteristic of lentic (standing water) environments.

4.510 Eutrophication. Silt and organic material would accumulate on the bottoms of cutoffs and would exert an oxygen demand on the water. Nutrients would also be supplied to these areas during high water and from surface runoff of adjacent areas. The effect of nutrient additions (enrichment) to streams is not well documented and can vary depending upon factors such as temperature, discharge, turbidity, magnitude of inputs, and existing nutrient concentrations in the water. Generally, nutrient additions provide stimulus for the growth of aquatic plants and result in changes in the species of plants present. Enrichment, along with increased light and temperature due to removal of riparian vegetation, would encourage the development of aquatic macrophytes and algae especially in areas of low water velocity (i.e. cutoffs). Large standing crops of aquatic plants could exert added demands on the dissolved oxygen during the night as a result of their respiration.

4.520 Reduced Oxygen Concentrations. Reduced oxygen concentrations in the cutoffs due to respiration would be compounded by reduced water circulation in these areas. Conditions would probably develop during the summer that would be unsuitable for many fish species and benthic invertebrates. Oxygen depletion could also occur during the winter when ice and snow cover reduce the amount of light available for photosynthesis. (Similar situations probably occur now in some of the oxbows and old cutoffs that are isolated from the main channel during low flow periods.)

4.530 Control Structures. Assuming serious dissolved oxygen conditions did not develop in the plugged cutoffs, these areas might provide limited spawning and rearing habitat for some fish species. However, the cutoff control structures would not permit fish to return to the river except during periods of high water. It is also questionable whether these areas would retain enough water to support reasonable populations. In general, the value of these areas as fish habitat would probably be minimal. Future studies are planned to determine pre-project population levels to assess the need for construction of low channel wiers or grassed channels to mitigate aquatic habitat losses resulting from the project. The possibility of construction of some other type of water control structures at channel cutoffs would also be pursued with appropriate conservation agencies.

4.531 The change in conditions prevailing in the unplugged cutoffs and channels would be less dramatic than in the plugged areas because there would be some circulation with the main channel (except during low flow periods), water levels would fluctuate with the river, and mobile organisms such as fish would be able to avoid areas in these abandoned channels that might experience low oxygen concentrations.

4.532 The cutoff proposed for the Roseau Lake area (number 8) would probably experience trophic conditions somewhere between the plugged cutoffs and the unplugged cutoffs. Release of water from the sewage lagoons at Roseau would, to an undetermined extent, enrich the water in the cutoff channels. The effects of this release would depend upon the amount entering the area, the time of the year, and the amount of flushing experienced through the old channel. Recently expanded treatment facilities at Roseau, coupled with controlled release from the stabilization lagoons, would ameliorate potential water quality problems in proposed cutoffs and oxbows.

4.540 Species Diversity. Current diversity within the main channel would be reduced as a result of the proposed channel modifications. The sequence of riffles and pools would be destroyed and/or modified with the resulting channel bottom exhibiting less roughness than before. Riffles are typically areas of high invertebrate production which provide necessary food items for higher trophic life forms (fish). Pools are generally utilized by fish as resting and cover habitat. A significant reduction in the number of riffle areas over the 43.9-mile reach of river would seriously affect the production potential in this reach and for some distance downstream.

4.550 Sediment Loading. Sediment production would be substantial during the initial construction operations. Erosion would also be increased for the period of time required for revegetation of disturbed areas. Increased siltation and turbidity would not only affect aquatic organisms in the immediate construction area, but would extend downstream for some distance, possibly to the confluence with the Red River of the North.

4.551 Accumulation of silt in the interstices in gravel bottoms can suffocate eggs and larvae of benthic invertebrates; it can interfere with filter feeding apparatus of aquatic organisms; and it can irritate gill membranes of invertebrates and fish increasing their susceptibility to bacterial infections. Adults of most aquatic organisms are more resistant to increased silt and turbidity than are the young. Adult mussels, for example, seem to survive silting, but the young do not (Hynes, 1970). Adult fish, likewise, seem not to be affected directly by siltation but would be indirectly affected since invertebrates (base food source) would experience a significant reduction in total biomass and shift in species. A negative correlation between dredged portions of streams and the density of benthic macroinvertebrates has been reported for a river in Missouri (Emerson, 1971). The immediate decrease in invertebrate biomass would result from construction activity, and similar effects of turbidity and siltation would be expected during periodic maintenance work on the channel. The long-term decrease in invertebrate biomass, however, would result from a decrease in habitat diversity.

4.560 Low Flow Conditions. During low flow periods, the river would tend to meander within the new banks, which would result in bank erosion and shifting of bottom sediments. The resulting unstable substrate would be detrimental to most benthic organisms and would contribute to the decreased production within the modified channel.

4.561. The potential for reductions in low flow conditions appears very slight. Should the entire low flow contribution of the affected project area be eliminated, a reduction of only 2 to 4 percent in the entire low flow contribution of the basin would be expected (4.321). The possibility that low flow contributions would be reduced to a larger extent would be unlikely because the major identified recharge areas of the basin, i.e. Beltrami Island and the Sandiland area in the Pine Creek sub-basin, are predominantly in public ownership and would not experience significant amounts of increased drainage.

4.570 Vegetation Removal. One of the initial steps in the channelization process, that of removing vegetation from the river banks (riparian vegetation), would result in more subtle, long-term effects. Riparian vegetation is important because it results in varied light patterns and modified stream temperatures, it contributes allochthonous[1] material to the stream and for the most part it reduces erosion. The exception would be leaning trees with exposed root systems which rip out and uncover part of the bank when they topple. The logs jam channels, and sand bars in the river can reflect flows and cause bank erosion elsewhere.

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[1] Material introduced from outside the particular environment, usually organic in nature.

There is a general dependence of streams on terrestrial vegetation. Most of the energy input to streams and small rivers comes in the form of primary production manufactured on the land and transported to the stream in the form of leaf litter (Cummins, 1973). Following wetting of this material, organic matter is leached out and enters the pool of dissolved organic matter which is available to microorganisms (heterotrophic forms). The wetted material is also invaded by microbes (bacteria and fungi) which break it down and take up additional nutrients from it (Kaushik and Hynes, 1971). The microbes are then consumed by detritus[1] feeders which in turn are preyed upon by organisms of higher trophic levels. In this manner a portion of the energy stored in the leaf litter is transferred through the food web. Removal of some of the sources of this allochthonous material would eliminate a major energy source of the aquatic system and thus would reduce the potential production of the system.

4.571 Clearing of riparian vegetation would also cause water temperatures to respond more quickly to changes in ambient air temperatures, especially during low flow periods. In addition to increasing daily and seasonal temperature fluctuations, increased water temperatures would result in decreased oxygen concentrations (see 4.430).

4.580 Recreational Fishery. The Roseau River supports desirable recreational fishing, particularly for northern pike and walleye as well as supporting sustantial populations of other fish (exhibits 18 and 19). It also supplies northern pike which stock the ponds in the Roseau River WMA and ultimately other local areas in the State. With higher temperatures, reduction of suitable living and breeding habitat, and a reduction in invertebrate food items, these fish would experience population changes, most likely resulting in lower standing crops than presently exist. An increase in other, less desirable, fish species would also be expected. It should be noted that although recent data supplied by the Minnesota DNR indicate significant populations of fish inhabit the Roseau River, it is unknown where these fish reside during the winter and other low flow periods. It is anticipated that the proposed fishery mitigation study would identify these areas and that this information would be incorporated into a structural mitigation plan for the river.

4.581 Examination of the fish census data indicates that the area of Big Swamp (Section IV on exhibit 16) contains the largest numbers of fish. Of the areas sampled by the Minnesota DNR, this was the only reach that had been entirely dredged in the past. Section V (downstream from Big Swamp) and Section III (from Big Swamp to Roseau Lake) exhibited catch rates that were less than one-fourth that of Section IV. Section III was estimated to have sustained dredging over 80 percent of its length while Section V showed no apparent signs of past dredging. Section III also had the shallowest average depth of any section, i.e., 2 feet. Section IV did, however, exhibit the greatest amount of gravel-type substrate of any area. Sections III and V also contained gravel. Sections I and II, which had the lowest percentage of the total catch per unit effort (CPE) had no gravel or larger sized bottom material.

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[1] Partially decomposed tissue of dead plants and animals

4.582 From examination of these data, it appears that deposition of gravel along certain reaches of the modified channel would substantially increase the probability that anticipated fishery losses could be mitigated. The possibility of other factors being involved would also be investigated in the proposed fishery study.

4.600 Impacts on Air Quality and Noise Levels

4.601 There would be a temporary decrease in air quality and an increase in noise levels during project construction due to operation of equipment.

4.700 Impacts on Terrestrial Resources

4.710 Terrestrial Vegetation. The most obvious effect of the proposed channel modification on the vegetation bordering the channel would be the direct elimination of many communities as a result of clearing needed to provide access for heavy dredging equipment, space for channel enlargement and space for deposition of the dredged material. Of the estimated 2,400 acres which would be required for the project, about 760 acres are vegetated by forest communities and another 320 acres support "brushland" types. On the remaining 1,320 acres vegetation types are "marsh", altered fen, and agricultural.

4.711 Few of the plant communities of the Roseau River Watershed have remained unaltered and in a completely natural state. This is particularly true of the communities bordering the river channel. As a result of channel modifications from 1906 to 1920 many plant communities between the upstream edge of Roseau Lake and the Canadian border were eliminated. Dredged materials were placed beside the modified channel and allowed to revegetate. In areas where trees remained nearby, this material slowly became revegetated with tree species, namely green ash, elm, and box elder. Core samples from these trees indicate that the oldest found are about 50 years of age. Since the early channel modifications were completed by 1920 and in most sections long before 1920, it is evident that riparian woodlands required considerable time to become reestablished, even though mature species remained nearby. In areas of dredge material deposition it would be necessary to clear an area up to 200 feet wide adjacent to the new channel. Along those stretches of channel where the wooded areas are less than 200 feet wide, the mature trees would be eliminated. This would not only represent an immediate loss of woodlands, but also a loss of mature reproducing tree species in the vicinity. Seed for natural revegetation of these tree species would not be abundant along those stretches. Seed would have to come from the mature trees of neighboring stands, which in some areas would be quite distant. The natural revegetation of these areas, would be greatly retarded. Natural succession of plant species on the dredged materials would be set back with each disturbance such as mowing, fire, cultivation or maintenance.

Considering that the majority of the tree species now present along the modified channel range to 50 years old, and that the tree ages in relatively undisturbed communities, such as those bordering the channel just north of Roseau, range over 100 years, there would be a long-term impact by the project upon these communities. To offset terrestrial vegetation losses the riverward sides of the disposal piles would be seeded and/or planted with grasses, brush and/or trees following construction. In addition it has been proposed that the Corps construct the structural features of a wildlife impoundment (see 1.726).

4.712 Existing forest communities in the Roseau River watershed are being reduced because of agricultural activity and road building. As woodlands are cleared, the values, both biological and social, of the remaining woodland communities are increased.

4.713 "Brushlands" and "marsh" communities in the path of the proposed project would also be directly eliminated. The impact upon the "brushland" types would be relatively short term. These communities are dominated by species such as willows, which rapidly invade disturbed areas. The marsh types would probably be permanently eliminated, however, from areas upon which dredged materials were placed.

4.714 An indirect impact of the project could be the drainage of wetlands such as the tamarack peatlands north of Sprague Creek and the wet fens of the Big Swamp area, although current State policy and the minor amount of channel lowering in the Big Swamp reach reduces this possibility. The remaining tamarack communities of the region are perhaps the least altered plant communities in the watershed. They constitute an important ecological resource, a more or less natural community. One of the natural attributes of the peatland ecosystem is its capacity for water retention. If more of this type is drained and cleared, more stress would be placed on the existing watershed drainage systems from increased runoff from these areas. The Big Swamp area also conducted before and after construction to determine whether the high-value potholes north and south of the Roseau River were adversely affected by project construction.

4.720 Terrestrial Wildlife

4.721 General. The 1904 to 1920 drainage attempts resulted in significant losses of wildlife habitat and subsequent declines in wildlife populations. These early programs were largely a failure; much of the land was abandoned and maintenance of drainage systems discontinued. Subsequently, much of the original habitat has been restored and wildlife has increased and has become an important natural resource in the basin.

4.722 The proposed project would have both direct and indirect impacts upon the wildlife resources of the area. Direct impact would result from changes in stream characteristics, woodland losses, and the possible increased drainage of wetlands, all of which would reduce and/or alter existing habitat. Indirect effects would result from changes in land use. More intensive agriculture and short-term increased human population would inevitably result in long-term changes in wildlife habitat, and could affect an undeterminable portion of the "wild" lands still in private ownership in the river basin.

4.723 Most waterfowl production in the basin currently occurs in the Roseau River WMA and on potholes and wetlands throughout the basin. The main river channel is less well suited for waterfowl breeding, and production there is probably minimal. The creation of oxbow lakes by plugging the ends of existing and proposed cutoffs would result in an increase in pond-type habitat. These areas would probably be suited for waterfowl.

4.724 The importance of these oxbow lakes as wildlife habitat would depend, to a large extent, on the magnitude of project-induced changes in land drainage and water recharge of wetlands. In general, the more land drainage occurring in the basin, the more important the remaining wetland areas would become.

4.730 Riparian Wildlife Communities. Aquatic habitat, wetlands, and wooded areas adjacent to the river would be subjected to the direct impact of the project. Project plans include the clearing of 1,080 acres of brush and light timber along the river, and utilization of a total of 2,400 acres for construction along 43.9 miles of river. A direct effect of construction would therefore be the loss of considerable riparian environment. Woods along and near the river are probably the most important habitat from the standpoint of migrating and wintering birds, and any decrease in woodland acreage and/or diversity would have an adverse effect on these birds.

4.731 Channel modification would affect mallards far less than it would common goldeneyes and hooded mergansers, for the latter two species require holes in mature trees for nest sites (see paragraph 4.711). Changes in water quality and bottom characteristics following construction would have a negative effect on aquatic vegetation and the invertebrate fauna, which in turn would result in a deterioration of some feeding areas for waterfowl broods.

4.732 Areas suitable for the maintenance of moose and deer populations exhibit sporadic distribution, and the woody fringes adjacent to the river act as important cover and avenues of dispersal for big game between such areas. Removal of these woody fringes would therefore adversely affect big game populations.

4.740 Vertebrates of Big Swamp. An area of concern is that an indirect impact of the project could be the future drainage of some areas of Big Swamp southwest of the Roseau River WMA. Big Swamp, in addition to supporting high populations of deer, moose and furbearers, has a breeding population of about 50 pairs of sandhill cranes. Breeding populations of this species in southern Canada and northern United States are unique, and increased drainage of suitable marshes and bogs would decrease prospects of their continued survival. Most of the fur bearers harvested outside of the Roseau River WMA are taken out of Big Swamp.

4.741 Future ditch development is not likely to be extensive in the area, however, because much of Big Swamp is in public ownership. In addition, it should be noted that future drainage within the Big Swamp area, even if it were permitted by State agencies, would not affect a significant amount of this area because of the channel design. By widening the channel through this reach with little increase in its depth, the opportunity for future drainage is significantly reduced. The reduction in peak flood stages in the Big Swamp area and downstream would be 0.6 foot for floods of 2-year frequency and 0.2 foot for less frequent floods (once in 5 years or larger).

4.750 Impacts on Wildlife Following Land Use Changes. Indirectly, the project has the potential to affect part of the wildlife habitat currently in private ownership in the U.S. portion of the watershed. The project would provide to a limited extent an improved outlet for drainage systems and would increase the arable land base of the basin. Any subsequent on-farm clearing and drainage would result in the loss of valuable habitat. The extent to which this would occur depends upon future drainage policies. The additional channel capacity in the proposed project providing for the potential drainage of 80,000 acres of Canadian lands in the Pine and Sprague Creek Watersheds would encourage such future drainage, thus inducing adverse impacts on waterfowl in Canada .

4.751 More important, perhaps, than total acreage of lost habitat is the distribution of the areas lost. The importance of the river edge to wildlife has been discussed. The interspersion of wild and agricultural lands is presently such that it supports good populations of wildlife. The removal of even small tracts of wildland could result in large areas with no wildlands at all. Extensive agricultural development is not compatible with maintenance of moose habitat. Deer and sharp-tailed grouse can tolerate some cultivation, but cannot thrive on continuous blocks of cultivated land. These species are thus most likely to be harmed by loss of small tracts of wildland. All three species are important, not only to Roseau County, but to the entire State.

4.760 Wildlife of Roseau River Wildlife Management Area. Direct effects of the project on terrestrial vertebrates in the Roseau River WMA itself may not be severe. Their impoundments are fed by a diversion from Pine Creek in Manitoba, and thus are not directly affected by changes in the water level in the Roseau River. Some of the small potholes in the area could, however, experience a reduced water level, and thus a decrease in waterfowl production area.

4.761 Because the extent to which normal and low river stages would be lowered by the channel excavation has not been accurately evaluated, plans have been incorporated for the construction of low weirs in the channel in the Big Swamp area to maintain low flow depths (primarily for fish habitat). Water level conditions would be monitored by the Minnesota DNR, and construction of the weirs would be based on their recommendations.

4.800 Socioeconomic and Cultural Impacts

4.810 Social Impacts. Flood control measures protecting public and private structures would constitute the major social impact of the proposed Roseau River project. Maximum direct social impact of the proposed Roseau River project would involve rural residents along that portion of the river to be modified as well as the inhabitants of the city of Roseau. Residents of the entire watershed (which includes all of Roseau County as well as portions of Lake of the Woods, Marshall, Beltrami and Kittson Counties) would experience lesser direct effects. Indirect social impacts would filter throughout this five-county area and would have ramifications for Minnesotans, particularly sportsmen, throughout the State.

4.811 Flood control resulting from the proposed channelization would be a long-term, local effect. The proposed project would significantly reduce the annual flood damages in the city of Roseau, as well as reducing damages to crops, rural property, roads, and bridges throughout an extensive rural area. The plan would also promote a more efficient use of cultivated land in the project area, resulting in an increased stabilized agricultural output. This would raise the incomes of farm owners and tenants, enabling them to enjoy an improved standard of living and resulting in more trade in Roseau, which would in turn improve the economic status of the city and its inhabitants. Significant public health benefits due to protection from flooding of the city of Roseau would likely occur. These benefits would include: reduced danger of loss of life or injury, improved vector control, reduced damages to water supply and waste disposal systems, and the prevention of other factors accompanying floods which tend to disrupt the maintenance of public health. Increased safety from flooding would have a positive impact on the community cohesion of the city of Roseau and the rural communities between Roseau and the downstream limit of the proposed project.

4.812 Project construction would not result in displacement of people nor displacement of farms. However some agricultural land would be lost to channel modification works, and the construction process itself would have a somewhat disrupting but short-term influence on residents near the river.

4.813 Only slight stresses would probably be placed on local transportation and other service facilities during project construction.

4.814 The channel project would probably result in a temporary increase in population--resulting from land speculators and, possibly, project workers. This slight increase would have only short-term local effects; the steady movement off the farm and out of rural townships would continue.

4.820 Impacts of Land Use Changes. Previously unusable land could become available for cultivation. Such changes in farmland would be long-term and would be primarily of local significance, since the amount of land made available for farming would not be enough to appreciably affect agricultural production in the State. An increase in land available for cultivation purposes is seen by area residents as significant; such an increase would probably be regarded as beneficial by the agricultural community of the watershed.

4.821 Long term alterations in wildlands resulting from the project would contribute to the decline in the amount of natural areas within the State and to the scenic views and natural amenities of the project area. An area survey conducted by the assessment team indicated that wilderness areas constitute a valued resource in the watershed, with area residents considering channelization a detrimental change. However, farmers living along the river favor a decrease in wetlands leaving more land for cultivation. They view channelization as beneficial.

4.822 Leopold and Maddock (1954) have argued that some flood protection encourages floodplain development, which means significant losses during floods which the project cannot protect against, and these in turn provide the justification for demanding even more protection. However, Minnesota floodplain regulations should prevent this possibility by preventing new structural or major redevelopment without adequate flood proofing (i.e. to withstand 1-percent flood). Also, as the affected lands would be primarily agricultural lands, little pressure for floodplain development would occur.

4.830 Economic Impacts. At the most general level, channel modifications of the Roseau River would reduce urban and rural losses due to flooding, increase agricultural output and incomes, reduce unemployment in the area as a result of project construction and subsequent spending by those with enhanced incomes, increase trade for some business establishments in the area, and reduce wildlife habitat and scenic values with a corresponding reduction in recreational opportunities.

4.831 Agriculture. Channelization of the Roseau River would enhance the agricultural base of the area by mitigating agricultural losses due to flooding, by encouraging farmers to bring more land under cultivation and, perhaps, by permitting higher value crops to be planted. Any uncultivated lands put into production would increase total agricultural production in the project area, and earlier drainage of floodwaters from agricultural lands would permit earlier planting and would in effect extend the growing season, although crop yields would still be subject to the limitations of climate and short growing season.

4.832 The Roseau River project would increase the opportunities for the marginal farmers to improve their economic positions. Such consequences would be primarily local in scope and would be only moderate and short-term, since the increase in land for cultivation would probably not halt the trend toward farm consolidation or remove the necessity for most area farmers to supplement their income with part-time, nonagricultural employment.

4.833 Based on reduced flooding, the Corps of Engineers (1975) has estimated that $330,200 of the total average annual benefits would accrue directly to agriculture.

4.834 Retail Trade Employment and Income. During the projected 4 years required for construction of the project, it is estimated that 80 percent of total labor costs would go to local labor. Purchases of materials and supplies in the impact area would likely be small because few municipalities in the area have adequate commercial establishments. Indirect economic effects would result when construction-generated spending generated additional local income, which in turn would generate an increase in local spending.

4.835 Although the indirect effects of construction would likely increase incomes and business sales in the area, the impact on employment as a result of those secondary effects is less certain. If significant excess capacity exists in the area's economy, then much of the temporarily increased business would be handled with the same number of establishments and the same number of employees. Thus, direct effects during construction could mean an increase in short-term employment in the impact area as well as some increases in sales by those businesses able to furnish construction materials and supplies. The secondary effects of the construction would also lead to increased incomes and increased sales for local businesses, but the secondary effects on area employment and the additions to business capacity would appear to be marginal.

4.836 The second and more permanent effect of the project on business, income and employment in the area would result from the spending by farmers whose incomes have been enhanced as a result of increased agricultural production. To the extent that such spending is done within the impact area, additional income would be generated which would generate more spending, and so on. However, the importance of this effect during the post-construction period would largely be concentrated in a few larger cities in the impact area and in the larger cities outside the impact area. It is unlikely that the project and its subsequent effects on agriculture would be able to arrest the general decay of the smaller communities in the area.

4.837 Property values and tax revenues would generally increase with implementation to the proposed project.

4.840 Benefit-Cost. The estimated average annual benefits for this project include $916,300 for flood control and $95,000 for redevelopment benefits which results in a total of $1,011,300. Redevelopment benefits are included as Roseau County has been designated a redevelopment area eligible for assistance under P.L. 89-136. The estimated first cost for the project based on October 1975 price levels is $15,670,000 which includes Federal costs of $15,200,000 and non-Federal costs of $470,000. The estimated first cost includes approximately $3.1 million for remedial works in Canada. The interest rate used for determining average annual costs is 3 1/4 percent based on Water Resource Council Regulations which provide that a discount rate of 3 1/4 percent will apply to those authorized projects where appropriate non-Federal agencies have given, by 31 December 1969, "satisfactory assurance to pay the required non-Federal share of project costs." A statement of assurance of intent to furnish local cooperation was furnished in a letter dated 24 April 1969 from the Roseau River Watershed District, local sponsor for the project. The estimated average annual costs are $676,800 which includes $38,500 for annual maintenance. The benefit-cost ratio for the project is 1.5.

4.850 Recreation. At the present time the Roseau River is used by fishermen, hunters, and canoeists. In spite of aquatic habitat and wildlife preservation measures, the realignment and enlargement of the river channel would be detrimental to aquatic life and aesthetic values. Recreational use of the river during the boating season could therefore be expected to decrease due to diminished low flow depths, particularly above Big Swamp, resulting from project construction. The undisturbed side of the channel could be developed for camping and picnic sites in view of the diminished frequency of flooding. Area hunting and fishing would undergo long-term changes which would affect both local residents and visitors. Any decrease in game or fish would be seen by sportsmen as a detrimental impact of the project.

4.851 Visitors from outside the watershed would probably be the group most affected as they constitute the bulk of recreationists utilizing the project impact area. A local economic impact would be felt with any decrease in recreational activities by non-area sportsmen, since recreationists spend money from an external supply which contributes stimulation to the local economy.

4.852 There are no firm plans to increase recreational opportunities in the U.S. portion of the basin beyond the possible waterfowl impoundments at Roseau Lake and Badger Creek. Implementation of recreational facilities would depend upon participation by State and local interests.

4.870 Aesthetics. Straightening and widening of the Roseau River, and the concurrent removal of riparian terrestrial vegetation, would decrease the aesthetic value of the river corridor. In addition, some would consider the proposed levees and disposal piles of the project plan to be aesthetically displeasing. Added to the short-term disturbances due to project construction would be the more significant long-term decrease in amenity area. The opinions of residents reflect the growing Statewide (and nationwide) interest and appreciation of natural areas as they recognize the uniqueness and the aesthetic qualities of their environment. The Roseau River has been previously modified and consequently does not now exhibit all the characteristics of a natural river setting although the river has reverted back to a somewhat "natural" state because the previous works were not maintained. Revegetation of the riverward sides of the disposal piles would mitigate to some extent the adverse aesthetic impacts of the proposed project.

4.880 Cultural Resources. During the development of the plans for this project three archaeological sites were identified within proposed construction areas. There will be no adverse impacts on any of these sites. Adjustments in project plans and detailed construction specifications will insure that impacts are avoided at two of the sites. The third site has been intensively tested by a professional archaeologist working under contract with the Corps of Engineers. As a result of that work, it has been determined that the site does not qualify for listing in the National Register of Historic Places, and no further archaeological work is recommended for the site.

4.900 Impacts on Canada

4.901 The channel modifications planned for the Minnesota portion of the Roseau River would result in increased flooding of the river downstream from the international border. Mitigation of this effect would be accomplished under the proposed project through construction of a flood diversion to the Red River downstream of Dominion City, rehabilitation of the Gardenton Floodway, and channel enlargement between Gardenton and Stuartburn.

4.902 Additional impacts to the Canadian portion of the river are similar to those discussed for the U.S. portion of the river. The magnitude of these impacts would, however, be much less in Canada. Because these types of impacts have been discussed in the previous sections they will only be identified here without a lengthy discussion. Discussion of impacts in Canada due to construction of the Canadian mitigation works is not considered to be within the scope of this document.

4.903 Impacts of the proposed project on the Canadian environment include:

1) Increased turbidity and erosion during and following construction.

2) Possible reduction in low flow especially if land drainage is increased.

3) Increased nutrient and pesticide concentrations due to intensified agriculture on lands improved through drainage.

4) Destruction of benthic organisms through increased siltation.

5) Deterioration of fish spawning, rearing, and resting areas.

6) Possible future drainage in Sprague and Pine Creek watersheds with resulting loss of wildlife habitat. However, this could take place with or without the project and probably depends more on economic factors.

7) Decline in fish populations as a result of loss of habitat and food organisms.

8) Initial period of increased sediment loading may necessitate dredging portions of Canadian channel to maintain existing conveyance capacities.

4.904 Little effect on terrestrial wildlife or wildlife habitat would result in Canada from the channel modification works in Minnesota. However, habitat losses would occur due to the Canadian mitigation projects. These losses would be similar to those discussed for U.S. works. The magnitude of these losses in Canada has not, however, been evaluated for this document.

5.000 PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

5.001 General. Temporary and unavoidable adverse impacts of the project include dust and siltation of the river as well as noise and unsightliness generated by construction activities. Specific long-term adverse impacts relate to the elimination of vegetation and wildlife and to the alteration of 43.9 miles of free flowing river. Certain impacts, if not permanent, can be considered prolonged for the life of the project.

5.002 The proposed project could cause a decrease in stability of the existing and excavated channel banks. This could result in localized sloughing or erosion of the channel slope and also in isolated occurrences of slumping of the river bank. In addition, the higher velocity caused by the concentration of flow can often create local sloughing of the channel bank at the top of the cut slope in a vertical, or near vertical, face. Such sloughing can precipitate slumping of the channel bank if the foundation materials beneath the channel banks are unusually weak, but this would decrease significantly once vegetation is established. It is likely that the 12 miles of channel excavation upstream of mile 125 would result in some slumping of the excavated channel slopes. (See section 4.210.)

5.100 Aquatic Resources. A temporary degradation in water quality would result from construction activities. Turbidity would be increased during and after construction. Sediment production would be substantial during initial construction operations, and erosion would be increased for the period of time required for revegetation of disturbed areas. Increased runoff from drained areas and intensified agricultural practices would result in increased nutrient loading to the river. Nutrient enrichment, along with increased light and temperature, would encourage algal production, especially in areas of reduced water velocity.

5.101 The channel modifications would produce great uniformity along the reach of the river subjected to construction activities, causing a loss of existing aquatic habitat. Current diversity within the main channel would be reduced and the sequence of riffles and pools would be destroyed. This would seriously affect the production potential in the 43.9-mile reach of the river and for some distance downstream.

5.102 An immediate decrease in invertebrate biomass would result from construction activity, and similar effects of turbidity and siltation would be expected during periodic maintenance work on the channel. Increased silt and turbidity could interfere with filter feeding apparatus of aquatic organisms and irritate gill membranes of fish as well. The young of most aquatic organisms would be more susceptible to increased silt and turbidity than would the adults. A long-term decrease in invertebrate biomass would result from the increased siltation and the decrease in habitat diversity. Adult fish would be indirectly affected by any reduction in their food source.

5.103 Construction of the eight channel cutoffs and the plugging of 11 additional old cutoffs or oxbows would alter the quality of the aquatic environment in these areas. Isolation of these cutoffs would essentially result in the creation of a pond-type environment. Plants and animals associated with the existing lotic environment would be replaced, over a period of a few years, by biota more characteristic of lentic environments. Silt and organic material would accumulate on the bottom of these areas and would exert an oxygen demand on the water. In addition oxygen depletion due to respiration, would probably result in conditions unsuitable for many aquatic organisms.

5.104 During low flow periods, the river would tend to meander within the new banks, which could result in bank erosion and shifting of bottom sediments.

5.105 Removal of riparian vegetation would result in more subtle long-term effects. Clearing of riparian vegetation would cause increased water temperatures and greater temperature fluctuations, both daily and yearly. The increased water temperature would result in decreased oxygen solubility. Partial removal of the source of leaf litter would decrease a major energy source for the aquatic system and thus would reduce the potential production of the system.

5.106 Increased drainage of adjacent lands could reduce the residence time of water in the watershed and could thus affect recharge rates, thus reducing groundwater sources to the river. This could result in lower base flows and higher temperatures in the river, especially during prolonged dry periods. This would probably be minor, however, because the major identified recharge areas of the basin (Beltrami Island and the Sandiland are in the Pine Creek basin) are in public ownership and would not be subjected to increased drainage.

5.200 Vegetation. Project plans would include the clearing of 1,080 acres of brush and light timber along the river. This would disrupt the current ecological balance between the vegetation and other physical and biological systems. To a great extent existing riparian communities are the result of channel works of 50 to 70 years ago. The main impact would, therefore, be to set back the "natural" ecological succession by about 50 to 70 years. As maintenance is programmed for the proposed project, the revegetation to a somewhat "natural" state that occurred after previous channelization projects would not occur in this instance. Of the remaining 1,320 acres involved in project construction, vegetation types are "marsh", altered fen, and agricultural. While the impacts upon the brushland communities would be relatively short-term, there would be a long-term impact upon the forest communities, and marsh communities would probably be permanently eliminated from areas upon which dredged materials would be placed. An indirect impact of the proposed channelization could be the drainage of wetlands such as the tamarack peatlands north of Sprague Creek.

5.300 Wildlife. A direct impact upon the wildlife resources of the area would result from habitat alteration due to changes in stream characteristics, woodland destruction, and the possible increased drainage of wetlands. Indirect effects on wildlife would result from changes in land use.

5.301 Areas suitable for the maintenance of significant populations of moose and deer are of sporadic distribution, and the woody fringes adjacent to the river are essential avenues of dispersal for big game between such areas. Removal of these woody fringes would therefore adversely affect big game populations. Woods along and near the river are probably by far the most important habitats from the standpoint of providing shelter and food for migrating and wintering birds. Any decrease in woodland acreage and/or diversity would have a negative effect on bird species.

5.302 Direct effects of the project on terrestrial vertebrates in the Roseau River WMA may not be severe. Some of the small potholes in the area could experience reduced water levels, and thus waterfowl breeding areas would be decreased.

5.303 Secondary effects of on-farm clearing and drainage could destroy areas of valuable habitat. Even more important than total acreage of lost habitat is the distribution of the lost areas and the loss of river edge habitat. The clearing of even small tracts of land, increasing arability as the result of improved drainage, could result in large areas with no wildlands at all. Extensive agricultural development is not compatible with maintenance of moose habitat. Deer and sharp-tailed grouse can tolerate a moderate percentage of cultivation, but cannot thrive on continuous blocks of cultivated land.

5.400 Recreation. Area hunting and fishing would undergo long-term changes, which would affect both local residents and visitors. Any decrease in game or fish would be seen by sportsmen as a detrimental impact of the project. Visitors from outside the watershed would probably be the group most affected as they constitute the bulk of recreationists utilizing the project impact area.

5.500 Social Impacts. Long term alterations in wildlands resulting from the project would contribute to the steady dwindling of the amount of natural areas within the State and the nation. Project construction would reduce wildlife habitat and scenic values with a corresponding reduction in recreational opportunities and incomes of those catering to recreation.

5.600 Impacts on Canada. The channel modifications planned for the Minnesota portion of the Roseau River would result in increased flooding of the river downstream from the international border. Mitigation of this effect would result in additional impacts to the Canadian portion of the river similar to impacts discussed for the U.S. portion of the river. The magnitude of these impacts would, however, be much less in Canada. These impacts are identified in section 4.900.

5.700 Threatened and Endangered Species. The Federal Register of 26 September 1975 (and updates) has been consulted, and no listed animal species would sustain measurable impact. The Register for 16 June 1976 has been consulted, and no threatened or endangered plants are known to be in the project area.

6.000 ALTERNATIVES TO THE PROPOSED ACTION

6.001 Through consideration of water resource needs of the basin, concerns and desires of local residents, and formal constraints over the use and control of water in an international river such as the Roseau, project objectives were developed to serve as guidelines for the evaluation and comparison of alternative plans. These objectives were:

1) Prevention, reduction, or compensation of flood damages for the flood prone areas of the basin.

2) Development in the U.S. portion of the basin should not impact negatively on the quantity or quality of water entering Canada. Anticipated damages resulting in Canada as a result of U.S. action on the Roseau River would be mitigated.

In addition the proposed plan considers preservation, creation and enhancement of the environmental quality of the basin where possible while addressing the water resource needs of the basin.

6.002 Flood induced damages in the U.S. portion of the Roseau River basin are primarily rural in nature with only about 10 percent of the average annual damages classified as "urban" and "transportation." Of the rural damages about 60 percent are accounted for by crop losses and about 30 percent by other rural damages including: loss of livestock, stored hay and grain; damages to structures, machinery, and drainage facilities; and expenditures for evacuation, rehabilitation, reoccupation, and related losses.

6.100 Nonstructural Alternatives. Several nonstructural alternatives, which tend to reduce flood damages primarily associated with urban areas, and structural alternatives, which can reduce both urban and agricultural damages, were considered and evaluated as to their ability to satisfy the above listed objectives.

6.110 Alternative 1: Base Condition (No Action). The base or the "without-the-project" condition consists of floodplain regulations and flood insurance as required by Federal and State policies. In 1974 the city of Roseau, by establishing floodplain zoning regulations in accordance with rules and regulations of the State of Minnesota, became eligible to participate in the flood insurance program administered by the U.S. Department of Housing and Urban Development. The statutory floodplain management program of the Minnesota Department of Natural Resources presently regulates new development and redevelopment in the existing floodplain.

6.111 Flood insurance, while not preventing flood damage, assists in reimbursing affected property owners of existing developments for losses sustained from floods; the flood losses are thus spread nationally. However no reduction in overall average annual flood losses would be effected by implementation of flood insurance alone.

6.112 Floodplain regulation reduces future losses in the floodplain and minimizes flood damage to existing developments by the application of flood proofing measures. Annual flood damages could be reduced to a minor extent as particularly flood prone structures are abandoned. However, floodplain regulation, as it is applied primarily to the city of Roseau, has little effect on agricultural flood damages. Some would also view its restrictions on individual freedom of land use as a negative impact. Because the authorized project would not provide complete protection from flood events, these programs would be applicable regardless of project construction, although the area of applicability would be redefined to the extent that the project reduces the size of the floodplain.

6.113 A natural river is in a delicate equilibrium such that channel characteristics are the results of prevailing energies within the channel and along the banks. Attempts to change any of these characteristics would cause a change in the energy balance. Although many of the subsequent changes are predictable, others are interdependent and difficult to predict. Consequently a "no action" alternative would eliminate the potential problems that may and would result with modifications of the channel.

6.114 In addition, this alternative could result in long-term benefits to the natural environment of the area with the probable removal of some structures in the floodplain and their replacement by open areas. However, these effects would be insignificant on a basin scale. Although accruing natural environmental benefits, the "no action" alternative would do little to improve the social environment of the affected area. Flood insurance and floodplain regulations by themselves would provide little relief to the rural sector of the basin, i.e., the sector that suffers the greatest economic impact of the floods. To do nothing would likewise have a negative impact on community development plans.

6.115 Adverse impacts of periodic inundation (i.e. damages to water supply and waste disposal systems, problems with vector control, and introduction of nutrients from surface runoff to aquatic systems) would continue, as well. Since the benefits resulting from implementation of any flood control measure(s), other than flood insurance and floodplain regulation, would not occur with the "no action" alternative, there would be a net cost to maintain the project area in its present condition. Because adverse social, economic and environmental impacts in the basin would continue, the "no action" alternative is not acceptable.

6.120 Alternative 2: Other Nonstructural Alternatives and Urban Protection. This group of alternatives includes flood warning, temporary and/or permanent evacuation of floodplain areas, and "structural" alternatives of emergency protection and flood proofing (temporary barriers).

6.121 These measures are most effective in urban areas and, in general, are insignificant in reducing damages in large agricultural areas such as the Roseau River basin. These measures would, to a limited degree, reduce damages to personal possessions from smaller, more frequent floods.

6.122 The biological impacts resulting from implementation of these measures would be small and would be localized, for the most part, within the urban river corridor. The permanent evacuation feature would probably result in some gains to recreationists as the floodplain would revegetate into a more "natural" wildlife habitat if agriculture were excluded from the evacuated areas. However, the beneficial biological effects of this plan would have to be weighed against the adverse effects which would occur in the relocation area.

6.123 The emergency flood protection plan would depend, at least in part, upon a flood warning system which would provide the lead time necessary for implementation of emergency protection measures. The emergency flood barriers would likely be constructed in a substandard manner due to time and funding constraints, thus resulting in adverse effects on safety, degree of flood protection, aesthetic appearance, and ecological systems.

6.124 Flood proofing could result in the perched appearance of homes and/or businesses, which many would consider aesthetically displeasing.

6.125 Emergency local protection, consisting of levees, channel work and similar construction would reduce flood losses in protected areas, but might increase flood stages in other unprotected areas.

6.126 A plan comprised of a flood warning system combined with temporary evacuation and/or emergency flood protection would have to be implemented for every flood occurrence.

6.127 Social impacts would be extensive due to the relocation and disruption of longstanding cultural ties. With relocation of residences the economic use of the floodplain would be lost; some individuals and businesses forced to relocate would probably leave the region.

6.128 Because of limited reduction of flood damages in the basin and unacceptable social impacts, nonstructural measures alone would not represent a viable flood control alternative. The value of these measures is, however, realized, and any significant flood control plan would formally and informally incorporate, where possible, these nonstructural features.

6.200 Structural Alternatives

6.210 Alternative 3: Reservoir Storage. Two areas within the limits of the Roseau River basin in the United States are potentially adaptable to reservoir development. The upper location lies in Roseau Lake (above mile 125) which, even under existing conditions, exerts an appreciable retarding action on flood flows entering the river. Its location is geographically favorable since it lies at the focus of the tributary fan formed by the upper Roseau River, Sprague Creek, and Pine Creek basins. However, such development would not reduce the degree of flooding in the city of Roseau. Local opposition toward development of Roseau Lake for floodwater storage is strong. The area in and surrounding Roseau Lake contains excellent soils, well suited for cultivation under flood-free conditions. Consequently, farmers in the area are anxious not only to retain the area for cultivation in drier years, but also to modify the Roseau River channel through the lake area so that it can be cultivated more extensively. Also, because of its limited size, most of the capacity of a reservoir in this area would be reserved for flood control purposes with little storage for wildlife management. Wildlife interests are generally opposed to development of a flood control reservoir at this site.

6.211 Because of local opposition to the Roseau Lake site, further studies were not conducted for this alternative, and a complete economic analysis and full assessment of environmental impacts are not available.

6.212 Generally economic benefits would accrue with reduction of flood damages downstream of Roseau Lake. However, the loss of present and potential agricultural lands in the Roseau Lake area would have a negative impact on the local economy.

6.213 While Roseau Lake would revegetate into a more "natural" wildlife habitat with the elimination of agriculture from the area, the limited size of the reservoir would not realize potential wildlife management benefits usually associated with a reservoir.

6.214 A minor deterioration in the water quality of the Roseau River could result from the increased duration of water retention on peat soils. Project construction would also adversely affect the water quality of the river. However, as flood flows would be somewhat attenuated by the temporary storage of water in the reservoir, sedimentation in the river due to erosion would be reduced. The decrease in acreage of agricultural lands inundated by floods and the elimination of agriculture from the Roseau Lake area would tend to decrease nutrient pollution of Roseau Lake, although this would be offset by nutrient pollution associated with increased agricultural output elsewhere in the floodplain.

6.215 The remaining possibility for storage in the Roseau River basin within the United States lies in utilizing the Big Swamp area, which has its downstream limit at mile 99.8. Because of its much larger size, unsuitability of surface soils for agriculture, and favorable location in the basin with respect to the control of any increased channel flows which might be brought about by necessary channel enlargement upstream, both local interests and wildlife organizations have expressed favorable interest in the development of Big Swamp as a multiple-purpose impoundment. A reservoir in Big Swamp would provide flood protection for the area lying below the reservoir, would prevent any increase in flows across the international border attributable to channel modifications upstream, and would furnish a conservation pool for wildlife.

6.216 Reservoir construction in Big Swamp would entail disproportionately high construction costs because of the topographic characteristics of the area. Over all, about 18 miles of dike would be required to confine an effective storage pool. Three alternatives for dike design were investigated. All designs included semi-impervious fill, top width of 10 feet, about 5 feet freeboard, and landward slope of 1 on 3. Variations were made in the side slopes and protection provided for the pool side of the dikes for each alternative.

6.217 Total average annual benefits of a Big Swamp reservoir were estimated at $611,000[1]; including $48,300 in reduction of flood damages of downstream crops and other rural property, and $565,000[2] in gains to wildlife as estimated by the U.S. Fish and Wildlife Service. Thus, wildlife benefits accounted for more than 90 percent of the total estimated reservoir benefits. The costs of the dike, together with outlet control works in the river channel and necessary spillways were estimated at about $17,500,000. The benefit-cost ratios for the three dike design alternatives ranged from 0.77 to 0.93.

6.218 Reservoir development at Big Swamp, without supplemental channel improvement, would fail to provide the desired flood control and improved surface water control facilities for the area within the floodplain which lies upstream from the reservoir. Although the reservoir would furnish a conservation pool for wildlife, a loss of wildlife habitat would result from inundation of lands necessary for reservoir construction. The water quality impacts would be similar to those effected by a reservoir at Roseau Lake (see 6.214), except those impacts associated with loss of agricultural lands would not apply to the Big Swamp area which is currently not cultivated.

6.219 Because the benefit-cost ratio was not favorable (0.93) and because only a minor reduction in flood damages would result, this alternative was not considered further.

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[1] All costs have been updated from earlier reports to a January 1975 level using Engineering New Record construction cost indices.

[2] Original FWS estimate of wildlife benefits updated by the Corps of Engineers.

6.220 Alternative 4: Channel Modification. In addition to the authorized plan that provides protection of from 10 to 50 years for various reaches of the Roseau River from the city of Roseau to Big Swamp, additional channel modification plans were investigated which included channels of various sizes, both as supplements to reservoir construction and as separate measures. A rather substantial capacity increase for the channel above and through Big Swamp was found economically justified, based on flood control benefits obtainable. However, because substantial channel modifications alone, without storage in Big Swamp, would produce an undesirable increase in flooding in Canada, only limited increases in channel capacity through Big Swamp were investigated so that most of the natural storage effect of Big Swamp might be retained. For the channel works, both with and without reservoir development, supplemental levees on the left or south bank along selected reaches were included to augment channel capacities in those reaches. Environmental, social and economic impacts associated with channel modification would be similar to those of the proposed channel modification project (see sections 4 and 5), although on a different scale.

6.221 100-Year Protection at Roseau. As an addition to the authorized plan, this plan was considered to attain a desirable degree of overall flood protection at the city of Roseau through the construction of flood barriers, levees, and interior drainage facilities. Incremental annual benefits resulting from this plan amounted to about $20,800 over the benefits obtainable from the authorized plan. With incremental annual costs of about $110,500, including maintenance, this alternative was found to lack economic feasibility. Levees necessitated by this plan would impact on the aesthetic nature of the urban channel since they would in effect divide the two sections of the city, the view of the river would be obscured and existing developments along the river banks would be adversely affected by the proximity of the levees. Additional land easements would also be required for such a plan which could result in adverse social impacts.

6.222 50-Year Protection at Roseau. A supplement to the proposed plan that provided 50-year flood protection for the city of Roseau was also considered. This plan included construction of an 80-foot wide channel upstream of the dam at Roseau and appropriate enlargement of the channel downstream of Roseau to Richardson's Bridge. The incremental annual costs for this plan, including maintenance, were estimated at about $84,500 while incremental benefits were estimated to be about $26,000 over those obtainable from the proposed plan.

6.223 This alternative would provide greater flood control benefits than the 100-year flood channel modification plan discussed above. This is attributable in part to the reduction in stage effected by the enlarged channel, and the fact that even with flows in excess of design capacity, some benefits would accrue; whereas with flood barrier protection, flows in excess of design capacity would cause very large damages. In addition, benefits to agricultural areas

AD-A121 895 FLOOD CONTROL ROSEAU RIVER ROSEAU AND KITTSON COUNTIES 2/3
MINNESOTA FINAL ENVIRONMENTAL IMPACT STATEMENT(U) CORPS
OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 76

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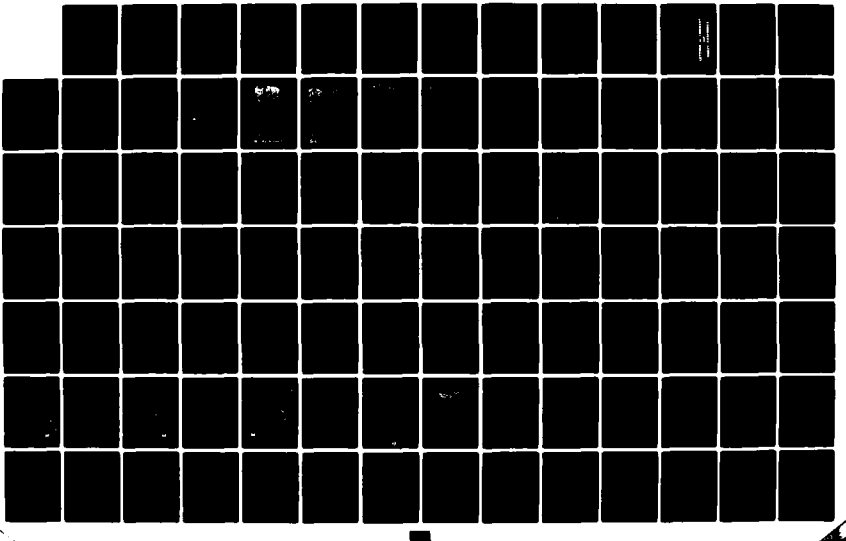
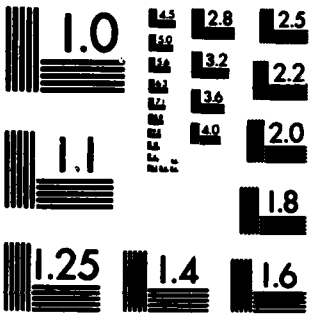




downstream from Roseau would be increased through construction of the larger channel in this area. Environmental impacts of this plan would be similar to the proposed plan but of slightly greater magnitudes since the project would extend farther upstream. This plan, however, as with the 100-year protection plan, lacked economic feasibility.

6.224 Further investigation of channel modification for protection at the city of Roseau disclosed that modifications terminating at the dam at Roseau would produce nearly the same benefits to the city of Roseau as could be obtained with modifications extending through the city.

6.225 The social impacts of channel modification terminating at the dam would generally be acceptable except for a necessitated bridge raise. The channel banks and dredge material disposal areas could be adequately treated. However, relocation of existing developments necessitated by the bridge and approach grade raises would adversely affect the area, due to the limited space available and disruption of existing streets and sidewalks in the area. Annual costs would then amount to about $45,500. This plan was, however, also found economically unfavorable.

6.230 Alternative 5: Levees. Construction of a complete system of levees along the Roseau River would provide a significant level of flood protection to portions of the basin. An extensive levee system would, however, seriously impact on remaining woodlands along the stream. The magnitude of the effects on the riparian woodlands could be greater than with the proposed project because both banks would be affected. Immediate effects on the aquatic systems would be much less severe in the main channel because dredging would not occur. Secondary impacts in the channel would result from removal of streamside vegetation. A significant effect on the aesthetic qualities of the river would also occur even after vegetation became reestablished on the levees.

6.231 Because the high costs necessitated by the inclusion of interior drainage provisions resulted in an unfavorable benefit-cost ratio, this alternative was not considered viable.

6.240 Alternative 6: Reservoir Storage Plus Channel Modifications. This alternative is essentially a combination of reservoir storage in Big Swamp (alternative 3) and the authorized channel modifications from the upstream limits of Big Swamp to the city of Roseau.

6.241 In general, a rather substantial capacity increase for the channel above and through Big Swamp was found economically justified based on the large flood control benefits obtainable. However, substantial channel modifications alone, without storage in Big Swamp, could produce undesirable increased flood flows across the international border. For this reason, and in recognition of the natural water storage capacity of Big Swamp, only limited channel modifications through this area were recommended for the authorized plan. However, incorporation of a storage reservoir at Big Swamp and the authorized upstream channel modifications would provide the upstream flood protection afforded by the authorized project and would reduce the need for the authorized downstream channel works. This would eliminate the impacts of downstream channel modification. In addition, on the average, flooding downstream from Big Swamp would be reduced, overflows into the Two Rivers basin would be reduced, Canadian mitigation would probably be less extensive, and fish and wildlife benefits would accrue in the Big Swamp area.

6.242 Because the primary objective of the Roseau River study was to develop the most economically feasible flood control plan that would significantly reduce the average annual flood damages in the basin, and because the economic feasibility of the recommended (authorized) project was greater than the reservoir storage-channel modification alternative, the latter received no further consideration.

7.000 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

7.100 General. The principal long-term impacts of the Roseau River channel modification project are a reduction in average annual flood damages, an increase in acreage for cultivation, and disturbance of biological, recreational and aesthetic attributes of the area. Beneficial and detrimental impacts would accrue directly to local residents and secondarily to larger sectors of the country.

7.101 Short-term impacts include disruptions to the aquatic and terrestrial system of the area, employment increase, additional business for area merchants and a population increase.

7.200 Biological Systems. Construction activities associated with the authorized project would result in significant increases in turbidity and erosion. Aquatic populations would be reduced and terrestrial vegetation would be removed from channel banks subjected to excavation and in areas of channel cutoffs. Turbidity and sedimentation would be increased until revegetation is established. Populations of aquatic organisms may require a longer time to increase and stabilize at a level lower than existing conditions but higher than those occurring during the construction phase. Project features such as one-bank excavation and the preservation of shade-producing vegetation, where possible, would mitigate these adverse effects to some extent. However, the amount of habitat suitable for important aquatic species would be reduced.

7.201 Some long-term benefits could accrue to waterfowl and aquatic mammals through increases in habitat resulting from channel cutoffs, although the overall effect would be adverse. It appears, however, that these areas would represent only marginal habitat for fish because of their shallow and ultimately euthrophic nature.

7.202 Channel modifications (excavation, levees, dredge material disposal) would reduce existing riparian vegetation. Disrupted areas would be revegetated to natural conditions only to the extent that the regrowth would not represent a potential for reducing channel efficiency. In this respect the losses would be long-term.

7.203 Secondary impacts are potentially more significant to the biological systems of the basin. If drainage increases the amount of arable land at the expense of wildlife habitat, then decline in the population of existing game and non-game species could be expected. At present, there is little State control over drainage projects.

7.300 Land Use. Increasing, to a limited extent, the efficiency of existing drainage facilities in the watershed through channel modification upstream from Big Swamp would probably result in an increase in the acreage of arable land. This would represent a long-term benefit to the agricultural economy of the area, directly to the farmers affected and indirectly to other areas of the economy. This also represents a negative impact to the natural biological systems in the area to the extent that changed land use reduces wildlife habitat.

7.400 Recreation. Hunting and fishing impacts would be long-term changes. The direct effects of the proposed project would reduce the standing crops and potential production of the river. This would in turn decrease angler harvest.

7.401 The recreational opportunities provided by other wildlife species in the project area would, in general, be reduced. The magnitude of this reduction would depend to a large extent on secondary effects on land use, i.e., intensified agriculture, woodland clearing, and wetland drainage.

7.500 Aesthetics. Natural amenities of the watershed would undergo both short-term and long-term alterations. Many of the areas that would be subjected to modification by implementation of the proposed project have previously been disturbed by channel modification projects. Some of these have returned to a "natural" condition. Long-term impacts would occur to the extent that natural vegetation would not be allowed and to the extent that the natural meanders of the river would be eliminated. Levees constructed downstream also would represent long-term impacts to the aesthetics of the area.

7.501 Reduction in the frequency of flood events represents a long-term beneficial impact in the area in that reductions in sheet erosion, damages to structures, and accumulation of debris would all impact positively on the general aesthetic qualities of the project area.

7.600 Social. A long-term result of the proposed channel modifications would be the lessening of economic damages in the city of Roseau. In addition, increasing the amount of time lands are available for cultivation would result in long-term economic gains to farmers in the project area. This would have the short-term effect of enabling the small farmer to continue farming. The trends in mechanization and economic contingencies could counteract this impact to an undetermined extent. Consolidation of small farms would continue, as would the increase in part-time, non-agricultural employment for area farmers. The rate of these trends would, however, probably be reduced.

7.601 The temporary influx of project workers would probably increase the area population for a brief period. The economic advantages accruing to area farmers would probably slow the movement off the farms and help to stabilize the basin's population. However, the project would likely have little effect on reversing the out-migration of young adults and would thus have a small long-term impact on reversing the population losses in the watershed.

7.602 Influxes of personnel during construction of the project would place some stress on the transportation and service facilities in the area. Local businesses would likely experience an increase in sales. However, the influx of project workers into the watershed would be short-term, creating little permanent damage or benefit to local facilities.

8.000 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

8.001 The construction of cutoffs to straighten the river channel would result in an increase in the area of aquatic environment at the expense of the present terrestrial environment, and the quality of the existing aquatic environment would be reduced.

8.002 Land use in the area upon which the dredged materials would be leveled would be primarily agricultural, at least along the stretches suitable for cultivation. However much of the excavated material would be gravel, cobbles, etc., and not desirable for agricultural use. Some areas of forest and shrub communities which would be cleared for the project could be permanently lost as such. At best, the natural revegetation of those areas would be greatly retarded.

8.003 Alteration of the stream environment and more intensive agricultural land use would result in a decline in populations of big game, upland game, waterfowl, and furbearers. Non-game species inhabiting forest and wetlands would also decline. Open country species which are compatible with intensive agriculture, e.g. various blackbird species, horned lark, killdeer, etc., would experience population increases.

9.000 COORDINATION

9.001 Coordination with elected officials, Federal, State and local agencies, and all known interests has been conducted and is continuing throughout project studies. The Roseau River basin boundaries extend into Manitoba, Canada. Therefore, the International Joint Commission (IJC), a permanent Canada - United States body, has also directed a study concerning a number of questions including impacts of the proposed project on the river basin as a whole. In the formulation of this study, the IJC, on 26 August 1971, established the International Roseau River Engineering Board. Members of this board consist of representatives of various Canadian agencies as well as representatives of Federal and State agencies from the United States. This board gathered all pertinent data and undertook complete coordination with State and Provincial agencies as part of its studies. Results of their studies were presented to the IJC for review in September 1975. The IJC held public hearings in January 1976 and issued its report to the Governments of the United States and Canada in October 1976.

9.002 The Corps of Engineers filed an environmental impact statement with the Council on Environmental Quality on 13 April 1972. Due to the international ramifications of the proposed project, and since the report by the IJC was not completed, it was not possible at that time to completely assess the mitigation required by the United States to the Canadian Government. Further review and coordination have resulted in some modifications of the authorized project to incorporate environmental concerns. Therefore, a more comprehensive impact statement, taking full consideration of the results of the study prepared by the IJC Engineering Board was deemed necessary.

9.003 The St. Paul District Engineer served on the International Roseau River Engineering Board, and all current information and study results were furnished to the board throughout the formulation of their report. A task force of the Engineering Board held several public meetings in Canada, prior to the formulation of the Board's coordinated plan and report. In addition, the Board prepared informational pamplets on the proposed project which were distributed to all known interests both in Canada and the United States.

9.004 The Corps of Engineers has held several meetings with the Roseau River Watershed District throughout the study to ascertain their views and to assure full local coordination and to keep them up-to-date on studies by the IJC. Various elected officials have also been kept informed of project developments.

9.005 The Corps has conducted correspondence with the Minnesota Department of Natural Resources regarding their comments on the draft environmental impact statement. The Corps has met several times with the DNR and representatives of the U.S. Fish and Wildlife Service (FWS) to discuss various aspects of the Roseau River project. One of the DNR's major concerns has been that of increased drainage potential of lands within the watershed due to modification of the Roseau River channel. Other issues have been riparian vegetation and wildlife habitat losses that would be incurred by project,

fishery losses, and potential adverse impacts on the existing high-value potholes both north and south of the Roseau River in the Big Swamp area. The Corps in coordination with the DNR and FWS is currently in the process of determining features to be incorporated in the proposed project to mitigate major impacts of the flood control project.

9.006 Coordination has been conducted with the Minnesota Pollution Control Agency regarding their concerns about the proposed project. Preparation of Corps responses to the concerns raised in the MPCA letter of comment was coordinated with that agency to insure that the issues were fully addressed in this document.

9.007 In compliance with section 106 of the National Historic Preservation Act of 1966 and Executive Order 11593, the most recent, July 1976, National Register of Historic Places has been consulted regarding the Roseau River. No property on or eligible for the National Register would be affected by the proposed project. In addition, coordination has been conducted with the Minnesota Historical Society and the National Park Service (exhibit 33), and the Minnesota State Archaeologist conducted a contracted survey of the project area. In compliance with Council on Environmental Quality requirements coordination has been conducted with the Minnesota State Planning Agency and the Northwest Regional Development Commission regarding land use plans.

9.008 The following agencies, interest groups and individuals were furnished copies of the draft environmental impact statement for review and comment.

Honorable Hubert H. Humphrey, U.S. Senate
Honorable Walter F. Mondale, U.S. Senate
Honorable Bob Bergland, U.S. House of Representatives
Honorable John A. Blatnik, U.S. House of Representatives

U.S. Environmental Protection Agency
U.S. Department of Agriculture
- Forest Service
- Soil Conservation Service

U.S. Department of Commerce
U.S. Department of Health, Education, and Welfare
U.S. Department of Housing and Urban Development
U.S. Department of the Interior
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Fish and Wildlife Service
- Bureau of Sport Fisheries and Wildlife
- Geological Survey
- National Park Service

U.S. Department of State, Office of Canadian Affairs
U.S. Department of Transportation
Federal Power Commission
Federal Energy Administration

International Joint Commission
International Roseau River Task Force
International Roseau River Engineering Board
Environment Canada

Honorable Donald Sinclair, Minnesota Senate
Honorable Richard W. Fitzsimons, Minnesota Senate
Minnesota Department of Agriculture
Minnesota Department of Business
Minnesota Department of Economic Development
Minnesota Department of Health
Minnesota Highway Department
Minnesota Department of Manpower
Minnesota Department of Natural Resources
Minnesota State Park Commission
Minnesota State Planning Agency
Minnesota Pollution Control Agency
Environmental Quality Council, Minnesota
Minnesota Recreation and Park Administration Department
Minnesota Department of Taxation
Minnesota State Archaeologist
Minnesota Dairy and Food Commission
Minnesota Historical Society
Minnesota State Park Commission
Minnesota Railroad and Warehouse Commission
Minnesota Regional Development Commission
Minnesota Resources Commission
Minnesota Water Resource Board
Minnesota Association of Conservation Education
Minnesota Association of Watershed Districts
Clean Air Clean Water Unlimited
Minnesota Conservation Federation
Ducks Unlimited
Ecological Society of America, Minnesota Chapter
Minnesota Education Association, Environmental Task Force
Minnesota Environmental Control Citizens Association
Minnesota Environmental Education Council
Minnesota Environmental Education and Research Association
Minnesota Environmental Education Steering Committee
Environment Information Center, Inc., New York, New York
Fresh Water Biological Institute
Friends of the Earth, Minnesota Branch
Institute for Ecological Studies, Grand Forks, North Dakota
Institute for Environmental Studies, University of Wisconsin
Izaak Walton League of America, Minnesota Division
National Audubon Society
The Nature Conservancy
Minnesota Pheasants Unlimited
Minnesota Public Interest Research Group
Sierra Club, North Star Chapter
Soil Conservation Society of America, Minnesota Chapter
Minnesota Waterfowl Association
Wildlife of America

Mayor, City of Roseau
Roseau City Council
City Clerk, Roseau
City Planning Coordinator, Roseau
Editor, Roseau Times Region
Roseau County Auditor
Roseau County Office of Building Official and Shoreland Administrator
Roseau County Extension Agent
Roseau County Highway Engineer
Roseau County Soil and Water Conservation District
Roseau River Flood Control Committee
Roseau River Watershed District
Superintendant, Roseau River Wildlife Management Area
Ross - Pinecreek Improvement Association
Supervisor, Beltrami Island State Forest

Rural Municipality of Franklin, Manitoba, Canada

Mr. John R. Behnke
Mr. and Mrs. Burton Bergeron
Brink, Solobik and Severson, Attorneys at Law
Mr. Robert J. Hall
Mr. Manfred Holm
Major Paul A.Lebo
Mr. Lloyd A. Ofstedal
Van Doren - Hazard - Stalling - Schnack Engineers
Yon and Carter, Attorneys at Law

9.008 Copies of this statement are being furnished to the following libraries where they will be held as reference material available to the general public for review:

111 Legislative Library
State Capitol
St. Paul, Minnesota 55155

St. Paul Public Library
Science and Industry
90 West 4th Street
St. Paul, Minnesota 55102

Public Library
Roseau, Minnesota

University of Minnesota
University Libraries
Documents Division
409 Wilson Library
Minneapolis, Minnesota 55455

9.009 A list of those who furnished written comments on the draft environmental impact statement is presented below. Copies of these letters with Corps responses follow.

U.S. Environmental Protection Agency
U.S. Department of Agriculture
Forest Service
Agricultural Extension Service, University of Minnesota
U.S. Department of the Interior
U.S. Department of Transportation
Federal Power Commission
Advisory Council on Historic Preservation
Minnesota Department of Natural Resources
Minnesota Pollution Control Agency
Minnesota Historical Society
Northwest Regional Development Commission

LETTERS of COMMENT
and
CORPS RESPONSES

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
[illegible]
CHICAGO, ILLINOIS 60604

NOV 10 1975

[illegible] District, St. Paul
[illegible] & Custodhouse
[illegible] 55101

[illegible]

[illegible] our review of the Draft Environmental Impact Statement (EIS) [illegible] on Roseau River, Roseau and Kittson Counties, Minnesota [illegible] your letter of August 28, 1975. We have major concerns regarding [illegible] impacts of this project and its short-term and long-[illegible] upon the Roseau River ecosystem and tributary wetlands. As you [illegible] Agency does not generally condone channelization or construction [illegible] encourage future drainage of flood plains and wetlands. This [illegible] these kinds of impacts.

[illegible] project does incorporate the one-bank excavation concept to reduce [illegible] impacts, water quality and the Roseau River's ecosystem will [illegible] adversely impacted. Therefore, before construction is permitted on [illegible] we request that assurances be provided that an effective pollution [illegible] plan will be developed and implemented during and after the construction [illegible] to mitigate the project's impacts upon water quality, erosion [illegible] and wetlands. This plan should be included within the Final EIS.

[illegible] in our attached comments and in accordance with EPA procedures, we [illegible] the proposed project as ER, environmental reservations, and have [illegible] this EIS as Category 2, additional information is required to adequately [illegible] the project's environmental impacts. The classification and date of our [illegible] will be published in the Federal Register. We appreciate the opportunity [illegible] this Draft EIS; please send us four copies of the Final EIS when it [illegible] with the Council on Environmental Quality.

Sincerely yours,

Donald A. Wallgren
Chief,
Federal Activities Branch

[illegible]

Corps Responses to the U.S. Environmental Protection Agency

1. Sections 2.620, 3.000 and 4.105 of the final environmental impact statement (FEIS) have been expanded to more adequately discuss existing drainage in the basin and to identify the potential for induced drainage that could occur as a result of the proposed project. In general, most of the drainage program identified by the 1956 and 1957 SCS reports (see 1.507-1.509 and exhibit 4) has already taken place. In addition, although the Corps project would increase channel capacity, it would not result in a significantly deeper channel. Thus, any drainage impacts would be a result of removing surface water (during floods and/or during runoff events) sooner and not of a deepening and/or extending the existing ditch system farther away from the river. See response 2 regarding water quality impacts.

2. There is very little that can be accomplished during the construction phase of a project of this type that would be effective in reducing expected water quality impacts, i.e. turbidity and temperature. Planting of grasses, shrubs, and trees would be undertaken following construction which would reduce post-construction erosion and turbidity. Post-construction efforts to mitigate fishery losses through the creation of riffles and low-head dams would also mitigate water quality through increased aeration. In addition, during construction it may be possible to construct cutoffs starting at their upstream ends. This technique has been recently suggested as a method of reducing turbidity. In addition, bank excavation may be accomplished by successively excavating approximately horizontal layers of soil. In this way dry (above water level) soil would be excavated before the wet soil (below water level). This method would cause less turbidity than if the bank (above and below water level) were removed in approximately vertical cuts from the existing slopes outward. Further, Canadian mitigative features include additional treatment facilities for the Dominion City water treatment plant. A retention tank estimated at a cost of $10,000 would be built. It would increase the plant's present capacity to remove sediment from intake water; thus any increases in sediment load due to the proposed project could be treated by the new facility.

[redacted] should include a better description of the project as authorized by the [redacted] Act of 1965. The estimated first cost of $11.264 million includes [redacted]'s construction costs of $7.8 million in the United States and [redacted] million in Canada. Does the cost-benefit ratio of the proposed project [redacted] consideration any long-term funding to Canada due to this project as [redacted] an outstanding or improving flood protection measures downstream? Since [redacted] interest cost or discount rate being used in determining the average annual [redacted] is 3 1/4 percent, the EIS should include an explanation on the reasonableness of this discount rate as it applies today and whether the same discount [redacted] would be incorporated into any possible future project phases.

[redacted]

[redacted] water quality impacts of this project should be further discussed. Anticipated changes in water quality should be compared to the applicable water [redacted] standards for Roseau River. Assurance should be provided by the participating agencies that if applicable water quality standards are exceeded and [redacted] developmental uses of the stream are severly impacted - during and after construction because of construction activities or new channel characteristics - [redacted] activities (proposed construction or future maintenance) and/or related [redacted] activities will be halted or postponed upon request until remedial [redacted] permit satisfactory compliance with standards.

[redacted] Roseau River is classified by Minnesota's federally-approved Water Quality [redacted] as Class 2B Fisheries and Recreation and Class 3B Industrial Consumption. Class 2B Fisheries and Recreation means that the quality of the subject [redacted] waters shall be such as to permit the propagation and maintenance [redacted] cool or warm water sport or commercial fishes and be suitable for aquatic [redacted] of all kinds, including bathing, for which the waters may be usable. [redacted] concentrations or ranges of substances or characteristics which should [redacted] not exceeded are established for dissolved oxygen, temperature, ammonia, oil, [redacted], turbidity and fecal coliform. Class 3B Industrial Consumption means that [redacted] quality of the subject interstate waters shall be such as to permit their [redacted] for general industrial purposes, except for food processing, with only a [redacted] degree of treatment. The quality shall be generally comparable to [redacted] D interstate waters used for domestic consumption, except values for [redacted], hardness, pH and fecal coliform would be different.

[redacted] stated in the EIS, this project may cause possible reductions in the low flow [redacted] characteristics of the Roseau River. This would in part be caused by the [redacted] of the ground water table in parts of the basin (pages 31, 32 & 34), [redacted] particularly in those areas adjacent of the stream and other on-farm ditches. [redacted] alteration of the hydraulics of this river plus reduced turbulence and [redacted] increased temperature due to channel straightening, bank excavation, and clearing [redacted] have an adverse effect on the reoxygenation and waste assimilative capacity [redacted] of the stream. Such effects could certainly alter the dissolved oxygen profile [redacted] of the river and therefore these effects should be carefully evaluated and [redacted] in more qualitative and quantitative terms. Future low flow hydraulic [redacted] characteristics of the new channelized system should be stated in the EIS.

Corps Responses to the U.S. Environmental Protection Agency (cont.)

3. Section 1 of the FEIS has been expanded (including more detailed exhibits) to provide a clearer description of the proposed project. The modifications which have been made to the originally authorized plan are discussed in section 1.710 of the FEIS.

4. Included in the Canadian mitigation funds are monies for normal operation and maintenance as well as replacement costs after 50 years for Canadian flood control measures necessitated by the increase in flows expected at the international boundary.

5. Following procedures adopted by the Water Resource Council (1969), projects which had received a resolution of participation from local sponsors prior to December 1969 had their interest rates fixed at the rate in effect at that time. In the case of the proposed Roseau River project, such assurances of local participation were provided by that date, and the 3.25-percent interest rate in effect at that time became fixed for the project.

6. The sections on existing water quality and on expected impacts of the proposed project have been expanded in the FEIS (sections 2.300, 4.500) to include the requested information. The proposed project is generally not expected to impact heavily on most water quality parameters with the exception of turbidity. The effects on turbidity are expected to be relatively short-term, i.e. during construction and for a few years following construction while the modified channel stabilizes. Impacts on other water quality parameters are expected to be minor except in localized areas such as channel cutoffs. A study would be initiated to identify pre-construction aquatic populations and to determine the extent of mitigation works necessary to restore the populations following completion of the proposed construction (see 1.723 of FEIS). Applicable water quality standards for the Roseau River are portrayed in exhibit 11. Once the project has been turned over to the local sponsor(s), the Corps has no statutory authority to regulate local activities.

7. The information provided has been considered in preparation of the FEIS and incorporated into exhibit 11.

8. Sections 2.220, 4.310, and 4.320 have been expanded to more thoroughly discuss existing low flow conditions and the effects of the proposed project on these conditions. As noted in the above cited sections, most of the project area is a discharge area and not a recharge area. Assuming that all contribution to the groundwater was eliminated along the project area (which is highly unlikely) a reduction of only 2 to 4 percent in low flow runoff would occur. The effects of increased temperature and reduced oxygen concentration on water quality have been discussed in sections 4.400 and 4.500 of the FEIS.

[redacted] hydraulic conditions for the Roseau River system, the effects [redacted] stream' ability to assimilate wastes from municipal, industrial and [redacted] sources should be assessed. As stated in the EIS, there are two [redacted] NPDES dischargers in the Roseau River system. The NPDES permits and the design of the dischargers disposal system are based upon the assimilative capacity of the river. The effects that this project will have upon the dischargers treatment plans and permit specifications (on file with the Minnesota Pollution Control Agency) should be evaluated with the State's assistance. If these effects are significant and would necessitate more stringent permit specifications and added treatment expense for the dischargers, these costs should be incorporated into the project's costs.

In regard to the above, a 1973 Roseau River Segment Plan by the Minnesota Pollution Control Agency (MPCA) specifically states that wastewater treatment facilities in Roseau are hydraulically overloaded, and that the plant continuously discharges effluent into the river which violates some effluent standards. This MPCA Plan also comments on other major and minor dischargers within the project area that put forth effluents which seriously affect water quality. The environmental setting should contain this information.

10

The EIS has not adequately evaluated the alterations in the thermal regime of the stream channel. The impacts associated with clearing bankside vegetation upon the fishery should be discussed in detail. The short-term effects of increased suspended and settleable solids upon local fish populations should also be mentioned.

11

WETLANDS

Some estimate should be made of the total amount of wetland habitat in the project area to be channelized and/or subsequently drained. Also the EIS should include some map exhibits and a determination of the water level coverage of affected wetlands on a seasonal basis during preproject conditions and postproject conditions. A determination of wetlands reduction (on an aerial basis) under low flow conditions before and after the project should be made.

12

Corps Responses to the U.S. Environmental Protection Agency (cont.)

9. The Minnesota Pollution Control Agency (MPCA), in its water quality report of January 1975, indicated that the point sources of pollution from the Annaska Creamery and the city of Roseau, both of which require a NPDES discharge permit, have been adequate treatment. Discharge standards for these two sources are based either on controlled discharges, which require less treatment but can only be discharged during periods of adequate flow, or on tertiary treatment. Because the proposed channel modification project would not significantly alter low flow conditions, it would not significantly affect the discharge standards for NPDES permitted dischargers. However it is true that the reduction in turbulence and increase in stream temperature caused by the proposed channel widening would reduce the capacity of the river to assimilate these wastes.

10. See response no. 9 and sections 2.316-317 of the FEIS for discussion of the MPCA report (as updated in 1975).

11. See sections 4.420 and 4.500 of the FEIS for discussion of the impacts mentioned in this comment.

12. The 1957 supplemental report to the Survey Report on Major and Local Drainage prepared by the U.S. Soil Conservation Service provides figures on acreage of wetland in the Roseau River basin which existed and would be affected by a drainage program proposed in that report. According to the 1957 SCS report, lands in the category of "idle and idle wetland" accounted for 56,347 acres of the total 201,750 acres of land that would have been subject to their proposed drainage program. (see FEIS, table 3). Implementation of this program would have resulted in land use changes on about 53,000 acres. The changes would have resulted primarily from conversion of lands of the "idle" (39,548 acres) and "pasture" (12,959 acres) categories to the "crop well drained" category (see FEIS, 1.507-509). The SCS proposal has never been authorized and is not a part of the proposed Corps project. However most of the drainage plan recommended by the SCS has already occurred without the modifications currently proposed by the Corps project (exhibit 4).

Any drainage which has occurred and will occur due to ongoing drainage plans would be difficult to differentiate from drainage induced by the proposed channel modification project. In addition, the proposed project, because it would result in only a slightly deeper channel, would not provide the opportunity for ditches to be extended farther away from the river than would be possible without the project. It is true that, by providing increased capacity in the river channel, the frequency and duration of flooding would be reduced. The drainage outlet would be improved during flood flows, but the outlet provided by the river during low flows would remain essentially unchanged for the purpose of drainage (see 4.105, FEIS). Following construction the project would be turned over to local interests for operation and maintenance. The side ditch inlets could then be redesigned by them, if they so chose. The Federal Government does not have jurisdiction over non-Federal drainage projects and thus future drainage practices in the area must be controlled through State and local jurisdiction. Local interests will be strongly encouraged to regulate drainage.

[illegible] determination should be made as to the degree to which the existing wetland [illegible] is utilized by waterfowl or other fauna.

[illegible]

We note that the U.S. Soil Conservation Service has developed drainage plans (Exhibit 25) for the Roseau River Watershed. Local cooperation should also provide assurance that effective soil conservation measures will be implemented to prevent on-farm ditch and sheet erosion agricultural practices. Those assurances should be required as part of the proposed flood control project. Field drainage via grass-lined or rock-lined drain corridors to ditches and streams should be considered to control waterway siltation.

According to page 28 of the EIS, drainage of nearly all the flood plain above Big Swamp is dependent upon the effective functioning of the public drainage ditches. The proposed flood control project includes the construction of 75 structures to accommodate flows from such drainage ditches. Improved drainage from the ditches would stimulate more intensive agriculture development in the

flood plains. Also additional on-farm ditching will probably result because of this project. The EIS further emphasizes under Section 3.008 that because of the potential for increased Canadian drainage and agricultural production in the Pine and Sprague Creek basins and on-farm drainage in the United States, this project has been further modified to include an "...incremental width to handle additional flows resulting from this added drainage." These additional flows have been estimated (page 30) from an assumed drainage of 30,000 acres and 50,000 acres in the Pine Creek and Sprague Creek basins, respectively. The reasons advanced in the EIS on why the project has been modified to include drainage for lands that have not yet been drained and for lands for which no definite plans have been developed (either in Canada or the United States) is based on speculation.

The EIS claims that drainage efforts (existing and future on-farm ditching) are secondary (Section 4.142), yet the project is being designed to accommodate these effects. Therefore, it would seem more appropriate to categorize these effects as primary effects. Increased drainage in other tributary watersheds not presently being accommodated by this project's design but as a result of de-increased flooding frequencies downstream would be considered secondary effects.

The EIS should discuss the eventual effects that the additional assumed drainage will have upon flood frequency levels and flood protection levels downstream and upstream of Big Swamp (see page 31).

[illegible]

According to the EIS (page 9), Roseau River between Roseau Lake and the United States-Canadian border has been straightened by pre-channel improvement. Development of undrained lands upstream of Roseau Lake basin and previous channel modification have increased stream flow and sediment transport capacity. This has and will contribute to create bank erosion and slumping after this project unless mitigating measures are incorporated into the project's design.

Corps Responses to the U.S. Environmental Protection [illegible]

13. Studies are being coordinated with the Minnesota Department of Natural Resources (DNR) and U.S. Fish and Wildlife Service to determine pre-project and post-project conditions of potholes on State land. The wetland values of [illegible] retained as the reduction in flood stage [illegible] about 0.2 feet. The Roseau River Wildlife [illegible] be expected to be seriously disturbed by the project. [illegible] pools are fed by a diversion from Pine Creek. [illegible] area office DNR in Thief River Falls has indicated [illegible] land habitat is highly used by animals and birds. [illegible] species of birds and between 50 and 75 species of [illegible] found in these areas.

14. The Corps has no authority to require local cooperation [illegible] implementation of land use controls for the Roseau River [illegible] area. Local cooperation requirements were fixed at the time of project authorization (1965) and did not include [illegible] regulation. We encourage State, county, and other local [illegible] units to implement, within their authorities, land use [illegible] for lands adjacent to the project lands to ensure that the land uses are in the best interest of the public.

15. At present 59 side ditch inlet structures are proposed. No [illegible] inlet structures are planned where existing ditches access the river over undisturbed banks except where required to protect bridge structures from erosion. In most cases the type of structure to be constructed was based on the size of the first existing culvert landward from the existing river channels, and was not based on anticipated or potential drainage. Because the improved channel would not be deepened significantly, improved drainage would be limited to high flow periods (see section 4.200).

16. These Canadian lands with potential for increased drainage were identified by Canadian participants of the International Roseau River Engineering Board. Although there are no [illegible] plans to drain these lands, it was felt that the possibilities do exist that they could be drained in the future, and therefore partially many of the flood control benefits associated with the project. As stated in the EIS, if this occurred it may not have been necessary to provide the incremental channel modifications necessary to provide that drainage at some future time.

17. Section 4.142 of the FEIS refers to potential impacts of the project on groundwater and low flow conditions. The project is not being designed to accommodate any future drainage in the U.S. portion of the watershed (note response 14 and section 4.200 of the FEIS). Future drainage in Canada has been incorporated into the project design and would be considered a primary effect.

18. The project is designed to accommodate drainage in Canada. In the U.S., a minor amount of drainage would not significantly affect project function. Major U.S. drainage will be strongly discouraged.

19. See response 22 and section 4.200 of the FEIS.

Section 4.121 implies that no revegetation measures would accompany the project, and that revegetation would be left to natural processes. It was indicated that [illegible] would continue from 1 to 3 years on excavated slopes. Furthermore, it is stated on page 35 that until the new banks become stabilized by vegetation, erosion would be increased and turbidity may be increased for as long as 3 to 5 years following construction. Such practices should not be allowed. Mitigative landscaping, seeding and/or sodding of all disturbed ground areas should be a required practice and strictly enforced during and after construction.

For those reaches having vegetation on and along both banks, consideration should be given to impacting the least ecologically productive side but still allowing vegetation to be retained on both sides. Several reaches of Roseau River have little or no wooded acreage on one side of the river; the other side is either being cleared, under cultivation or in pasture. When compatible with stream hydraulics, bank excavation and spoil placement should be completed on the [illegible] or non-wetland side.

Bank erosion control measures should be incorporated into all modified channel sections. Bank slope and distance of the spoil piles away from the channel should be compatible with the type of soil being excavated, particularly on Reaches 6 and 7. Unless special design considerations are incorporated into the project, it is likely that the 12 miles of channel excavation upstream of mile point 125 would result in mass slumping of the excavated channel slopes. According to the EIS (page 35), the project's design requires that spoil sites be located from about 50 to 100 feet landward of the channel cut in the upstream portions of the project. Yet Plate 25 (August, 1975) of the General Design Memorandum defines the typical distance from the bank to the base of the spoil bank to be 30 feet for Reach 6. These distances should be modified accordingly. The impact discussion on cutoffs should be made consistent with the revised cutoff construction plan as described on page 7. It is stated in the EIS that the one-bank excavation concept involves excavation from approximately the centerline of the river to one side. The profile of a typical channel section (Plate 25-EIS) should be modified to conform to this concept.

With respect to the disposition of the levees and the spoil piles, they should not be plowed or used for other incompatible agricultural purposes but instead maintained for vegetative buffers. Consideration should be given to preserving, maintaining and/or placing or a permanent vegetative buffer zone on both sides of the river for erosion control and water quality improvement.

SOCIOECONOMIC IMPACTS

It is realized that the proposed project will decrease the flooding frequence on small agricultural lands and will open up new flood plain and upland lands for agriculture. Yet, the trend presented in EIS from 1959 to 1970 is a steady decline in the number of farms and a slight decrease in the percent of land that is farmland in Roseau County. More up-to-date data on such trends for Roseau and Kittson Counties should be presented in the EIS. Also, it should be quantified what percentage of the farmland in Roseau County and Kittson counties is actually being farmed.

The EIS should discuss the socioeconomic impacts of the project relative to land use changes, changes in recreational activities and opportunities, and woodland losses.

Corps Responses to the U.S. Environmental Protection Agency (cont.)

20. Since publication of the DEIS the Corps has incorporated revegetation measures into the proposed plan. Revegetation in the form of grasses, shrubs and trees would be accomplished following project construction, and efforts would be coordinated with appropriate resource agencies.

21. Consideration was given to vegetation characteristics when determining which bank would be excavated.

22. The foundation conditions for reaches 6 and 7 are much less severe than for reaches 2 through 5. Therefore, the optimum distances of the disposal sites has been decreased accordingly. Experience with other projects having similar foundation conditions indicates that slumping of the channel slopes would not be serious nor frequent.

23. Paragraph 1.406 of the FEIS has been amended to reflect this comment.

24. Exhibit 3 of the FEIS has been amended to reflect this comment.

25. Agriculture would be permitted on the landward side of the disposal piles and the equipment would be allowed to use the ends of the piles for a turn-around. Vegetation would be planted on the riverward slopes and between the piles and the channel for erosion control and wildlife habitat.

26. The data on farming trends presented in the DEIS is the most current information presently available to the Corps. Table 10 of the FEIS gives a breakdown of farmland use in Roseau and Kittson Counties.

27. The discussion of socioeconomic impacts of the project relative to these land use changes has been expanded in the FEIS (see section 4.800, especially 4.820).

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA. 19082
(215) 596-1672

8460
October 20, 1975

Alan W. Nash, Colonel
Corps of Engineers
Department of the Army
St. Paul District
1135 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Refer to: NCSED-ER, Draft Environmental Statement, Flood Control, Roseau River, MN

Dear Colonel Nash:

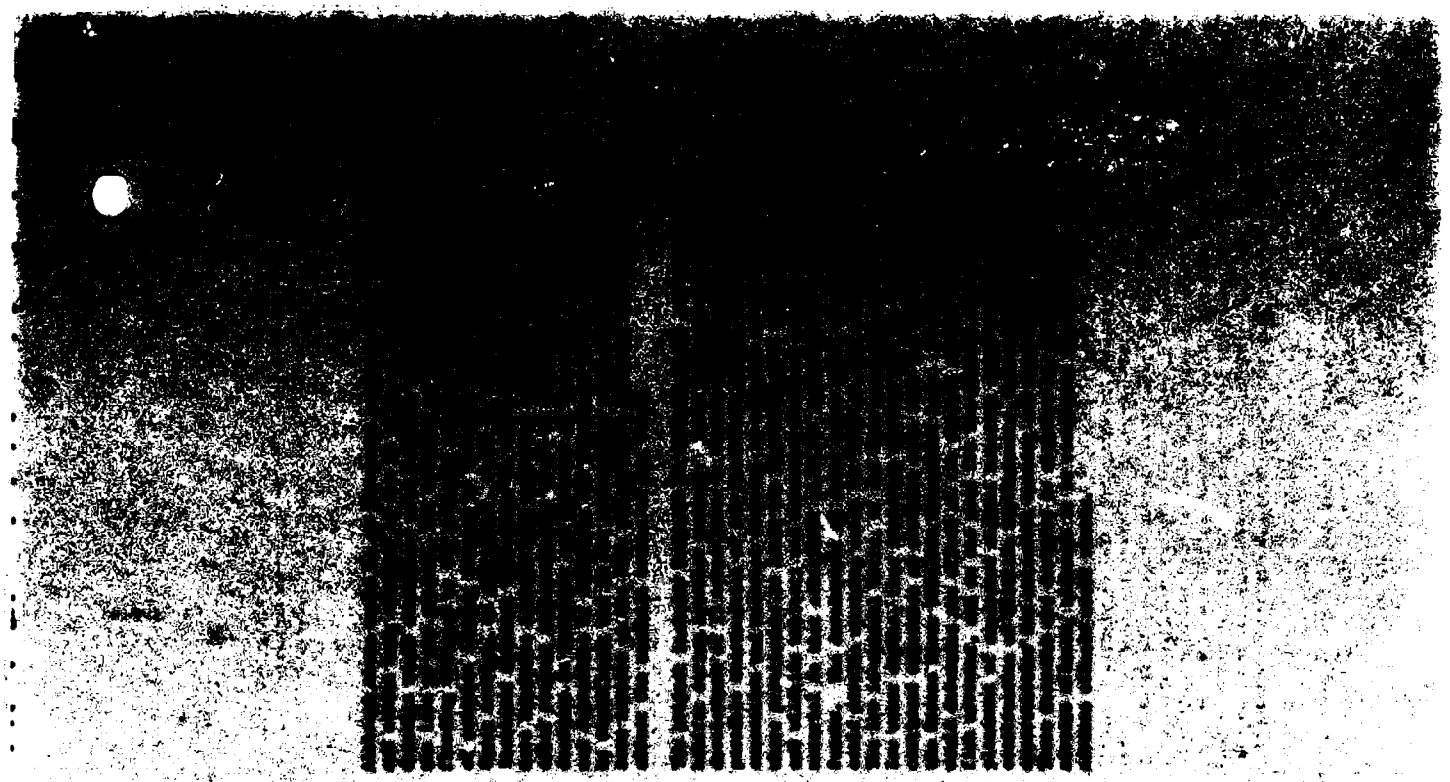
We, and our St. Paul office have reviewed the above statement.

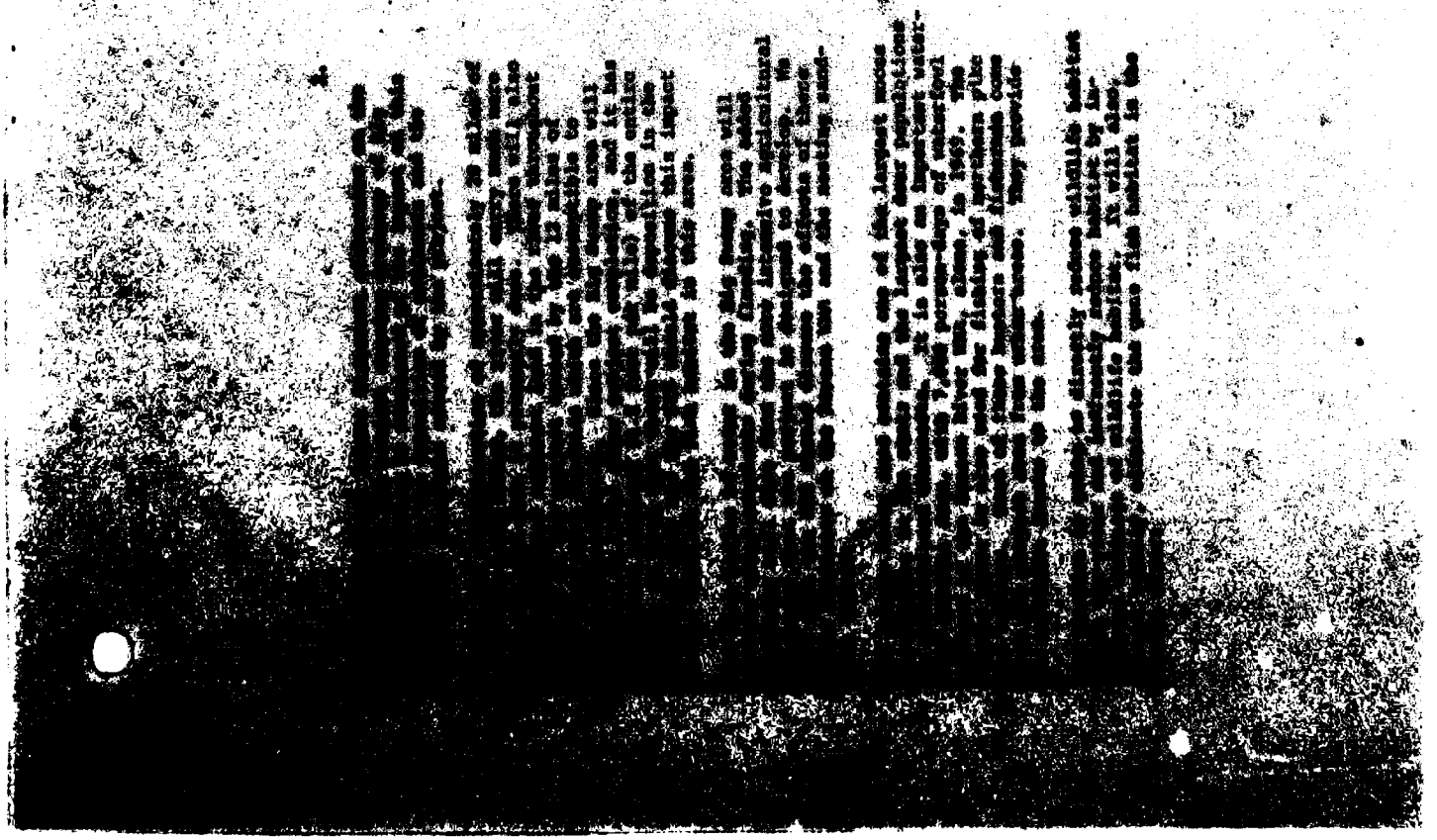
The purpose of the project should be made clear at the beginning of the statement instead of being mentioned only in the cost-benefit analysis. The Introduction and the project description should show what is being proposed, and why. 28

Big Swamp is a unique area in the Roseau River Basin. In addition to supporting a high population of deer, moose, and furbearers it has a breeding population of about 50 pairs of sandhill cranes. These birds are unique and increased drainage of suitable marshes and bogs has not enhanced prospects of their continued survival. Big Swamp also contains the Roseau River Wildlife Management Area (WMA). It was established to furnish food and cover for ducks upland game, muskrats, and mink. It is also used by Minnesota DNR as a northern pike spawning, rearing and winter rescue operation. Between 50,000 and 100,000 northern pike are trapped there annually and transplanted to suitable state waters.

Corps Response to the U.S. Department of Agriculture, Forest Service, [illegible]

28. Section 1 has been expanded in the FEIS to include a discussion of the purpose of the proposed project (see FEIS, page [illegible]). In addition a foreword has been included in the FEIS for further clarification.





[illegible]

[illegible] an annual benefit of [illegible] by completing the project.

[illegible]

1964.

The Corps is [illegible] and U.S. [illegible] effect [illegible] are [illegible] program [illegible] also adding new information [illegible]

The "average annual damage" [illegible] following procedure. Once the [illegible] has been estimated, it [illegible] damage would be done at [illegible] are calculated by [illegible] flood [illegible], that is by [illegible] stage by the corresponding [illegible] values. These values are [illegible] annual damages. [illegible] of economic [illegible] the appropriate [illegible] growth of damages is added to [illegible] average annual equivalent damages over [illegible]

[1] United States. 1964, Report on Survey of [illegible] for Flood Control. Appendix F. U.S. Army [illegible] St. Paul District.

[illegible] states that the last major flood [illegible] caused $162,000 in damage and that the [illegible] flood damages in the area in 2020 are [illegible] 1.7 times those in 1967" (or $281,000). [illegible] this discrepancy?

[illegible] benefit of this project would be to the [illegible], especially crop lands. We feel that the [illegible] are only minimal at most. Crop land in this [illegible] is marginal. The value of farm products sold per [illegible] is only about one third the State average. The [illegible] will not improve yields because of the limita[illegible] of climate and a short growing season. Total [illegible] would increase by placing previously un[illegible] lands into production. This increased [illegible] will not halt the trend toward farm [illegible] or remove the necessity for most area [illegible] to supplement their income with part-time [illegible] employment. It is estimated that by [illegible] only 10% of the remaining farmers in the basin will [illegible] farmers.

[illegible] cost of these minimal benefits is too high. Good [illegible] habitat will be lost. A river that presently [illegible] fish habitat will become much more turbid and [illegible] polluted and destroy its present habitat. There [illegible] possibly be serious damage to a unique and [illegible] wildlife area.

[illegible] with Canadian natural resource managers [illegible] beyond consultation with the International [illegible] Commission because of the introduction of [illegible] into Canadian waters. If possible, Canadian [illegible] Service, Canadian Fisheries and Marine [illegible] of the Department of the Environment, and [illegible]'s Environmental Management Division should [illegible] in the planning and receive review copies [illegible] the Statement.

Thank you for the opportunity to review this report.

Sincerely,

[illegible]
[illegible] Director
Environmental Quality Evaluation

Corps Response to the U.S. Department of [illegible]

32. The 1967 damages are for a [illegible] [illegible] [illegible] applied to the [illegible] average annual [illegible] [illegible] has been [illegible] average annual [illegible] in October 1975 prices was approximately [illegible]

33. Although the cropland in this area is [illegible] would still be realized by agriculture [illegible] flood control project (see 4.031-4.[illegible]). [illegible] (4.033) an estimated $230,200 of total [illegible] would accrue directly to agriculture, and the [illegible] has a benefit-cost ratio of 1.5.

34. The Corps recognizes that the proposed project [illegible] adverse impacts on wildlife habitat and has [illegible] measures to lessen the impacts (see section [illegible] response 33).

35. In recognition that Federal, Provincial, [illegible] governments in Canada and the United States [illegible] involvement and interest in the future [illegible] River basin, a high degree of coordination [illegible] agencies has been maintained throughout [illegible] Representatives from Canada's Department of [illegible] and Manitoba's Provincial natural [illegible] in and reviewed the studies prepared by [illegible] Roseau River Engineering Board for the [illegible] Commission. Copies of the draft EIS have [illegible] International Joint Commission, and it is [illegible] these copies were in turn distributed to [illegible] National, Provincial and local agencies in [illegible] To date, there have been no written comments [illegible] agency.

[illegible] SERVICE
[illegible] MINNESOTA

Agricultural Extension Service
[illegible]

[illegible] statement about the flood control on the [illegible] discussed with Mr. George Kelly of the Tribal Council.

[illegible] the proposed project would have little direct effect [illegible].

[illegible] question about the effect of the water level in [illegible] that would be regulated in the future.

LeRoy A. Stumpf
Acting Extension Agent

[illegible]

Corps Responses to U.S. Department of [illegible]
Extension Service

30. Milligan Lake is located on the [illegible]
upstream of both the proposed [illegible]
Consequently the proposed project would [illegible]
water level in Milligan Lake.

[redacted] TO THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

[redacted] control on our reduction to Red Lake ceded lands and Reservation damage that may result.

(1) We look at the Roseau River flood control project as a very positive way of dealing with many needed future developments and improvements throughout the Roseau River Basin.

(2) We do not see any damages to the lands listed in the above heading or to the environment because of the proposed flood control.

(3) None of the following areas listed would be damaged or affected when speaking of the above lands listed in heading: Grasslands, peatlands, forests, game fish habitat, wildlife, waterfowl, fur-bearing animals, big game animals etc. Really in above named lands there should be no change in wildlife habitat.

(4) Overall the project will greatly enhance agriculture. We look at flood control and water control as a stabilizing factor not only for [redacted] water levels but with eventual positive effects on our environment.

United States Department of the Interior

OFFICE OF THE SECRETARY
NORTH CENTRAL REGION
[illegible] DEARBORN STREET, 32nd FLOOR
CHICAGO, ILLINOIS [illegible]

IN REPLY REFER TO: [illegible] October 28, 1975

Colonel Kim Smith
District Engineer
U. S. Army Engineer District
St. Paul
1135 U.S. Post Office and
Custom House
St. Paul, Minnesota 55101

Dear Colonel Smith:

The Department of the Interior has reviewed the Draft Environmental Statement for Flood Control, Roseau River, Roseau and Kittson Counties, Minnesota, as requested in Major Hintz's transmittal letter of August 28, 1975, to our Assistant Secretary, Program Development and Budget. Our comments relate to areas of our jurisdiction and expertise and have been prepared in accordance with the National Environmental Policy Act of 1969.

ENVIRONMENTAL SETTING WITHOUT THE PROJECT

Historical and Archeological Records

Archeological surveys still incomplete have identified archeological resources which could be disturbed by the project. In order to permit completion of the review process, the survey program should be finished prior to preparation of the final statement and the survey results and the specific comments and recommendations of the principal investigator should be presented. 37

Any expected adverse impacts of the project on archeological resources should be explained. Also, any cultural sites located which may qualify for inclusion on the National Register of Historic Places should be treated in accordance with the procedures for the protection of historic and cultural properties codified in 36 CFR Part 800. 38

Corps Responses to the U.S. Department of the Interior

37. The cultural resources survey of the project area has been completed, and the results are described in the FEIS, paragraphs 2.531 and 4.000.

38. See paragraphs 2.530, 2.531, 4.000, and 9.007 of the FEIS.

[illegible]

[illegible]

[illegible] that hunting and fishing are expected to [illegible] of the project, but this is not specifically stated. [illegible] which are expected to occur should be enumerated. [illegible] of riverside parks within the project area should [illegible] the impacts (if any) stated. The impact of channel modi- [illegible] activities occurring at the Roseau River [illegible] Area should be discussed.

[illegible]

[illegible] wildlife habitat losses we suggest that the feasibility [illegible] further back from the river to accommodate flood flows [illegible] riparian woodlands should be determined.

Sincerely yours,

[illegible]
Acting Special Assistant
to the Secretary

Corps Responses to the U.S. Department of the [illegible]

39. With the loss in wildlife habitat and [illegible] fishery of the Roseau River, hunting and [illegible] to decrease due to project implementation. [illegible] studies will be conducted on the [illegible] features incorporated into the project [illegible] to maintain the fishery [illegible] (Sections 1.723 and 4.580). Efforts would also [illegible] potholes north and south of the river [illegible] Placement of material excavated from the channel [illegible] coordinated to facilitate possible future [illegible] at Roseau Lake and Badger Creek as well as [illegible] a number of oxbow lakes. In recent coordination [illegible] Minnesota DNR, it has been proposed that the [illegible] structural features of a wildlife impoundment [illegible] ameliorate riparian vegetative and wildlife [illegible] Such an impoundment would increase hunting and [illegible] opportunities. The three wildlife [illegible] Roseau River Wildlife Management Area (WMA) [illegible] directly jeopardized by the flood control [illegible] are supplied by the Pine Creek Diversion. [illegible] channels to the WMA would continue to [illegible] existing fish migration routes to the wildlife [illegible] decreased availability of hunting grounds [illegible] River WMA would tend to shift hunting pressure [illegible] itself. Local game officials feel that hunting [illegible] currently very heavy and the WMA cannot support [illegible] pressure.

No riverside parks exist within the project [illegible] currently planned. Section 4.[illegible] of the [illegible] impact of the proposed project on recreational [illegible]

40. To move levees further back from the river [illegible] the construction cost and the cost of [illegible] the project as well as [illegible] additional [illegible] impacts. Such an alternative would be [illegible] nor economically feasible.

[illegible] Department of the Interior

[illegible]

October [illegible], 1975

[illegible]

[illegible] response to Major [illegible]'s August 28, 1975 [illegible] of the Interior comments on the Draft Environ[illegible] Flood Control, Roseau River, Roseau and Kittson [illegible]. We hope these comments will be considered even [illegible] are supplied following your formal review period.

[illegible] that "in the few [illegible] structures are located in [illegible], care would be taken to insure that dredge [illegible] affect the stability of the structures" (p. 35, [illegible] has been given as to the number, location or [illegible] located in potential failure zones. It [illegible] this information in the environmental [illegible] detail on the probable hazard and possible [illegible]. [illegible] specific structure that has been identified [illegible] safety due to the possibility of slumping [illegible] 3.5 miles north of (downstream from) Roseau [illegible]. [illegible] has been made to the General Design [illegible] contains a more detailed analysis of poten[illegible] the bridge. Since the bridge is situated immediately [illegible] from proposed meander cutoff No. 9 (exh. 2), and since this [illegible] area of lacustrine clay banks that have been charac[illegible] instability as "evidenced by numerous slump blocks and [illegible] of bridge approaches and supports" (p. 14, par. 1), it would [illegible] to provide available information relevant to safety of the [illegible] in the environmental statement. For example, a specific plan for [illegible] of the bridge supports appears appropriate for inclusion. In [illegible], Bridge No. 9, which is also within the area of bank instability, [illegible] be discussed.

[illegible]

48. [illegible]

The largest map is at a scale of 1:180,000 (exh. 2), a scale at which
[illegible] proposed meander cutoffs are not in excess of one-tenth inch long.
At that scale, little or nothing can be interpreted as to probable
environmental impacts of the proposed action. The map shows the limits
of 22 plates, evidently included in the General Design Memorandum, which
has not been distributed with the draft environmental statement. In
42 view of the fact that the project will have significant impacts on bank
stability along 12 miles of channel, on the safety of structures, on
[illegible] (p. 30, par. 5.200), and on flooding downstream in Canada , it
might be advisable to append at least the 5 plates covering the critical
[illegible] above mile 125, in which the bulk of new channel cutoffs and bank-
[illegible]bility problems exist.

No indication of approximate volumes of earthwork has been found. It is
evident that volumes would be significant in view of the excavation of
43 over 6 miles of new channel from 48 to 120 feet wide, the widening of
the Roseau River channel between Roseau and the Canadian border, the
construction of 1.9 miles of levee, and the plugging at both ends of as
many as 19 meander cutoffs.

An appropriate section on the surface-water hydrology of the project area
should be included in the discussion of the hydrologic environment (p. 14-
44 16). This is needed to provide an adequate basis for assessing streamflow
characteristics in relation to the chemical, physical, and biological
quality of water (p. 15, par. 2.221).

An appropriate statement should be included regarding mitigating measures
45 to minimize effects of siltation and turbidity resulting from erosion
and excavation of bank and channel slopes (p. 32, par. 4.121-4.124 and
p. 35, par. 4.300).

Sincerely,

Madonna F. McGrath

Madonna F. McGrath
Acting Special Assistant
to the Secretary

Corps Responses to the U.S. Department of the Interior (cont.)

42. Exhibit 2 has been replaced in the FEIS with more detailed plates.

43. The current estimate of channel excavation for the project is 7,152,000 cubic yards.

44. Refer to section 2.220 of the FEIS for information on the surface water hydrology of the project area.

45. Refer to response number 2 for a discussion of mitigative measures for project induced siltation and turbidity.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
18209 DIXIE HIGHWAY
HOMEWOOD, ILLINOIS 60430

September 22, 1975

IN REPLY REFER TO: 05-00.5

Major Herman C. Hintz
Acting District Engineer
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55102

Dear Major Hintz:

As requested, we have reviewed the draft environmental statement for the proposed flood control project on the Roseau River in Roseau and Kittson Counties, Minnesota.

The proposed project includes widening, deepening, and straightening of the Roseau River. Exhibit 2, depicts 9 bridges accross the Roseau River within the project limits. Possible impacts on the bridges are discussed only in one place, Paragraph 4.202 on page 35. It also appears that the
46 proposed "Cutoff No.8" would cross County Road 123, but there is no discussion of its effects or what type of roadway structure will be installed. Throughout the report there is extensive discussion of the probable impact of the proposed project upon bank stability.

In view of the above, and the possibility that adverse effects upon bank
47 stability could also affect highway structures, we do not believe the draft statement offers factual data to permit a reasonable assessment of possible environmental effects upon highways and highway users.

Sincerely yours,

Donald E. Trull
Regional Administrator

BY: W. G. Emrich
W. G. Emrich, Director
Office of Environment and Design

Corps responses to U.S. Department of Transportation

46. Refer to response number 41 for a discussion of the impacts of the proposed project on bridges.

County Road 123 is an unsurfaced road which presently ends about one-half mile north of cutoff No. 8. Since there are no dwellings or other structures served by the portion of the road beyond cutoff No. 8, no bridge over cutoff No. 8 would be constructed.

47. Refer to paragraph 4.813 of the FEIS for a description of possible impacts upon highways and highway uses.

FEDERAL POWER COMMISSION
REGIONAL OFFICE
31st Floor, Federal Building
230 South Dearborn Street
Chicago, Illinois 60604

September 9, 1975

Reference: NCSED-ER

Major Norman C. Hintz
Acting District Engineer
U. S. Army Engineer District, St. Paul
1135 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Major Hintz:

We have reviewed the Draft Environmental Impact Statement for Flood Control, Roseau River, Roseau and Kittson Counties, Minnesota, which you furnished us with your letter of August 28, 1975 for our review and comments.

The project would include modification of the existing Roseau River channel, construction of channel cutoffs, and installation of related works along the river between the city of Roseau and the Canadian border in northwestern Minnesota. The modification would consist primarily of increasing the width of the bottom of the channel limiting the excavation to one bank of the river where possible.

Comments of this office are made in accordance with the National Environmental Act of 1969 and the August 1, 1973 Guidelines of the Council on Environmental Quality. Our principal concern with developments affecting land and water resources is the possible effect of such developments on bulk and electric power facilities including potential hydroelectric developments and on natural gas pipeline facilities.

Since the above noted proposed project apparently would pose no major obstacle to the construction and operation of such facilities, we have no comments on the Draft EIS.

The foregoing statements are of this office and therefore do not necessarily represent the views of the Federal Power Commission itself.

Thank you for the opportunity to comment on the Draft Environmental Statement.

Sincerely yours,

Leonard B. Young
Regional Engineer

Advisory Council
On Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

October 3, 1975

Major Herman C. Hintz
Corps of Engineers
Acting District Engineer
Department of the Army
St. Paul District
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Major Hintz:

This is in response to your request of 28 August 1975 for comments on the environmental statement for Flood Control, Roseau River, Roseau and Kittson Counties, Minnesota. Pursuant to our responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, we have determined that your treatment of cultural
48 resources is not at a level concomitant with a Phase II AE&D study. Change in design would indicate that this study is in Phase I AE&D and that submittal of an environmental statement is premature.

We request that, the final environmental statement, include the
49 results of the cultural resource survey as appropriate for this level of study along with a copy of the comments of the Minnesota State Historic Preservation Officer.

Should you have any questions or desire any additional assistance, please contact Charles Spilker of the Advisory Council Staff at (202) 254-3380.

Sincerely yours,

John D. McDermott
Director, Office of Review and Compliance

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress on the field of Historic Preservation.

Corps Responses to Advisory Council on Historic Preservation.

48. At the time studies on the Roseau River Flood Control Project were initiated, project planning processes were not divided into Phase I and Phase II AE and D studies. The Corps feels that its treatment of cultural resources is at a level concomitant with the planning stage of the flood control project, and that submittal of the environmental statement is not premature since it is easier to incorporate, at an early date, mitigative or alternative measures that might be suggested by reviewers of the DEIS.

49. Additional cultural resources surveying has been completed since preparation of the DEIS, and the FEIS has been expanded to include resultant information (see paragraphs 2.531 and 4.800). Exhibit 33 of the FEIS presents the initial comments received from the Minnesota State Historic Preservation Officer and his letter of comment on the FEIS is presented on page A-47.

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING • ST. PAUL, MINNESOTA • 55155

December 31, 1975

Colonel Max W. Rosh
District Engineer
St. Paul District
Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Re: Clarification of Department of Natural Resources Statement of November 28, 1975, on Roseau River Flood Control Project

Dear Colonel Rosh:

Based on the discussions at our meeting of December 12 and subsequent discussions between our staffs, modifications to our letter of November 28, 1975, have been instituted for the purpose of clarifying the concerns of the Department of Natural Resources.

The attached statement of the Department of Natural Resources contains these revisions discussed. Revised sections are denoted by an asterisk for ready identification.

If we can be of any further assistance, please contact us.

Sincerely,

Robert L. Herbst, Commissioner
Department of Natural Resources

RLH:JMK:sl
cc: Howard Degerness, President
Roseau River Watershed District
Attachment

AN EQUAL OPPORTUNITY EMPLOYER

Corps responses follow. See also our letter dated 9 August 1976, exhibit 35, page A-50.

STATEMENT OF THE DEPARTMENT OF NATURAL RESOURCES

ROSEAU RIVER FLOOD CONTROL PROJECT

December 31, 1975

The Department of Natural Resources (DNR) has reviewed the Draft Environmental Impact Statement (EIS) on the proposed Roseau River Flood Control Project and offers the following comments.

The DNR has been involved with this project for many years and we continue to recognize the serious flooding problems and the need for reducing the losses which residents along the river frequently suffer.

As the draft EIS notes, this project was authorized by Congress in 1965, prior to the passage of the National Environmental Policy Act and other environmental legislation including the Minnesota Environmental Policy Act and other state policies and laws relating to wise utilization of natural resources. Some of the important legislative directives which the Department of Natural Resources is to follow in carrying out its duties and responsibilities are the following:

1) Minn. Statutes (M.S.) 111.02 states that it is the policy of the state to promote the retention and conservation of all water precipitated from the atmosphere in the areas where it falls, while M.S. 105.41 (enacted 1974) states that diversions of water from the state to other states, regions of the U.S. or Canada shall be discouraged.

2) M.S. 105.405 (enacted 1973) states that no permit nor plan for which the Commissioner's (DNR) approval is required or permitted, involving a diversion of any waters of the state, to a place outside of this state shall be granted or approved until after a determination is made that the water remaining in this state will be adequate to meet the state's water resources needs during the specified life of the diversion project. M.S. 105.42 (enacted 1974) further states that a permit shall be granted only when the project conforms to state, regional and local water and related resources management plans, and only when it will involve a minimum encroachment, change, or damage to the environment, particularly the ecology of the water-way. The permits are required to include provisions to compensate for the detrimental aspects of the change in the resources. In addition, this statute states that no permit involving the control of flood waters by structural means shall be granted until the Commissioner has given due consideration to all other flood damage reduction alternatives.

3) In addition, M.S. 116 D. 01 (enacted 1973), the Environmental Policy Act, declares that it is the policy of the state to create and maintain conditions under which man and nature can exist in productive harmony, and that it is the responsibility of the state government to provide for the wise use of our remaining areas of natural habitation, including necessary protective measures where appropriate. The statute also directs state agencies "to identify and develop methods and procedures that will ensure that environmental amenities and values, whether quantified or not, will be given at least equal consideration in decision making along with economic

Encl. Dept. of Nat. Res. B. 3/10/75

and technical considerations" and in addition, requires that state agencies "study, develop and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources."

As the Minnesota agency with responsibilities for protecting natural resources, our primary interest is in assuring that proposals with the potential for significant environmental effects are properly designed to minimize impacts on natural resources, and where such impacts are unavoidable, plans be incorporated into the project to provide adequate mitigation to compensate for the losses. Accordingly, it is appropriate that we review the proposed Roseau River project in the light of the above considerations.

OVERVIEW

Some of DNR's major concerns are discussed below, including important factors which have changed since the original authorization of the project and which we feel justify its reconsideration, as well as factors relating to some of the major impacts of the project (See table 1).

Two of these important factors are the benefit-cost ratio and the annual average flood damage. These changes are:

50 a) Significant decrease in the Benefit-Cost (B/C) ratio.
b) Substantial reduction in the estimate of annual average flood damages.

Table 1

B/C Ratio and Flood Damage

	1962[1]	1975
	Justification to Congress	Draft EIS
Benefit-Cost Ratio	2.6 to 1	1.6 to 1
Annual Average Flood Damage	$483,000	$285,000 (for year 2020)

51 a) The B/C ratio includes "flood control benefits" which assume "increased agricultural productivity and growth in the area."[2] However, paragraph 4.711 of the EIS states that "improved drainage resulting from this project would probably not provide substantial increases in crop yields because of the limitation of climate and short growing season."

[1]Transmittal letter from Secretary of Army to Speaker of the House, August 29, 1975 paragraph 53, pp.4.

[2]Report to the IJC, Appendix E. p. E. 35.

Corps Responses to Minnesota Department of Natural Resources

50. Construction costs have increased primarily due to inflation and to the channel enlargement of the 7-mile reach below the Roseau Dam which was added to the plan in the General Design Memorandum (1971). Plans to dispose of dredged material on one bank also constitute expense additional to original costs. Other additions to costs include earth plugs, cutoff cofferdams and disposal banks in Roseau Lake and Big Swamp areas to alleviate channel effect on fish and wildlife resources. The increases in benefits, based primarily on inflation, has not been as great as the increases in costs, thus the declining benefit-cost ratio. However, if 1975 Minnesota normalized crop prices, furnished recently by the Water Resources Council, were used in the benefit analysis instead of benefits updated primarily for inflation, agricultural benefits would probably be increased and the benefit-cost ratio for the project would probably be higher. (Note that the $285,000 figure given as the average annual flood damages was erroneously derived. See response 32 for explanation of the error. The total average annual equivalent damages over the life of the project in October 1975 prices would be approximately $1.2 million.)

51. Although climate would remain as a limitation to agricultural practices, the improved drainage of agricultural land would enhance production. Excess water on agricultural land causes substantial losses to the production of food. Agricultural losses from inadequate drainage are the result of temporary ponding and high water table and occur as direct damages limit productivity. Removal of excess moisture allows earlier planting and full utilization of the available growing season. An estimated $330,200 of total average annual benefits would accrue directly to agriculture. See paragraphs 4.831 - 4.833 of the FEIS.

page 3
Roseau River

The only other methods of increasing production are to bring more land under cultivation by the construction of new drainage systems, or by improving drainage systems on presently drained lands, both of which would require additional expenditures which are not included in present project costs. The final EIS should discuss how the agricultural flood benefits were calculated.

52

B) This plan provides for increased flow capacities to accommodate drainage from approximately 80,000 acres of land in the Sprague and Pine Creek basins both in the United States and Canada (3.008-3.010). What percent of this 80,000 acres is in Canada; the United States; and what portion of the United States ownership is public versus private land?

53

C) The IJC Report[1] states that the benefits of the proposed SCS project (estimated at 3,340,000 annually in the EIS) are based on "completely flood-free conditions" (Appendix E, p. E-35). It appears that flood-free conditions are going to be far from the actual condition, however, since protection is going to be afforded for only 10-year frequency floods from Big Swamp to Roseau Lake, 10 to 50 year frequency floods from Roseau Lake to Roseau Dam, and 30 to 50 year frequency floods from the dam to the upstream limit of Roseau (paragraph 4.112).

54

D) Although the increase in flow due to additional drainage has been planned for in the project, if this increase has been grossly underestimated, the peak flows may readily exceed design specifications of the Roseau River Project (University of North Dakota Environment Assessment, Roseau River Project (University of North Dakota Environment Assessment, page 118). This concern was also expressed by the IJC Board (IJC, Main Report, pages 43-44) and we quote: "The Board has identified concerns regarding the possibility of expanding land drainage works in either country beyond those anticipated and identified in the coordinated plans. Should such drainage works be installed, peak flood flows in the Roseau River in both countries could be increased beyond that which could be accommodated by the elements of the coordinated plan. The resulting flood damages in either country could partially or even totally negate the efforts of the coordinated plan to provide flow capacity for the predicted increase in flood peaks that would result from projects in the proposed uncoordinated plan."

55

Corps Responses to Minnesota Department of Natural Resources (cont.)

52. The average annual agricultural flood control benefits were obtained by determining the difference in the average annual flood damages between present and proposed conditions. A general description of the methodology for determining agricultural flood damages is given in response 32. The average annual agricultural benefits presented in the EIS are from damage reduction on existing agricultural lands in the Roseau River floodplain.

53. The additional channel capacity provided in the Corps project downstream of Pine and Sprague Creeks is for drainage that could occur in the Canadian portions of these two streams. There is no provision in the project for developmental drainage in the United States. In Appendices C and E: Canada, of the IJC Report, it is anticipated that 30,000 acres of additional land in the Canadian portion of the Pine Creek basin and 50,000 acres of land in the Canadian portion of the Sprague Creek basin could be drained in the future. The FEIS has been amended to clarify this point (see paragraph 3.002).

54. The figure for estimated average annual agricultural benefits of the drainage program proposed by the SCS was based upon the assumption that the agricultural land would have a 15-year frequency storm protection from the major drainage channel, as was indicated in the DEIS, page A-32. (See also IJC Report, Appendix E, United States, page E-62).

55. If anticipated increases in drainage have indeed been grossly underestimated, peak flows could eventually exceed design capacity. However, the Corps feels that the proposed project has been properly evaluated and designed to the highest engineering standards, and that the concerns expressed by the IJC Board are overstated. It should be noted that with-project flood stages would be lower than without the project whether or not future discharges were greater than anticipated.

In addition to the increased channel capacity discussed in response 53, overflow conditions to the Two Rivers basin which now exist within Big Swamp would remain the same. Whether improved agricultural drainage would result in an increase or a decrease in the magnitude of a main channel flood would depend to a large degree on the timing of local runoff and the main channel flood in a given year. While Federal and State policies do not support unrestricted drainage projects, they have no authority to regulate drainage of private lands, and improvements to the established system of public and private ditches continue to be sponsored at the local level.

(2) The increased drainage potential is undoubtedly the most significant and potentially detrimental aspect of the total project. The [illegible] drainage project of the scope proposed by the SCS would create [illegible] adverse environmental effects. We recognize that the House amendment to the Agriculture Appropriation Act and Public Law 87-732 may limit development of the companion SCS project which would have cost an estimated $25,000,000 and provided new drainage to an estimated 285,000 acres of land. However, the impacts which would be attributed to the [illegible] SCS proposal must be addressed, fully evaluated, and mitigated, [illegible] the manner that the Corps project as presently proposed is designed for accommodate comb drainage, at least in-so-far as increased channel capacity is included in the proposed design. More importantly, as this project was developed to provide the major outlet for the proposed drainage facilities (3.004), total deletion of the SCS project does not eliminate the opportunity for private drainage proposals developed without

[2]Transmittal Letter to Congress, P. 63.

Corps Responses to Minnesota Department of Natural Resources (...nt.)

56. It is agreed that the drainage issue is of extreme importance. The Corps feels, however, that much confusion exists regarding the SCS drainage proposal, and discussion of that proposal has been expanded in the FEIS (paragraph 1.307 - 1.309).

The original SCS proposal prepared in 1956 identified a planning area of 295,232 acres. A supplement to this report (January 1957) identified a project area of 201,750 acres which excluded State and federally-owned lands and school and indemnity school lands. Of this 201,750 acres, the SCS identified these potential land use changes:

	Before	After	Anticipated Change
Cropland	103,830 acres	155,633 acres	(+51,803 acres)
Pasture	12,959	0	(-12,959)
Woodland	2,259	1,914	(-345)
Idle	56,347	16,799	(-39,548)
Other	26,355	27,374	(+ 1,019)

The original SCS proposal prepared in 1956 identified a planning area of 295,232 acres. A supplement to this report (January 1957) identified a project area of 201,750 acres which excluded State and federally-owned lands and school and indemnity school lands. Of this 201,750 acres, the SCS identified these potential land use changes:

	Before	After	Anticipated Change
Cropland	103,830 acres	155,663 acres	(+51,833) acres
Pasture	12,939	0	(-12,939)
Woodland	2,259	1,914	(-345)
Idle	56,347	16,799	(-39,548)
Other	26,355	27,374	(+ 1,019)

A total of 52,852 acres of potential land use change was anticipated. The SCS, however, estimated that only 90 percent of the project (and impacts) would be accomplished, and this over a 15-year period.

The SCS calculated agricultural benefits for the drainage project after assuming that major necessary drainage improvements would be made, i.e. "the Roseau River channel will be improved to provide an adequate outlet for local drainage." At no point in the SCS report are the necessary requirements for the Roseau River discussed. However, from the SCS discussion of the drainage problems in the area, it is evident that not only would the Roseau River need to be modified to reduce the extent and duration of flooding, but it would have to be deepened to insure the adequate functioning of the proposed ditch system.

the use of Federal funds. It has been the experience of the DNR that projects which are designed with built-in opportunities for drainage will result in the development of additional drainage projects.

57 (1) The draft EIS states that agriculture in much of the basin is marginal at best, and the best lands are already cultivated. Additional lands which might be drained and cultivated in many cases may be poorer than those now cultivated, and success may be questionable. Also, the draft EIS states that additional drainage would not likely improve productivity on presently cultivated lands (EIS paragraph 4.713). The University of North Dakota assessment noted that the ditching may, in fact, make the soils too dry to farm in dry years. In light of the experience of past drainage programs in the region which resulted in failure over wide areas, the wisdom of the proposed drainage project is questionable, especially considering the environmental costs and the limited flood protection which will be provided by the Corps project (10 to 50 year floods).

Corps Responses to Minnesota Department of Natural Resources (cont.)

The Corps of Engineers, in designing the Roseau River project, has not modified the project to provide for any additional drainage except that identified by the Soundings in the Norman and Pine Creek Watershed (see responses 10). The channel is being deepened only slightly and side ditch inlet structures were designed based on the first culvert size landward from the main

56. channel and not on potential drainage contributions.

It is true that once overbank flooding occurs, drainage of flooded lands would occur more rapidly with the proposed project. However, under non-flood (low-flow) conditions, the efficiency of the main channel as a drainage outlet would be increased only by the minor amount of deepening that would occur. Lands that have been cultivated in the past when not flooded would probably be fallow less often and wildlife values would probably be decreased on these lands; some lands adjacent to the river that were not previously cultivated could now be subject to drainage due to the minor deepening of the channel, and wildlife losses could occur on these lands. (See FEIS, paragraph 4.105).

Most of the drainage ditches proposed by the SCS in 1956-67 have already been built without construction of the channel modification project proposed by the Corps. Because implementation of the proposed channel modifications would not provide the deepened outlet necessary for adequate functioning of the proposed ditch system, the land use changes on the 52,852 acres identified in the 1957 SCS report would probably be much less than anticipated. Because the Corps proposed project would not result in the conditions necessary for implementation of the original SCS plan, the Corps does not feel that it should be responsible for mitigation of drainage that has already occurred or that would occur in the future as part of that plan.

57. Although the cropland in the area is marginal, improved drainage of agricultural land would increase production (see responses 10 and 51). Lands that were previously uncultivated may or may not be suitable for cultivation with the proposed project, depending to a large extent on their proximity to the main channel which would provide improved drainage for a limited distance from the river.

Because the areas downstream from Roseau are discharge and not recharge areas for groundwater (FEIS, paragraphs 2.211 and 2.212) it is unlikely that reduced flooding in these areas would affect the groundwater level to a significant extent. It is possible, however, that a slight lowering of the groundwater table could result.

The Corps agrees that the SCS proposal is questionable as to the predicted effects as discussed in the 1956 and 1957 reports. However, the proposed Corps project is a flood control project and would not be developed for the purpose of increasing drainage in the basin except during periods of overbank flooding.

The U.S. Fish and Wildlife Service evaluated the effects of a smaller (141,000 acre) drainage program in the basin in 1958[1] and estimated that if only 60 percent of the drainage were completed, the value of the lands for wildlife would be reduced by 50 to 80 percent and that 70,000 to 113,000 acres of wildlife habitat would be lost.

As the draft EIS correctly predicts, it is the increased opportunities for drainage projects which will create the most significant adverse effects on natural resources. It would be needlessly destructive if substantial losses of lands best suited as wildlife habitat were permitted to occur in order to allow for anticipated agricultural benefits which may prove non-existent, and which are presently unsubstantiated.

Therefore, it is appropriate that the lands comprising the 285,000 acres which potentially may be drained be evaluated for their present values as natural habitat, and for their potential as productive agricultural lands. We recommend that this study be designed and undertaken by the Corps with the assistance of the appropriate federal and state agencies and that the results of the study be utilized as justification for the development of mitigation measures which may be required.

6) It should be noted that the Department of Natural Resources has not previously approved the design changes which have the purpose of accommodating increased flows resulting from additional agricultural drainage. Modifications to the 1971 Design Memorandum to increase channel capacity to accommodate additional agricultural drainage were not received by the DNR until September of this year. As of this date, the DNR has not responded to the Design Memorandum changes. On April 24, 1975 a letter from Peter Fletcher requesting review comments on the IJC Report Appendices was directed to Gene Gere as a member of the International Roseau River Engineering Board (IRRED). At that time, Mr. Gere was also Director of the Division of Waters, and Morris Eng of his staff was requested to review these documents on his behalf. It should be noted that the appendices contain only superficial references to incorporation of design changes to increase channel capacity for accommodation of additional agricultural drainage, and that the June 25, 1975 response of Mr. Eng on behalf of Mr. Gere as a member of the IRRED should not be considered a DNR response regarding the increased channel capacity of the proposed project.

[1]Transmittal letter to Congress, p. 63.

The following comments refer to specific sections of the Draft EIS and are therefore restricted to discussion of the proposed action and the direct impacts of the proposal. These issues should be addressed in the final EIS together with the secondary impacts referred to in the foregoing sections.

Introduction to EIS

1) It is unclear (1.301) whether excavated material will be disposed of within the flood plain and if so, what the effect will be on floodwater stages.

Corps Responses to Minnesota Department of Natural Resources (cont.)

58. The U.S. FWS evaluation was based on the 1967 Supplement to the SCS report and was not a different project (see response 36). The U.S. FWS assumed that approximately 70 percent of the project area (141,200 acres) provided suitable wildlife habitat. However, land use classifications identified by the U.S. FWS differed substantially from those identified by the SCS.

According to the SCS report, about 51,000 acres of land could have been subjected to a land use change because of the FWS drainage project (based on conditions existing at that time). (See table 3.) However, about 69 percent of this change would have occurred in the area downstream from Roseau to Big Swamp (Zone III of SCS report). The U.S. FWS report identified this zone as "containing some of the better agricultural land" and as being more intensively cultivated, and as a result it "does not supply quite the type of high quality wildlife habitat provided by lands lying further from the river." They felt that "completion of the Corps program would result in some loss of wildlife habitat in the affected area. However, the losses . . . would be much less than those realized if the entire major outlet and local drainage program were carried out." However, it is recognized that current mitigation studies in the basin are probably revealing impacts not anticipated when the U.S. FWS report was written.

59. A large amount of the drainage proposed by the SCS in their 1966 report has already occurred in the watershed (see exhibit 4). There can be no guarantee that attempts at local on-farm drainage would not continue to occur, especially since the State has very little control over this aspect of land use. However, because the Corps proposed project would result in only a slightly deeper outlet, it is unlikely that the potential for additional drainage would increase significantly or that the land use changes identified by the SCS would occur as a result of flood control project implementation. To the extent that the reduction in the frequency and duration of flooding would make lands suitable for agriculture, losses of wildlife habitat could be anticipated. However, the Corps feels that wildlife habitat lost as a direct result of the proposed project, or indirectly through increased drainage would not be large. It was agreed at a recent interagency coordination meeting that land use changes and induced private drainage would not be studied.

60. Excavated material would be disposed of within the floodplain. The 100-year discharge would pass through the project area with no increase in stage over pre-project conditions. Channel modifications would more than offset the constricting effect of placing the disposal banks within the 100-year floodplain.

[illegible] designed project would include measures to insure banks [illegible] of flatter slopes. Spoil sites and altered river [illegible] properly designed project would be seeded to grasses, legumes, [illegible] to minimize erosion and slumping and to hasten revegetation [illegible] would provide food and cover for wildlife.

[illegible]
[illegible] River

<u>Environmental Impacts</u>

67 4) The entire section (4.120 to 4.130) notes the serious problems to be encountered with slumping and erosion of river banks. This is more than adequate justification for requiring adequate sloping and revegetation of [illegible] channel slopes, which would also result in reduction of [illegible]. These measures will also increase biological activity and [illegible] recovery of biological systems in the project area.

<u>Low Flow Conditions</u>

68 5) This section (4.141) notes that earlier removal of stored water coupled with the drop in river stage below that which presently exists, would advance the withdrawal of water from groundwater supplies but that this advancement is not likely to be very pronounced. The North Dakota Environmental Assessment predicts that in areas of peat soils the effect on the water table could be significant enough to cause an increase in the incidence of peat fires as well as making the peat lands more valuable from an agricultural and mining standpoint. In view of the uncertainty regarding these effects, there should be a better evaluation and discussion of surface water-groundwater relationships.

<u>Engineering Aspects</u>

69 6) This section (4.300) notes that from station 2018 eastward, initial observations have shown the bank stability to be rather poor. As such, the proposed removal of vegetation could cause additional problems from station 2018 to the city of Roseau and a more thorough identification and discussion of the problem and expected impacts are warranted. In addition, items such as precautionary measures to be taken, alternatives to the project proposal, and mitigative measures to be implemented in this reach should be noted. The North Dakota researchers noted, and we quote: "In reaches 84 through 87 the Corps of Engineers (1971) study indicated that no problems were likely with the randomly occurring lake clay, sand and lake-washed till. However, no boring and no testing was done on reach 86, which begins at approximately the location of Bridge 88 (station 1965 for Bridge 88, station 1971 for reach 84). This may be a serious omission, for the area appears to show considerable bank instability. Because of this observed bank instability, the spoil pile specifications for reaches 84 though 87 also seem questionable." Station 2018 is included in these reaches.

Corps Responses to Minnesota Department of Natural Resources (cont.)

65. The Corps considers the elements of the proposed project to be conservatively designed. The proposed Roseau River project has been designed using more conservative criteria than were used for existing projects in the Red River Valley (see response 61). Although a few failures have occurred on these existing projects, we do not consider them sufficiently serious to make design criteria more conservative. No large cost overruns have been experienced because of measures required to repair the failures and correct the causal conditions. Prevention of all failures would require additional land and construction procedures which would not only increase the cost of the project, but would cause unnecessary adverse environmental and social impacts.

66. See response 20.

67. See responses 61, 64, 65 and 20.

68. Sections 2.210 and 2.220 of the FEIS have been expanded to provide a more detailed description of surface-groundwater relationships, and section 4.300 discusses the possible impacts in more detail.

69. The types of stability problems which would occur in the reach from mile 131.7 upstream to the city of Roseau are described in paragraph 4.212. This reach would be subject mostly to local erosion problems rather than severe mass slumping. The severity of these problems would decrease with time. Based on available borings, it is not likely that there would be any major problems upstream of mile 131.7. No borings were taken between mile 130.8 and mile 131.7; however, borings available at mile 132.3 indicate that the character of the foundation material improves considerably upstream of mile 130.8. The design for between mile 130.8 and 131.7, however, was conservatively assumed to be similar to that for the poor foundation profile between mile 129.5 and mile 130.8. This design is adequate to prevent widespread slumping of the riverbank and disposal piles.

7) Paragraph 4.302 notes that the bank stability analysis presented in the Design Memorandum for the project indicated that safety factors against slumping in the area around Bridge 88, 5½ miles north of Roseau, were less than normally accepted for earthen slopes and embankments and that some slumping would occur between station 1650 (reach #2) and the upstream reach of the project. The prime factors involved are slumping and the proximity of the dredge disposal piles to the top of the channel banks. The document goes on to state that present project design requires dredge disposal to be located 50 to 100 foot landward, since to increase safety factors above minimum values would result in both increased construction costs and increased right-of-way requirements for the project.

70

It is unclear from the project description and explanation whether the present project design is adequate from a safety standpoint. For example, the North Dakota researchers noted, and we quote: "The factor of safety of 1.1 is questionably low for the conditions experienced in

previous construction projects (bridges and channel modifications) in reaches #2 through #6. . ."

"A factor of safety of 1.1 for the general design of the channel in reaches #2 through #6 will precipitate localized bank slumping or upwelling of channel bed material. Such mass movements will decrease channel efficiency, increase erosion and the resulting sediment load of the stream, locally change channel flow characteristics through scour and fill, and possibly affect the drainage characteristics of the surrounding land. Each incident of slumping or upwelling will require costly maintenance. Although more costly initially, a higher design factor of safety will reduce the impact of potential instability in these reaches. When the theoretical bases for factor of safety calculations are compared with the natural conditions existing in the river area, a factor of safety of 1.1 does not allow for much error."

70

This entire section should be clarified and justification provided for the degree of safety selected.

Impacts on Water Quality

8) This section (4.300) notes that until the new banks become stabilized by vegetation, there would continue to be greater movement of sediment into the channel for a period of 3 to 5 years following construction which may necessitate more extensive treatment of water in downstream areas where it is used for domestic consumption.

71

A properly designed project would not rely upon natural revegetation to occur, but rather restoration of vegetative cover by planting and seeding would be an integral part of project planning process. This may be less costly than to provide extensive treatment of water downstream where it is used for domestic consumption. This would also result in lesser impacts on the aquatic ecosystem from increased turbidity and temperatures. We note this impact may be particularly significant to Canada where more of the river water is used for consumption than in the United States.

Impacts on Aquatic Systems

9) Paragraph 4.404 notes that the nutrient additions to the river would probably be reduced. This may be erroneous depending on the character and origin of the sediments. Nutrients are often increased in waters receiving an increased sediment load, and thus increased nutrient concentrations and accelerated eutrophication might be expected.

72

Corps Responses to Minnesota Department of Natural Resources (cont.)

70. The selection of an acceptable factor of safety for an earthwork design involves consideration of many factors, both technical and nontechnical. Major factors used in the selection of the required magnitude of safety precautions are 1) the consequence of a failure, 2) the economic and environmental cost which would be incurred to increase the factor of safety, and 3) the amount of experience the designer has had with similar projects which had similar foundation conditions.

In the case of the Roseau project, a failure would result in a slumping riverbank, the limits of which would not extend beyond the project right-of-way. No structures would be involved and there would be no chance for loss of life. Such a failure may involve maintenance costs to reshape the slide area, but no major expenditure of money. To increase the factor of safety on the Roseau project would involve both obtaining additional right-of-way and large additional construction costs. Clearing the additional lands adjacent to the channel would increase the impacts of the project both upon the agricultural and the wildlife communities. A review of past projects in the Red River Valley indicates that while local failures were encountered, the severity and frequency of such failures were quite low (see response 61). Based upon the above considerations, a factor of safety of 1.10 seemed appropriate for the Roseau project. It should be noted that this factor of safety is only 15 to 25 percent lower than the factor of safety normally required for large earth dams.

71. See response 20.

72. Nutrients originating from suspended material may be increased during construction. However, following stabilization of the modified channel, nutrient additions should be reduced because of reduced flooding frequencies which would result in reduced surface erosion.

[illegible] Paragraph 2.429 notes that the Roseau River supports desirable [illegible] and supplies northern pike used to stock other waters. [illegible] In September, 1979, a survey crew from the Department of [illegible] the river. A sophisticated electro-fisher [illegible] clear, low water conditions and good weather. The electro-[illegible] revealed that the river has an even more significant

Page 8
Roseau River

73 fishery than was originally thought. All of the river, from Malung [illegible] from Roseau) to the Canadian Border, contains walleyes, sauger, northern pike, and rock bass in addition to minnows and rough fish. Though numbers and species of game fish may be currently under-utilized, game fish populations are equal to, or better than, those of other well-known warmwater streams in the state. Implementation of the project as presently proposed would have severe adverse effects on this fishery resource.

74 For example, the loss of instream cover will result in a decrease in the total numbers of aquatic organisms through a lack of attachment places and through scouring action. Instream cover presently provides resting and hiding places as well as feeding sites for fish species throughout the year. This cover is especially important to fish species for its value as protective cover during flooding and times of high water levels. The obstructive nature of instream cover to water also causes scouring to occur, creating deeper water in the vicinity of the obstruction. This increase in depth is especially important during periods of low flow such as during the winter months when fish species are already under great stress.

In addition, the effects from the loss of stream bank cover, channel straightening and widening, and loss of instream cover will result in high water temperatures during the day and lower water temperatures during the night. Such temperature effects could adversely affect the hatching of fish spawn and the development of aquatic organisms leading to a decline in the river fishery.

Impacts on Terrestrial Vegetation

75 11) Paragraph 4.303 notes that an indirect impact of the project could be the drainage of wetlands such as the tamarack peat lands north of Sprague Creek and the wet fens of the Big Swamp area. The importance and uniqueness of these areas is mentioned. The North Dakota researchers predicted that incidences of peat fires will increase as the bogs dry up. Specific actions and plans to protect these areas from possible drainage, however, are lac[illegible] and should be presented and discussed.

Impact on Big Swamp

76 12) Paragraph 4.631 notes that future ditch development is not likely to be extensive in the area, and because of the channel design, drainage would not affect a significant amount of the Big Swamp.

This statement is in direct conflict with the findings of the North Dakota researchers and we quote: "A most significant effect of the project will be the further drainage of perhaps up to 30,000 acres of the Big Swamp Area, southeast of the Roseau River Wildlife Management Area."

This impact and mitigative measures should be addressed in the Final EIS.

Corps Responses to Minnesota Department of Natural Resources (cont.)

73. Results of the September 1979 fish survey have been included in the FEIS (paragraph 2.425 and exhibits 16-19). The Corps agrees that the proposed project would have an adverse impact on the stream fish population through a reduction in habitat and food sources and because of increased turbidity during and following construction (see section 4.500). For these reasons the Corps is planning to initiate a fisheries study to identify the existing fish resources, assess losses that could result from the proposed project, and to indicate the amount and type of mitigation (instream structures, substrate changes, etc.) required to restore the fish resources of the affected stream reaches to their pre-project levels insofar as possible. (See paragraph 1.723).

74. Regarding loss of overbank cover, the proposed project has been modified to include only one-bank excavation for 80 percent of the affected river reach (see FEIS, 1.404). The effects of reduced riparian vegetation on water temperature were considered in determining which bank should be excavated. The adverse impacts associated with dredging and bank removal are discussed in section 4.500.

75. The proposed channel modifications would have very little effect on Big Swamp (see responses 13 and 55 and FEIS, table 13). The tamarack communities lie in the northeastern area of the watershed. This area is already serviced by an extensive system of drains (exhibit 4) and little additional drainage would probably occur in this area.

76. See responses 55 and 56 and section 4.105 of the FEIS.

Social and Cultural Impacts

17) Paragraph 6.710 states that an increase in land for cultivation purposes is seen by area residents as significant and that such an increase would probably be regarded as beneficial by the entire watershed population.

77 Though the increase in land for cultivation is seen by area residents as significant and beneficial, the North Dakota study also noted, and we quote: "The effects of the channelization, particularly the long-range ones, would apparently be considered detrimental by most area residents."

Economic Impacts

18) This section (6.800) notes that the interest rate for determining average annual costs is 3¼ percent. Even though we realize this interest rate is based on Water Resource Council Regulations, it is an unrealistically low interest and discount rate which understates the
78 interest costs to be incurred during construction, and, when employed as a discount rate, it has overstated the present value of the project's future benefits.

19) The greatest omission in this section is the lack of any attempt to quantify environmental costs. As a result, environmental costs were omitted in calculating the benefit/cost ratio for the project. Also it
79 is noted that the Corps has entered into negotiations with Canada to determine the costs of remedial work in Canada. However, the benefit/cost ratio was calculated utilizing a figure of $3.1 million for work in Canada, even though negotiations are continuing. How this estimate was calculated should be noted and explained.

Corps Responses to Minnesota Department of Natural Resources (cont.)

77. Area residents apparently indicated that the economic benefits of the proposed project were greater than potential adverse environmental effects. A general feeling of local people noted by the North Dakota study was that " 'poor land' should not be drained for farming but 'good land', like that along the river, should be under cultivation."

78. The Corps agrees that the 3 1/4-percent interest rate is unrealistic; however Water Resources Council regulations require that the rate remain the same as that in effect at the time local assurances of cooperation are received. The choice of interest rate for the design and evaluation of public projects is a difficult economic problem. Choice of a rate involves fundamental social value judgments about benefits accruing to different generations and about overall objectives. One economist has estimated that a hypothetical interest rate of 3 percent with a benefit-cost ratio of 1.3 would produce an average rate of return on Federal projects of about 6 percent. The proposed project was evaluated in 1975 at 6 1/2-percent interest rate and was still feasible at that rate with a B/C ratio of 1.1

79. See response 31 for quantification of environmental costs. In Canada, mitigation works were designed on the basis of enlarging the Roseau River channel in Manitoba to accommodate any increase in flow at the same level as would have occurred had the proposed works in Minnesota not been constructed. Under this principle, Canadian works would include: rehabilitation of the Gardenton Floodway to its original 5,300-cfs capacity, channel enlargement and extension of existing bridges in the reach between Gardenton and Stuartburn to accommodate a 1,190-cfs increase in channel capacity, and construction of a diversion channel having a capacity of 1,190 cfs from the Roseau River to the Red River northwest of Dominion City. In addition, the Dominion City water treatment plant would require modifications to remove the additional sediment load that would occur during and immediately following channel enlargement in Minnesota. In other reaches of the river in Manitoba, higher discharges would not cause significantly increased flood damages, but would result in adverse effects related to increased rates of erosion. Measures to mitigate these effects have not been included. Neither has provision been made in the plan to alleviate adverse impacts on flood flows and on the environment resulting from implementation of the protective works themselves. Such impacts include the damage to fish and wildlife habitat and to aquatic vegetation in the enlarged channel, the increased cost of future bridge construction across the widened channel, the loss of productivity from agricultural lands required for the channel enlargement and diversion projects, and the inconvenience to residents of relocating or removing structures during the process of channel enlargement in Manitoba. These effects cannot be quantified with sufficient accuracy to provide a reliable basis for estimating the cost of mitigating works. Therefore, they have not been included in these costs.

Impacts on Canada

16) This section (4.900) notes that little effect on wildlife or wildlife habitat would result in Canada from channel modifications works in Minnesota. This statement has not been substantiated, however, since increased turbidity and nutrient loads will be experienced in Canada from channel modification works in the United States. Changes in the ecosystem downstream from the project will continue for a prolonged period of time if the project is implemented.

Alternatives to the Proposed Action

17) In Alternative 3 (6.210) it is stated that wildlife interests are generally opposed to development of a flood control reservoir at this
81 *site (Roseau Lake). This opinion depends upon proper interpretation. We would not favor structures wholly directed to flood control; we would favor wildlife impoundments and multi-purpose proposals.*

[1]*Environmental Impact Assessment of the Roseau River, Minnesota, Flood Control Project Research Report No. 6, Institute for Ecological Studies, University of North Dakota.*

The alternative notes that the geographical location of a reservoir within the Roseau Lake area is favorable since it lies at the focus of the tributary fan formed by the upper Roseau River, Sprague Creek and
82 *Pine Creek basins. A benefit/cost ratio for this alternative should be presented and the project weighed on its merits and all of its costs.*

Corps Responses to Minnesota Department of Natural Resources (cont.)

The table below indicates the cost of each of the protective works in Canada, the total of which is approximately $3.1 million. The Corps has included provision for this compensation in its estimated overall project costs.

Manitoba Protective Works and Costs (January 1975)

Project	Cost (Canadian dollars)
Gardenton Floodway rehabilitation	$ 307,000
Channel enlargement	2,063,000
Extension of bridges	300,000
Roseau-Red River diversion	405,000
Dominion City water treatment	10,000
	$3,085,000

*Costs include capital construction costs plus engineering, design, supervision and administration costs

Costs were estimated on the basis of January 1975 unit cost data. When a mutually agreed upon date for transfer of funds is reached by the U.S. and Canada, unit cost data reflecting construction costs at that time would be used to update the costs of mitigation measures.

80. Paragraph 4.904 of the FEIS has been amended and discusses only terrestrial, not aquatic, habitat. Potential impacts of the proposed project on Canadian aquatic resources are discussed in paragraph 4.903. Appendix F of the IJC report indicates little effect on terrestrial wildlife in Canada as a direct result of the project. However, drainage of areas in Pine and Sprague Creeks could result in wildlife losses that could be construed as secondary effects of the proposed project.

81. The multipurpose reservoir, i.e. for flood control and wildlife habitat, evaluated for Roseau Lake, could provide little storage for wildlife management because of the limited total storage at the site, most of which would be needed for flood control. This alternative lacks both social and economic acceptability (see response 82).

82. Local opposition toward development of Roseau Lake for floodwater storage is strong. The area in and surrounding Roseau Lake contains excellent soils, well suited for cultivation under flood-free conditions. Also because of its limited size and under optimal project sizing, most of the capacity of a reservoir in Roseau Lake would have to be reserved for flood control purposes with little storage for conservation. Dual-use storage with a winter drawdown would reduce this problem, but would cause others. It is our understanding that wildlife interests would find a reservoir at the Roseau Lake site generally acceptable. However, due to the local opposition, further consideration of this project does not seem warranted, and no benefit-cost ratio was determined.

10) Alternative #6, (6.241). Reservoir storage in Big Swamp and channel modifications upstream from Big Swamp are stated as providing the upstream flood protection afforded by the authorized project, reducing the need for authorized downstream channel works, reducing flooding downstream from Big Swamp, resulting in less Canadian mitigation, and increasing fish and wildlife benefits in the Big Swamp area. Yet no benefit/cost ratio is provided for this alternative although this section notes that this alternative was lower in economic feasibility than the recommended project and therefore received no further consideration. The final EIS should include the benefit/cost ratio for this alternative.

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19) Another possible alternative which we feel should be considered in the EIS is the construction of a separate floodway running generally parallel to the existing river channel. Such a concept is being utilized by the Tennessee Valley Authority on the Bear Creek Project in Alabama and Mississippi and is proposed as a part of the Hastings Local Flood Control Project. This concept would consist basically of a shallow grassed floodway at a higher elevation than the river and at some distance away from it. In certain reaches where it may be necessary for the floodway to follow the river, a low flow channel within the wider and higher flood channel would have to be provided. This alternative, if found appropriate for some portions of the riverway, would preserve some of the stream bed characteristics and fishery of the Roseau River.

84

Conclusion

In view of the foregoing comments, DNR finds the Draft Environmental Impact Statement to be deficient in several respects. Numerous impacts are not discussed in their entirety, important data are omitted, benefit/cost ratios for all alternatives were not calculated or presented, the impact from the planned SCS program was not addressed, and all environmental costs were excluded in calculations of the proposed projects benefit/cost ratio. In addition very little in the way of mitigation for the recognized losses of natural resources within the total river basin has been proposed.

85

The project documents should consider modifications in order to offset the problems and losses caused by the present proposal. The DNR recommends the following mitigations for consideration:

1) Creation of waterfowl impoundments through planned deposition of dredge spoil in the Roseau Lake and/or Big Swamp areas. Spoil would be deposited in a manner to create dikes necessary to make an impoundment.

86

Specifically, these mitigation measures could consist of the following:

a) Roseau Lake be partially restored to provide a "conservation" pool of about 1,400 acres at elevation 1028 north of the new channel and east of Pine Creek. This pool could be drawn down completely after each waterfowl hunting season, or about November 15, and restored to elevation 1028. Costs would include those for engineering, core-cutting, diking, emergency spillways, water control sturctures, and diversion of Pine Creek for water during low flow periods (if needed).

86

b) A new waterfowl marsh in the Big Swamp of about 1,400 acres in a wet sedge meadow in Sections 22, 23, 25, 26, and 27, T163, R43, or a similar area as agreed to by the DNR and Fish and Wildlife Service. This could be accomplished by wasting the spoil on the south side of the channel to form a dike, from the junction of Lateral 1 of State Ditch 69 with the main channel, to the west line of Section 22. Diking would also have to be done on the west side of Lateral 1, the west side of Section 22, and the north side of State Ditch 69. Core cutting would be required to prevent seepage. Culverts with flap gates of sufficient capacity for proper water management would have to be installed in the dike paralleling the channel on the south side to bring water south into Sections 22, 23, 25, 26, and 27.

Corps Responses to Minnesota Department of Natural Resources (cont.)

83. Reservoir storage in Big Swamp and channel modifications upstream from Big Swamp were considered as possible solutions to flood control on the Roseau River in the Report on Survey of Roseau River, Minnesota, for Flood Control (8 May 1964). (See sections 6.210 and 6.240.) The benefit-cost ratios with three alternatives for dike design ranged from 0.77 to 0.93 (paragraph 6.217). Reservoir storage at Big Swamp would probably require raising of highway 7, which would subject the wetlands to the south to drainage pressure.

84. The channel cutoffs identified for the proposed project are essentially bypass channels. To implement this concept further could drastically increase costs because of right-of-way requirements and construction of bridges. To construct a separate channel along most of the project area would adversely affect substantial acreages of cropland. Mitigation of identified fishery losses insofar as possible is proposed following completion of the project (see FEIS, paragraph 1.723).

85. As a result of recent meetings between the Corps and the DNR, it is anticipated that the above responses and revisions made in the FEIS will clarify points of contention and confusion expressed by the DNR. The Corps will continue working with the DNR to resolve the problem areas.

86. Refer to paragraph 1.725 of the FEIS and responses 81 and 82.

2) Acquisition of an amount of upland habitat to be determined jointly by the DNR and the Corps as mitigation for upland habitat destroyed

87

3) All spoil sites and river banks altered as a result of the project should be seeded to grasses, legumes, and/or shrubs to minimize erosion and slumping and to hasten revegetation of the project area. The DNR should be contacted on plant and grass species to be used in revegetation.

88

4) The permanent right-of-way and spoil piles resulting from the proposed project should be retained as wildlands as an erosion control measure for protection of the river and to provide for wildlife habitat except in those areas where present agricultural practices demonstrate that there will be no additional impacts on the river.

89

5) The existing high-value potholes both north and south of the River in the Big Swamp area should be protected, by all available means, from drainage that may result from the channeling itself, or which may come later in the rehabilitation of existing legal drainage ditches and construction of new ditches. If, after all practical measures have been taken during and following construction to protect these potholes, it is determined that the project has adversely affected these valuable waterfowl production areas, steps should be taken by the Corps to mitigate these losses. This could be done by installation of a series of low-head dams in the channel through the Big Swamp after bank and bottom soils have stabilized, and/or by construction of new or replacement pothole communities with dragline and bulldozer in suitable locations in the Big Swamp. Details as to additional specific mitigative features that should be considered would be provided by DNR personnel in the event of adverse effects.

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6) Sport fishing in the Roseau River depends to a large extent on existing meanders and oxbows, which provide pools and resting areas as well as spawning and rearing facilities for fish, particularly northern pike.

It has been determined that the adult northern pike move into the Roseau Wildlife Management Area pools to spawn from the river during high water in the spring (over the control structures). If channeling should result in northern pike habitat losses in the river and if lowered water levels in the spring prevent fish from moving into the pools to spawn, there could be serious adverse effects not only to sport fishing in the river but to the excellent production facilities now provided by the Roseau WMA pools. Should northerns have difficulty reaching the Roseau WMA pools during the spring spawning run because of project channeling, mitigation of this loss would require construction by the Corps of dams in the main channel and/or installation of a series of small dams in the tributary channels between the Roseau WMA pools and the main channel. This would be in addition to the proposal outlined in item five for mitigation of waterfowl habitat lost.

91

Because construction of the proposed project will create significant adverse effects, the excellent sport fishery and the northern pike spawning and rearing areas in and adjacent to the Roseau River should be further evaluated in project surveys as proposed in the General Design Memorandum. With the participation of the appropriate federal agencies, study findings can be utilized as the basis for the development of fishery mitigation measures which can be incorporated into the project design.

Corps Responses to Minnesota Department of Natural Resources (cont.)

87. Planting of the riverward slopes of the disposal piles would partially restore habitat. The original estimate of the acreage of vegetation lost has been reduced, and with the one-bank excavation plan, much of the habitat value of the river corridor would continue to exist. Because of problems with land acquisition, particularly at this late date, incorporated structures, plantings, and management within the presently planned right of way are felt to be preferable to the suggested upland habitat acquisition.

88. See response 20.

89. Concur. The local sponsor would retain part of these lands and the project operating manual would recommend maintenance measures which would attempt to optimize wildlife habitat. Much of the temporary right-of-way would probably be used for agriculture.

90. Adverse effects on potholes on State land would be mitigated as a project design deficiency. At a recent interagency coordination meeting, it was agreed that effects of private drainage would not be studied

91. A study of impacts on fisheries would be initiated with a view toward mitigating identified losses during and following construction.

7) Construction plans should include adequate provisions for minimizing damage to fish and wildlife habitat during the construction phase of the project. 92

8) Other mitigative measures previously suggested, such as water level controls (flapgate culverts) on designated oxbows noted as a part of the project, should be constructed as previously agreed to by the DNR, USFWS and the Corps. 93

In addition, any unanticipated adverse impacts in and adjacent to the Roseau River which result from implementation of the project that appear at a later date may require mitigation measures. Also we wish to reiterate the need to document and evaluate existing wildlife habitat within the 205,000 acres of lands that may be drained and to evaluate this resource for its capability and value as agricultural lands. This study effort should be developed with the assistance of the appropriate state and federal agencies for the purpose of determining the extent of the adverse impacts and the development of mitigation to offset unavoidable losses. 94

The concerns of the Department of Natural Resources relate both to the direct effect of the project, and to the potentially harmful secondary effects on the resources of the region which may result if the area is not managed in the best possible manner to assure wise use and development

of the lands and waters. The value of these resources is significant, and only as new methods of assessing these values are developed and utilized will the true value become known.

We thank you for the opportunity to review the Draft EIS. We look forward to working with the Corps of Engineers and other concerned state and federal agencies to assure that the objectives of local, state, and federal interests are reasonably met within a sound socioeconomic and environmental framework. We believe this approach is deserving of the support of all who desire the development of a well balanced, environmentally acceptable project.

Corps Responses to Minnesota Department of Natural Resources (cont.)

92. The Corps plans to upgrade construction plans and specifications to minimize habitat damage.

93. These structures would be constructed in accordance with consultation with the Minnesota DNR and U.S. FWS.

94. We intend to remedy unanticipated adverse effects as a project design deficiency in the case of potholes which are on State land adjacent to the channel and which are adversely affected by the project. Some of the fishery mitigation would also have to be done after construction. It was agreed at an interagency coordination meeting that the study referenced in the latter 2 sentences of the comment would not be accomplished.

Minnesota Pollution Control Agency

October 28, 1975

CERTIFIED MAIL

Colonel Max Noah
District Engineer
St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and
Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

Pursuant to 40 C.F.R. § 1500.11 of the President's Council on Environmental Quality's (C.E.Q.) "Rules and Regulations for Preparation of Environmental Impact Statements: Guidelines"; the statutory responsibilities of the Minnesota Pollution Control Agency (MPCA), including but not limited to those under the Minnesota State Environmental Policy Act of 1973; and Major Norman C. Hintz's letter of August 28, 1975, the comments below are submitted in response to the Draft Environmental Impact Statement, Flood Control on Roseau River, Roseau and Kittson Counties, July, 1975 (Draft EIS). These comments are based on the MPCA's review of the Draft EIS, the Environmental Impact Assessment of the Roseau River, Minnesota Flood Control Project (March, 1974) (prepared by the Institute for Ecological Studies of the University of North Dakota) and the General Design Memorandum of October, 1971 (with updated plates 1-25). 37

As you know, this project essentially includes modification of the existing Roseau River channel, construction of channel cutoffs, and installation of related works along the river between the city of Roseau and the Canadian Border in northwestern Minnesota. Modifications proposed primarily consist of increasing the width of the bottom channel.

The following are the general concerns of the MPCA regarding this project:

1. Conflicts between the Corps' activities and State law are not discussed in the Draft EIS; this is clearly a C.E.Q. guideline requirement which has not been satisfied. The Draft EIS does not adequately discuss "how the proposed action may conform or conflict with the objectives and specific terms of approved or 95

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Corps Responses to the Minnesota Pollution Control Agency (cont.)

Corps Responses to Minnesota pollution Control Agency

95. Correspondence has been initiated with State and local planning agencies to determine potential conflict between Corps activities on the Roseau River and approved or proposed Federal, State or local land use plans. (See FEIS, exhibit 34.)

proposed Federal, State, and local land use plans, policies and controls, if any, for the affected area including those developed in response to the Clean Air Act or the Federal Water Pollution Control Act Amendments of 1972" (40 C.F.R. § 1500.8 (a) (2)). The Draft EIS does not address the existing conflicts and does not describe the extent to which the Corps "has reconciled its proposed action with the plan, policy or
95 control, and why the Agency has decided to proceed notwithstanding the absence of full reconciliation." The Corps has, therefore, not fully complied with the requirements which the C.E.Q. promulgated pursuant to the National Environmental Policy Act of 1969 (P.L. 91-190, 42 U.S.C. 4321 et seq.) and Executive Order 11514 (35 C.F.R. 4247).

As you know, the October 9, 1975 decision of Chief Justice Edward J. Devitt (State of Minnesota v. Callaway) granted Minnesota authority to require the Corps of Engineers to comply with state pollution control abatement requirements
96 including obtaining a state discharge permit. The permits necessary for compliance with Judge Devitt's order will require specific consideration in the treatment of water associated with dredging and any other activity where a discharge would occur. The Corps has not to date applied for these necessary permits.

2. The Draft EIS inadequately discussed alternatives. C.E.Q. guidelines (40 C.F.R. § 1500.8) specifically state, "A rigorous exploration and objective evaluation of the environmental impacts of all reasonable alternative actions, particularly those that might enhance environmental quality or avoid some or all of the adverse environmental effects, is essential." I feel that
97 further consideration should be given to several ecologically less harmful alternatives. These could utilize levees to protect the City of Roseau and reduce agricultural losses either by encouraging a change in crop types to those suitable to the natural conditions of the area (such as wild rice) or by public acquisition of flood-prone areas (perhaps as wildlife areas). The need to preserve the environment wherever possible makes alternatives to the proposed project more desireable.

3. Many secondary consequences of the proposed project must be more fully considered. C.E.Q. guidelines (40 C.F.R. § 1500.8 (a) (3) (ii)) specifically emphasize the importance of secondary or indirect consequences and state that secondary
98 consequences "may often be even more substantial than the primary effects of the original action itself." The MPCA is concerned over several direct and indirect environmental consequences which are identified in greater detail in the attached Technical Review Paper.

Corps Responses to the Minnesota Pollution Control Agency (cont.)

96. The Corps disagrees with Chief Justice Devitt's decision and is appealing the ruling in the Eighth Circuit Court of Appeals.

97. The alternatives section has been expanded in the FEIS (see section 6). A levee system to protect the city of Roseau is not economically feasible due to bridge and railroad relocations that would be necessitated. A large-scale change in crop type to that of wild rice is impractical, because the sustained flow in the Roseau River is not adequate to provide the water needed throughout the growing season. It is questionable whether the base flow in the Pine Creek Diversion would be sufficient to provide water for wild rice operations in addition to providing the water necessary for maintenance of the Roseau River Wildlife Management Area impoundments. The extent of the Roseau River floodplain makes public acquisition of flood prone areas economically infeasible, nor would it be locally acceptable.

The land use changes suggested in this comment would be economically and socially unacceptable to the local population, although recreation and wildlife benefits would accrue.

98. Secondary consequences of the proposed project are more fully considered in the FEIS (sections 4.105, 4.750, and 4.820).

[redacted] additional violations of state [redacted] which already occur in the [redacted]. Specific concerns of the MPCA include impacts on [redacted] levels of turbidity and suspended solids as well as [redacted] of the natural aquatic biota. Temperature and [redacted] oxygen in the Roseau River may also be affected. These [redacted] are detailed in the attached Technical Review Paper, [redacted] considers water quality and other environmental consequences [redacted] the proposed project.

[redacted] justification of the project (i.e. the cost/[redacted] is inaccurate. All costs and benefits associated [redacted] with the proposed project have not been considered. Since it is [redacted] that increased drainage activity will be undertaken [redacted] the project, I believe that the costs and benefits [redacted] these activities should be considered in the benefit/cost [redacted]. Other related costs which apparently have not been [redacted] are as follows: The cost to landowners of providing [redacted] necessary for the project; the cost of potential crop [redacted] resulting from increased drainage reducing available [redacted] moisture during dry periods; the cost of losing potential

Corps Responses to the Minnesota Pollution Control Agency (cont.)

99. These impacts have been addressed in the MEIS (section 4.400).

100. The project is not being designed to accommodate any future drainage in the U.S. portion of the watershed (see response 56). These costs and benefits for this activity were not considered in the benefit-cost ratio. Had future drainage been incorporated into the proposed channelization project, the B/C ratio would probably have increased considerably. The report prepared by the SCS in 1956-67 showed a drainage B/C ratio of 4.2.

While future drainage in the Canadian portions of the Pine and Sprague Creek watersheds has been incorporated into the project design, this represents only a potential for which no definite plans have been developed. The increase in channel width to handle this potential drainage entails an increase of about 8 percent in excavation quantities and an increase of about $490,000 in project costs over those indicated in the 1971 proposal (General Design Memorandum). However, because this increase in channel width would increase channel capacity and directly benefit flood control in Roseau County, the cost of this incremental widening is considered as an immediate flood control cost with widespread benefits.

101. Non-Federal first costs (October 1975 price levels) for lands and damages would be $279,000 and for relocations, $146,000 (General Design Memorandum Supplement No. 1, 28 October 1975). These costs are reflected in the updated B/C ratio. At the time of the design memorandum supplement (and MEIS) it was considered premature to negotiate right-of-way needs for areas isolated by channel cutoffs until the design had been approved.

102. Excess water tends to increase agricultural costs, delay planting and reduce quantity and quality of products produced. Proper land drainage for agricultural use results in improved soil structure, better utilization of available moisture, accelerated and improved microbiological processes, less compaction of soils, and deepened root zone. Agricultural soils on the upper Roseau River are clay or sandy loam, and in the lower reaches are lacustrine soils similar to those located in the Red River Valley. These types of soils, particularly the clay soils, tend to hold moisture for later use. The water table is high throughout the area. Sixteen damaging floods have occurred on the Roseau River since 1919, but droughts have been infrequent. Due to the water holding capacity of most of the floodplain soils and the infrequency of droughts in the area, it appears there would be little or no significant average annual crop damages from channel modifications due to decreased moisture during droughts.

[illegible] crop growing areas due to increased drainage (as stated in the Draft EIS, wild rice is a possible future crop which [illegible] of economic importance); and the potential increased [illegible] of water treatment downstream. To protect water quality and minimize impacts, spoil piles should be set back to a [illegible] necessary to ensure more than minimal protection from bank sloughing; this will necessarily increase construction-related costs beyond those identified by the Corps. Because [illegible] development benefits would result from any type of [illegible], flood control or otherwise, I believe that it should not be considered a benefit peculiar to this project. As a result of these omissions and inappropriate benefits, the benefit/cost ratio is inaccurate and, therefore, cannot serve [illegible] accurately justify the project.

[illegible] economic considerations significantly affect justification [illegible] project and are by no means as clear as stated in the [illegible]. Beyond the specific economic concerns identified [illegible], I wish to point out that the estimated cost of this [illegible] has risen sharply over the years and the benefit/cost ratio has declined. Surely the recent period of inflation has accompanied the rise of increase in construction costs; and while some increase in benefits have surely resulted, I suspect that the benefit/cost ratio has declined even further. Furthermore, it must be considered that the total cost of the project is based on a very unrealistically low discount rate of only 2.25 percent. Since this is only about half the [illegible] current discount rate, the true cost of the project must be significantly higher than that stated by the Corps.

Corps Responses to the Minnesota Pollution Control Agency (cont.)

103. The EIS stated that grass seed is currently being grown on the land which, with extensive water management, could be suitable for wild rice production. However, future wild rice production in the area would depend upon relatively uncertain future crop prices and comparative production costs between the two crops and other alternative crops. In addition, as noted in response 97, a lack of adequate surface water supply could limit any potential large-scale wild rice production.

104. The cost of water treatment downstream is included in the Canadian mitigation costs (see FEIS, paragraph 1.730) and in the B/C ratio.

105. See responses 22 and 61 for explanation of why the disposal piles would not be set back any further than was designed in the DEIS. Since the piles would not be set back further, there would not be increased construction related costs beyond those identified in the DEIS.

106. Unemployment benefits are a special category of benefits and are a component of the National Economic Development (NED) account. This component is conceptually an adjustment to the cost of a project, because there is no [illegible] cost associated with the use of an otherwise unemployed resource or full utilization of an otherwise underemployed resource. Benefits are limited to payments to unemployed and underemployed labor resources directly employed in the construction and implementation of a plan. Labor areas are designated as having substantial or persistent unemployment by Manpower Administration, U.S. Department of Labor. Roseau County was designated under section 401(a) (1) of the Public Works and Economic Development Act of 1965 (Public Law 89-139), and so these benefits are claimable.

107. The Corps feels that all appropriate costs and benefits have been reflected in the B/C ratio, and that the B/C ratio is accurate and can serve to justify the proposed project.

108. See response 50.

The interest rate used for determining average annual costs and benefits is 3 1/4 percent based on Water Resources Council Regulations which provide that a discount rate of 3 1/4 percent will apply to those authorized projects where appropriate non-Federal agencies have given, by 31 December 1969, "satisfactory assurance to pay for the required non-Federal share of project costs." See also response 78.

In conclusion, the number and magnitude of environmental impacts identified in the Draft EIS and by the MPCA have led us to conclude that the project is environmentally unsound and that further discussions of alternatives with less potential for significant environmental degradation should be considered if flood control measures are necessary. 109

The MPCA's technical staff are available to discuss our concerns in greater detail if necessary. The MPCA appreciates the opportunity to provide comments on this project and especially appreciates the time extension granted to the MPCA by the Corps of Engineers.

Sincerely,

Peter L. Gove
Executive Director

PLG/DHH:km
Enclosure
cc: Agency Board Members
The Honorable Robert Bergland, U.S. Representative
Mr. Andy Kosak, Governor's Office, Minnesota
Mr. Russell Peterson, President's Council on Environmental Quality
Mr. Francis T. Mayo, Regional Administrator, U.S. E.P.A.
Mr. Robert L. Herbst, Commissioner, DNR, Minnesota
Mr. George Memphill, U.S. Fish and Wildlife Service

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Corps Responses to the Minnesota Pollution Control Agency (cont.)

109. As a result of recent coordination with the MPCA (see 9.006) it is anticipated that the above responses and those which follow, and revisions made in the FEIS, will clarify points of contention with the MPCA. Although there may yet be disagreement in placing ultimate values on the various socioeconomic and natural parameters involved, the Corps feels that the FEIS addresses these concerns and describes potential impacts on these conflicting parameters.

MINNESOTA POLLUTION CONTROL AGENCY

TECHNICAL REVIEW PAPER
on
"Draft Environmental Impact Statement,
Flood Control on Roseau River, Roseau and Kittson
Counties," Corps of Engineers, July 1975

This document is intended to provide more specific information regarding concerns of the MPCA. Information has been divided into the following categories: A) water quality impacts, B) aquatic biological impacts, C) terrestrial impacts, and D) other areas needing further study and consideration.

A. Water Quality Impacts

MPCA regulation WPC 25 classifies the Roseau River within water use classes 2B, 2C, 3B, 3C, 4A, 4B, 5 and 6. Regulation WPC 15 specifies the water quality standards applicable to each of these use classes. Of concern is the standard of 25 JTU for turbidity specified for classes 2B and 2C to protect the suitability of waters for fish and other aquatic organisms. The MPCA believes that this standard would be more frequently violated if this project were carried out. As documented in the "Water Quality Management Basin Plan for the Red River of the North" (MPCA, Division of Water Quality, 1975), water quality data obtained near Malung during the period 1968-9 shows that the Roseau River already suffers violations of the turbidity standards about 25% of the time. Any increase in the levels of turbidity will result in additional violations and deterioration of the present stream quality. 110

The proposed project has the potential for increasing turbidity levels for several reasons, as follows:

- As indicated in the "General Design Memorandum", construction activities will probably extend over 4 construction seasons, as excavation is planned for a continuous 43.9 mile reach of the river. During excavation of the stream bank and bed, significant quantities of particulate matter can be expected to be released into the stream, thus raising turbidity levels. 111

- Following construction, the newly exposed stream bank and spoil pile, unprotected by deadfall and vegetation, will be highly susceptible to erosional forces; the Draft EIS states that it is likely to take from 3 to 5 years for the excavated bank to stabilize to the extent necessary to eliminate the problem. 112

Corps Responses to the Minnesota Pollution Control Agency

110. The Corps concurs in general with your statements regarding the impacts of the proposed project on turbidity. These impacts have been discussed in the FEIS (section 4.410). However, there is some question regarding the accuracy of turbidity measurements obtained at the Malung and Caribou stations. These water quality data were obtained from STORET and are included as exhibit 9 in the FEIS. Interpretation of these data is difficult. Only one year of sampling was done (eight samples), and anticipated relationships between turbidity, flow, and precipitation are not evident. Typically, high turbidity values in streams unaffected by point sources of pollution, occur during high flow conditions and are the result of either channel scour and/or sheet erosion. In turn, high flows result from melt runoff and/or precipitation runoff. However, turbidity data from Malung and Caribou do not appear to be correlated with either flow or precipitation events. At Caribou, for the dates 13 September 1967 and 6 February 1968, the USGS reported flows of 1.1 and 1.0 cfs, respectively. Precipitation records (U.S. Dept. of Commerce) indicated that only 0.05 inch of rain fell at Caribou and only 0.17 inch at Wannaska on and immediately preceeding 13 September 1967 and 0.01 inch at Caribou and 0.08 inch at Wannaska for the period before 6 February 1968. Thus, for the two sampling dates, flows were almost identical while precipitation was only slightly greater for the 1967 period. Yet surprisingly, turbidity on 13 September 1967 was only 1.0 JTU while on 6 February 1968 it was 26.0 JTU and exceeded recommended State standards by 1 JTU. At Malung on the same days, flows were 0.5 and 1.0 cfs, respectively, while turbidity values of 5.0 and 20.0 JTU were recorded, respectively. On 18 July 1967, the day when turbidity values of 100 and 50 JTU (the highest recorded for any samples) were recorded at Caribou and Malung, respectively, the discharges at the two sites were 73 and 7.8 cfs, respectively. No precipitation had been recorded prior to or on the day of sampling. In contrast, on 23 May 1967, the sampling day with the highest recorded discharge (2,160 cfs), the turbidity recorded was one of the lowest, i.e. 10 JTU. At Malung on this day a discharge of 234 cfs and a turbidity of 15 JTU were recorded. Precipitation at both sites on this day was about 0.05 inch. It appears that the turbidity data at both sites should be carefully reviewed by MPCA water quality experts and a decision made as to whether the data should be allowed to remain in the STORET system. Using these data to describe existing conditions in the Roseau River and for predicting impacts of the proposed project would be questionable at this time.

111. This has been noted in the FEIS, section 4.410.

112. Disposal piles (riverward side) and the area between the channel and the piles would be revegetated following construction. This would greatly increase the recovery rate (through stabilization) of these areas and reduce the period they would contribute to suspended sediment in the river.

As indicated in the Draft EIS, the upstream one-fourth of the [illegible] channel would be highly susceptible to mass slumping of the excavated bank because of the instability of the soils. In projects of this type, as stated in the "General Design Memorandum", the prime causative factor of slumping is the proximity of the spoil pile to the channel cut. Because of the soil instability in some areas, it has been deemed too costly to place the spoil piles far enough back to allow more than the "minimum safety factor". The EIS states that, as a result, some isolated slumping is anticipated in the upstream one-fourth of the project. 113

As noted in the Draft EIS, the alteration of the natural channel (through cutoff of meanders and widening and deepening sections of the channel) may cause increased erosion at the bank base as the stream carves a new channel at non-maximum flow. This effect would also aggravate the possibility of bank slumping as described above. 114

Removing deadfall and minor stream bank irregularities would decrease channel roughness and thereby increase flow velocity during high flow periods. Cutoff of meanders would increase the gradient of the channel and increase flow velocity at all times. The increased stream velocity could increase bed erosion and raise particulate loadings. 115

As a result of the above factors, it appears that the proposed project would cause a lengthy decrease in the quality of the Roseau River. This quality impairment would be most prominent during construction, remain for several years after construction and could continue indefinitely. 116

A water quality parameter important to aquatic life which may be adversely impacted from the project is temperature. While temperature effects are briefly mentioned, little attention has been given to them. Loss of vegetation along one bank and a widened channel to flow over would increase the rate of heat input from sunlight. Reduced base flows during dry periods would reduce the cooling effects of groundwater addition to the stream. These factors would combine to result in higher daytime temperatures and greater fluctuations from the natural. Shallower flow at night would result in lower nighttime temperatures. Thus, the diurnal temperature cycle would cover a wider temperature range. These changes could also have an adverse impact on water quality and fishery potential. 117

The maximum allowable temperature change for the Roseau River, as specified by MPC 15, is 5°F above the natural, based on the monthly average of the maximum daily temperature; and the allowable upper limit for temperature is 86°F. While it seems unlikely that the project could cause violations of the 86°F standard, the Draft EIS should address the possibility of the project causing violations of the incremental temperature standard. 118

Corps Responses to the Minnesota Pollution Control Agency (cont.)

113. See response 70.

114. Concur. However this effect should be relatively short-term, lasting until the new channel develops a stabilized configuration; longer-term erosion due to this effect would not be expected to be greater than with existing conditions.

115. Because of the limited slope along the proposed modified reach, areas presently aggrading and degrading may be altered but the overall magnitude of the impact of the process should not be increased. In addition, future efforts to mitigate fishery losses, i.e. low head dams, artificial riffles, and other in-stream structures, would also reduce velocities resulting from the proposed project. Furthermore, the channel itself was designed to keep velocity down. The increased width of the proposed channel would have a diminishing effect on velocity. Although there would be some increase in channel velocity, it would not be significant and should not increase bed erosion. Past experience with the type of soils encountered in this project area indicates that velocities above 4.5 feet per second (fps) can cause erosion problems. The average channel velocities for design flows under modified conditions range from 1.5 to 4 fps.

116. The Corps agrees that the proposed project would have significant short-term impacts. The long-term effects, however, should be relatively minor. (See section 4.340 of the FEIS for discussion of sediment loading.)

117. These impacts on water temperature have been expanded in the FEIS, section 4.420.

118. Although possible, it is unlikely, that incremental temperature standards would be violated. Also the project's impacts on temperature change would decrease in magnitude over the years as revegetation and stabilization of the low flow channel occurred. In addition, the shading effects of riparian vegetation were considered in selecting which bank would be subject to excavation.

...of waters increases, lower oxygen transfer ... by water result. This action with inhibited vertical ... would decrease the rate of oxygen transfer (oxygen regime) and ... the composition of biological communities.

Aquatic Biological Impacts

In addition to the impacts associated with impaired water quality, the excavation of the stream bank will, as outlined in the EIS, ... other severe impacts on aquatic organisms and their habitats. ... along one bank the organisms and habitats will be destroyed ... removed. Because of increased uniformity of the excavated stream bank environment, fewer types of habitats and, thence, ... types of organisms will be reestablished. Within *cutoff oxbows*, ... changes will occur due to the change from running water to ... water. Furthermore, if eutrophication occurs, as anticipated, ... changes to less desirable species may occur. Conditions would ... growth of macrophytes and algae, which could cause sufficient ... depletion to kill fish - if the cutoffs could support fish popu... at all. It is questionable that sufficient water would remain ... dry periods for fish life and also that the gate mechanisms ... not allow access in and out of the cutoffs, except at high flow ...

Loss of diversity in the straightened channel would result in decreased production potential. Riffles are typically areas of high invertebrate production necessary as food sources for fish, and fish themselves commonly inhabit pools. Increased uniformity in the channel would eliminate most of these habitats. In addition, low flow meandering in the widened channel would create an unstable benthic environment, with consequent reduced productivity. These impacts indicate that the project will have far-reaching adverse impacts *affecting the* overall ecosystem of the area.

Terrestrial Impacts

Although terrestrial impacts of the project are not directly within the purview of the MPCA, these must be considered in an overall evaluation of environmental consequences. Twenty-four hundred acres - 760 of forest, 320 of brush land and 1,320 of marsh, altered ... or agricultural land - would be taken for the project construction. A distance of up to 200 feet back from the river would be ... for spoil piles wherever excavation would be done. In some ..., this would eliminate all the mature trees; re-vegetation ... a long-term process due to the loss of reproducing trees to ... seed for new growth. Brush lands would probably reestablish ... fairly quickly, but would probably take over former marsh ... also.

Perhaps the greatest impact on terrestrial vegetation would ... on wetland, especially the tamarack peat land north of Sprague ..., which are a valuable resource because of their natural state. ... increased drainage which could result following the project might ... alter this unique ecosystem.

Corps Responses to the Minnesota Pollution Control Agency (cont.)

119. This effect is discussed in the FEIS, section 4.430.

120. It should be noted that channel cutoffs were proposed as habitat for waterfowl and that it was stated that their value to fish would be minimal. In addition, post-construction efforts to mitigate fishery losses would also increase substrate diversity. This problem area is being investigated further. (See response 6 and paragraph 1.723.)

121. Refer to response 115.

122. The estimated amount of permanent project right-of-way is 1900 acres. An additional 900 acres would be required for disposal of dredge material. The values of 760 acres of forest and 320 acres of brush were based on two-bank excavation. It is expected that with the proposed one-bank excavation these losses would be reduced, although to what degree has not been determined. Following construction, the area from the channel bank to the top of the riverward side of the disposal pile would be revegetated with grasses, shrubs, and trees for both erosion control and wildlife habitat. It is unlikely that brushlands would take over former marsh areas unless drainage of these areas were to occur. Potential drainage is discussed in response 56 and paragraph 4.105.

123. This area already is subject to an extensive drainage network (see exhibit 4). It is unlikely that much more drainage would occur in this area, or any area in the U.S. portion of the Roseau River basin, as a result of the proposed project (see response 56 and paragraph 4.105).

Terrestrial animal and bird populations would also be affected by the project. An increase in waterfowl production would probably result from the creation of cutoff oxbows, but increased drainage activities would reduce other waterfowl acreages. Bird species, such as common goldeneyes and hooded mergansers, which nest in holes in large trees would lose substantial habitat areas. Removal of wooded corridors along the stream would eliminate avenues of dispersal for moose and deer, and would, therefore, adversely affect populations. 124 Some species - such as moose, deer and sharp-tailed grouse - are quite sensitive to small changes in wild land abundance when these wild lands are interspersed with crop land. Thus, the impact of the loss of the habitat areas along the river can be expected to be greater than in proportion to their actual size.

D. Other Areas Needing Further Study and Consideration

The MPCA believes that an additional study of possible impacts on the Big Swamp area should be conducted. This area, mostly in public ownership, consists essentially of wet fens and is a unique resource. In addition, the Draft EIS indicates that approximately 50 pairs of breeding sand hill cranes are known to inhabit the Big Swamp area. Because these cranes are considered a Threatened Species by the Minnesota DNR, their protection is especially worthy of consideration. 125 While Big Swamp will be little altered as a flood detention area and will not be subject to future drainage projects (because of public ownership), flood stage elevations will be reduced. This could alter the distribution of vegetative types and, consequently, the wildlife dependent on them. Further study is needed to analyze how this hydraulic change may affect the crane population. 125

Corps Responses to the Minnesota Pollution Control Agency (cont.)

124. It is agreed that the proposed project would have these impacts on wildlife. It should be noted, however, that the importance of each reach's habitat was an important consideration in selecting which bank would be excavated (see FEIS, section 1.404). It should also be noted that project induced drainage would not occur to the extent proposed in the 1956-57 SCS report. The Corps has attempted to clarify the drainage impacts of the proposed channel modification project (FEIS, paragraph 4.105, and response 56.

125. While the proposed project could cause some changes in Big Swamp as a result of the effects on flood stages in the area, it is unlikely that these changes would be large in extent or significant in type. Flood stages in Big Swamp would only be reduced 6 inches for floods with a 2-year frequency, and floods with a frequency of 5 years or more would only be reduced 2.4 inches. (Refer to table 13.) See also responses 13 and 55.

MINNESOTA HISTORICAL SOCIETY
690 Cedar Street, St. Paul, Minnesota 55101 • 612 296 2747

29 September 1975

Mr. Norman C. Hintz, Major
Corps of Engineers
St. Paul District
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Mr. Hintz:

RE: HCSED-ER
Flood Control
Roseau River
Roseau and Kittson Counties

I have read with great interest the Draft Environmental Impact Statement for the project described above. I appreciate the attention which has been given in the report to historic and archaeological values, particularly the statements that specific archaeological sites have been discovered in the area and, additionally, that in paragraph 4.740 legally demanded mitigative efforts will be made to preserve those and other archaeological sites from damage. In this regard I expect that you will keep me fully informed as to the specific mitigation efforts; such documentation should be sent to me at the above address.

Thank you for your attention.

Sincerely,

Russell W. Fridley

Russell W. Fridley
State Historic Preservation Officer

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Northwest Regional
Development Commission
429 Woodland Avenue • Crookston, Minn. 56716 • 218-281-1996

April 16, 1976

Major Norman C. Hintz
Acting District Engineer
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

RE: NCSED-ER

Dear Major Hintz:

The enclosed letter (Sept. 25, 1975) represents the concerns of the Northwest Regional Development Commission in regard to the proposed Roseau River Flood Control Project. These concerns were forwarded to you in response to the July, 1975 draft EIS.

Our Commission is interested in keeping informed on new developments regarding this Project. We will look forward to reviewing the final EIS when completed.

In response to your statement about the NWRDC's existence, the Commission was formally established by Governor Anderson on February 8, 1973 under the auspices of the Regional Development Act of 1969. Since March of 1974 the NWRDC has had full-time personnel to implement Commission directives. After our annual report comes back from the printer we will forward a copy to you which will explain our operations in detail.

If you have any questions please call.

Sincerely,

Eugene A. Abbott
Executive Director

Enclosure

EAA:dc

Northwest Regional Development Commission

114 W. Second St.
Crookston, Minnesota
56716
Phone: 218-281-1996

September 25,1975

Major Norman C. Hintz
Acting District Engineer
St. Paul District Corps of Engineers
1135 U. S. Post Office and Custom House
St. Paul, MN 55101

RE: Roseau River Flood Control Project

Dear Major Hintz:

The Northwest Regional Development Commission appreciates the opportunity to review and comment on the Roseau River Flood Control Project.

Your representative, William Slocum presented a comprehensive overview of the project to our Board of Directors on September 23,1975. Everyone in attendance agreed that the project would be beneficial.

We recognize that the project does address the issue of waters spilling from "Big Swamp" into adjacent watersheds during high water. However, the question arose as to if it would be possible to modify the channel design from Big Swamp to the Canadian border to increase the duration of flow without increasing the maximum volume of flow currently acceptable to Canada. 126

This would have the effect of reducing the spilling of water from Big Swamp into county ditches and contributing to the flooding of agricultural land.

We would appreciate it very much if you would respond to this particular issue because it could make a good project even better.

The NWRDC Board of Directors went on record endorsing the concept of the project at the September 23,1975 meeting. This endorsement is contained in the board minutes and can be obtained at a later date if desired.

If you have any questions, feel free to contact our office.

Sincerely,
Eugene E. Abbott
Executive Director

EEA/bv

cc Ervin Strandquist, Chairman NWRDC
Roseau River Watershed District

Serving the Counties of

- Kittson - Roseau - Marshall - Pennington - Red Lake - Polk - Norman -

Corps Responses to Northwest Development Commission

126. As the Corps has previously responded to this comment, the original letter of response dated 9 October 1975 is reprinted, below.

NCSED-H

AHPera/js/7881

9 October 1975

Mr. Eugene E. Abbott
Executive Director
Northwest Regional Development
Commission
114 W. Second Street
Crookston, Minnesota 56716

Dear Mr. Abbott:

This is in reply to your letter of 25 September 1975 relative to the Roseau River Flood Control Project.

To increase the duration of flow as you suggest would require a reduction of peak flow rates near the Canadian Border. This can be accomplished only by increasing the storage in Roseau Lake (which would be contrary to the project purpose) or in Big Swamp (which would increase the danger of spill-over into the Two Rivers Basin. To reduce flooding at the Border without causing higher storage stages could be accomplished by deepening or widening the channel through the problem area and downstream into Canada. This, of course, would be opposed by the Canadians unless the reparations paid to their country were increased to cover their costs for the additional excavation. To propose such a modification in project design at this time would cause another lengthy delay before all the ramifications could be resolved by the two countries. Inasmuch as the project is now approaching the construction stage, we would hesitate to pursue any course of action which would cause any further delay in the schedule.

Our studies show that the proposed project improvement will increase the 10-year design peak flow at the border from a present-condition rate of 2,700 cfs to a project-condition rate of 3,200 cfs. However, this will cause a stage increase of only 0.1 foot. As you may be aware, approximately 10 miles of the Roseau River on the Canadian side are to be improved by the Canadians with funding provided by the United States. When this Canadian improvement is completed, a drop in stage at the Border can be expected.

NCSED-H
Mr. Eugene E. Abbott

9 October 1975

I trust that I have responded adequately to your questions, made you aware of the implication of a project change at this late date, and satisfied you that such flooding as may occur at or near the Border will be reduced when the Canadians complete the improvement on their side of the border.

Sincerely yours,

NORMAN C. HINTZ
Major, Corps of Engineers
Acting District Engineer

GLOSSARY

Admixture	- A mixture, a thing or ingredient added in mixing.
Adsorption	- Adhesion of the molecules of a gas, liquid, or dissolved substance to a surface.
Allochthonous	- Material introduced from outside of the particular environment, usually organic in nature.
Alluvial	- Of, found in, or made up of, alluvium (see below).
Alluvium	- Sand, clay, etc., gradually deposited by moving water, as along a river bed.
Amenity	- An attractive or desirable feature, as of a place or climate.
Arability	- Suitability for plowing and hence for producing agricultural crops.
Artesian flow	- Flows of water which rise under pressure.
Aquifer	- A rock formation capable of holding and transmitting water. An aquifer is supplied with water from its "recharge area" - the area at the surface where water is able to seep down into the aquifer.
Benthos	- All the plants and animals living on or closely associated with the bottom of a body of water.
Biopel	- Relating to biopelite, black shale.
BOD	- Biological Oxygen Demand

Detritus	- Rock in small particles or other material broken away from a mass, as by the action of water or glacial ice.
DO	- Dissolved Oxygen
Eutrophic	- Designating, or of, a lake, pond, etc., rich in plant nutrient minerals and organisms, but often deficient in oxygen in mid-summer.
Evapotranspiration	- Loss of water from an area both by evaporation and by transpiration from the plants.
Fen	- An area of low, flat, marshy land; a swamp, a bog.
Fluvial	- Of, found in, or produced by a river.
Gley	- A bluish gray or olive gray, sticky layer of clay formed under the surface of certain waterlogged soils.
gpm	- Gallons per minute
Groundwater Recharge	- The process of groundwater collection.
Insolation	- 1) The geological action of the sun's heat upon rocks at the surface. 2) The effect of the sun's rays on the materials composing the surface of the earth.
Lacustrine	- Of or having to do with a lake or lakes; found or formed in lakes.
Lentic	- Designating, of, or living in still water, such as lakes, ponds, marshes, etc.
Liquid Limit	- Moisture content at which soil passes from a plastic to a liquid state.

Lotic	- Designating, of, or living in flowing water, such as rivers, streams, etc.
Macrophytes	- A member of the macroscopic (large enough to be seen by the naked eye) plant life, esp. of a body of water algae, a group of plants variously one-celled, colonial, or filamentous, containing chlorophyll and other pigments, and having no true root, stem or leaf.
mgx	- Million gallons per year.
Outwash	- Sand and gravel deposited by meltwater streams in front of glacial ice.
Peat	- Partly decayed, moisture - absorbing plant matter found in ancient bogs and swamps.
Photosynthesis	- The biological synthesis of chemical compounds in the presence of light.
Plankton	- The usually microscopic animal and plant life found floating or drifting in the ocean or in bodies of fresh water and used as food by fish.
Plastic Clay	- Capable of being molded into any form, which is retained.
Plastic Limit	- The lowest water content at which the soil becomes plastic.
Pleistocene	- Designating or of the first epoch of the Quaternary Period in the Cenozoic Era (the geologic era following the Mesozoic Era and including the present. It began about 65 million years ago and is characterized by the spreading and recession of continental ice sheets and the appearance of modern humans.

Reradiation	- Radiation emitted as a consequence of a previous absorption of radiation.
Roseau River WMA	- Roseau River Wildlife Management Area.
Till	- Unstratified, unsorted, glacial drift of clay, sand, boulders, and gravel.
Vector	- An agent capable of transmitting a pathogen from an organism to another either mechanically as a carrier (as houseflies that transport typhoid bacteria) or biologically by playing a specific role in the life cycle of a pathogen (as mosquitos in relation to the malaria parasite).
Void Ratio	- The ratio of the volume of void space to the volume of solid particles in a given soil mass.

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TECHNICAL

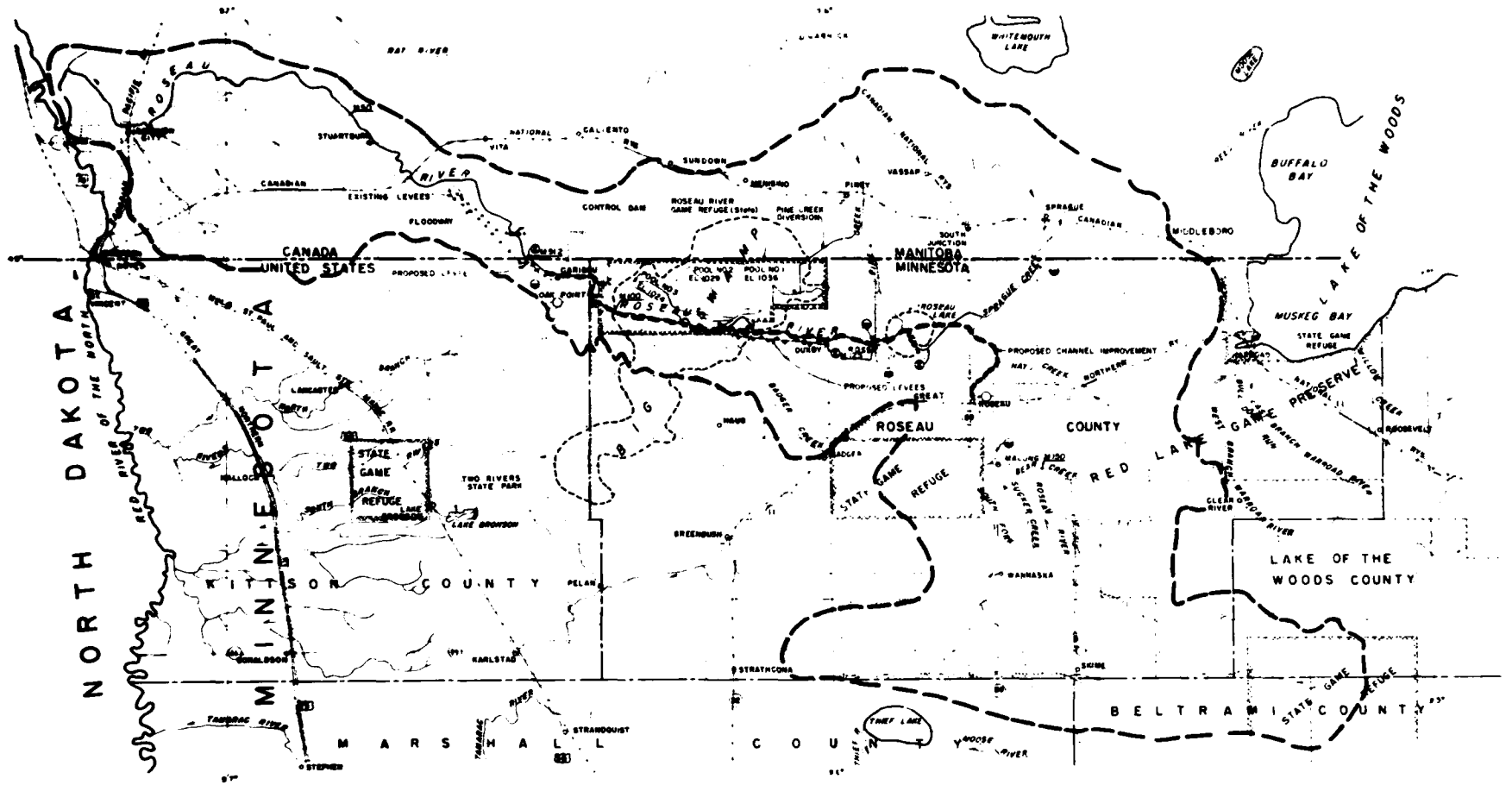
APPENDIX

ST. PAUL DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

ENVIRONMENTAL IMPACT STATEMENT
FLOOD CONTROL
ROSEAU RIVER
ROSEAU AND KITTSON COUNTIES
MINNESOTA

TECHNICAL APPENDIX

TABLE OF CONTENTS



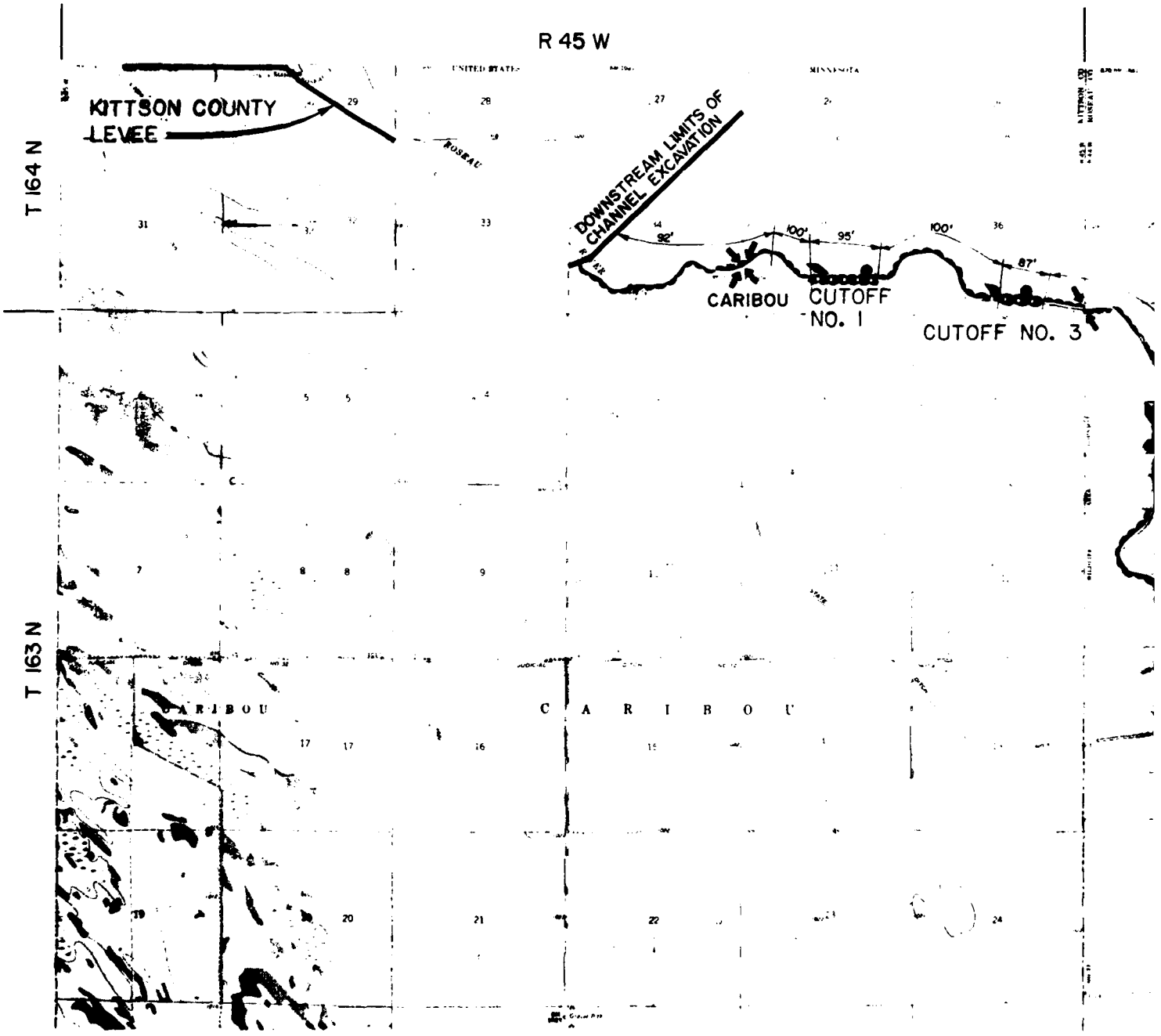
LEGEND

- RIVER BASIN OUTLINE
- STATE LINE
- COUNTY LINE
- DRAINAGE DITCH
- RAILROAD
- U S HIGHWAY
- STATE HIGHWAY
- STATE AID ROAD
- CANADIAN TRUNK HIGHWAY
- STREAM GAGING STATION (ACTIVE)
- STAGE GAGE (ACTIVE)
- REACH OF PROPOSED CHANNEL IMPROVEMENT
- PROPOSED LEVEES
- MILES ABOVE MOUTH
- STATE GAME REFUGE BOUNDARY
- GAME PRESERVE BOUNDARY
- STATE FOREST BOUNDARY
- U S WEATHER BUREAU STATION

SCALE IN MILES

GENERAL REPORT MEMORANDUM
FLOOD CONTROL
ROSEAU RIVER, MINNESOTA
GENERAL MAP OF BASIN
SUPPLEMENT I
DATE
AUGUST 1975
SCALE
AS SHOWN
DRAWING NUMBER
-R-5/2.1
SHEET OF

EXHIBIT I

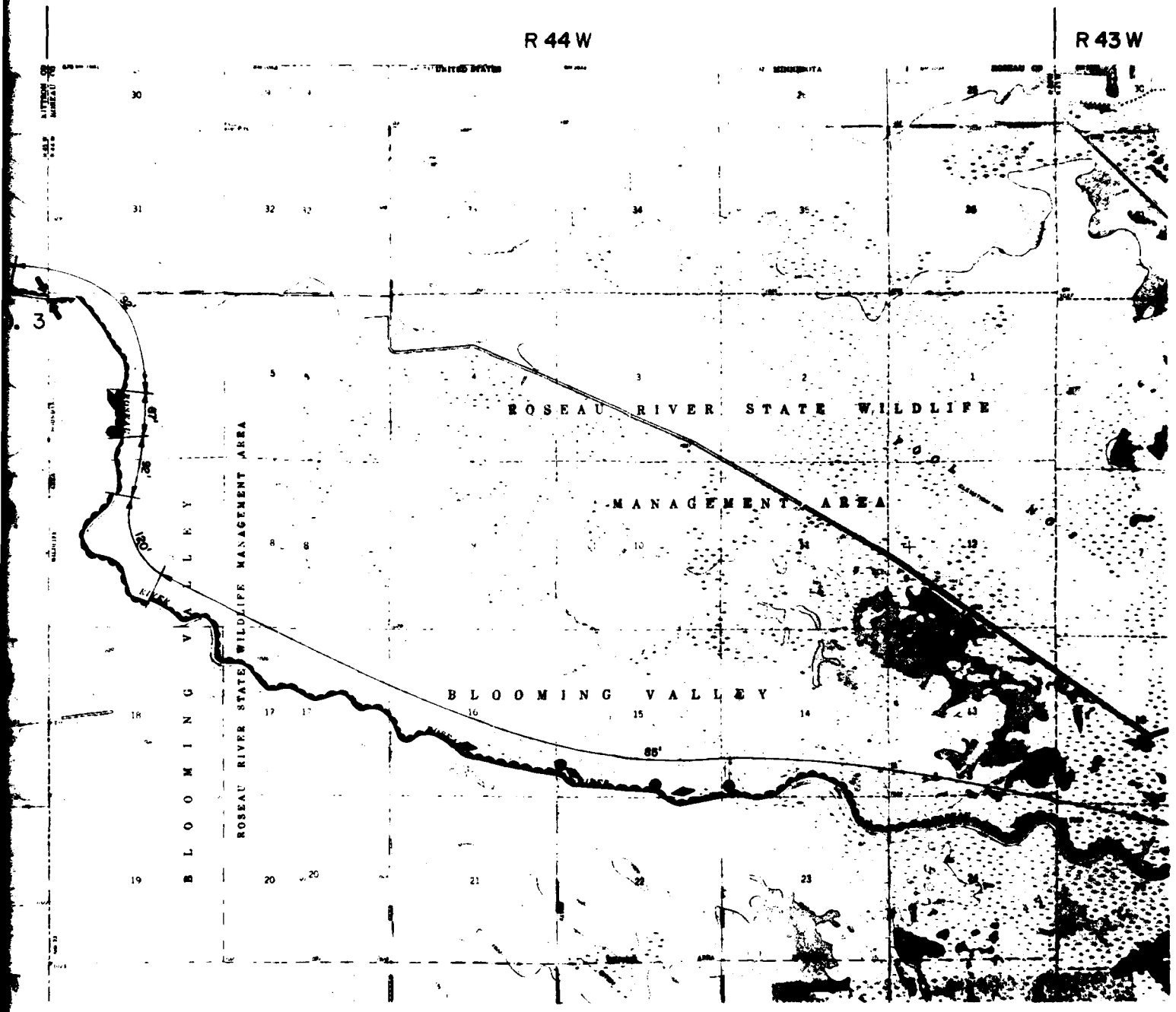


LEGEND

- DOWNSTREAM CONSERVATION PLUG
- UPSTREAM CONSERVATION PLUG
- PLUG EXISTING CHANNEL
- MODIFIED DITCH INLET
- DISPOSAL AREA
- NEW CHANNEL CUTOFF
- LEVEE

PROJECT AI

MILE 91.2 – I
ABOVE I



OJECT ALIGNMENT
ILE 91.2 – MILE 106.0
ABOVE MOUTH

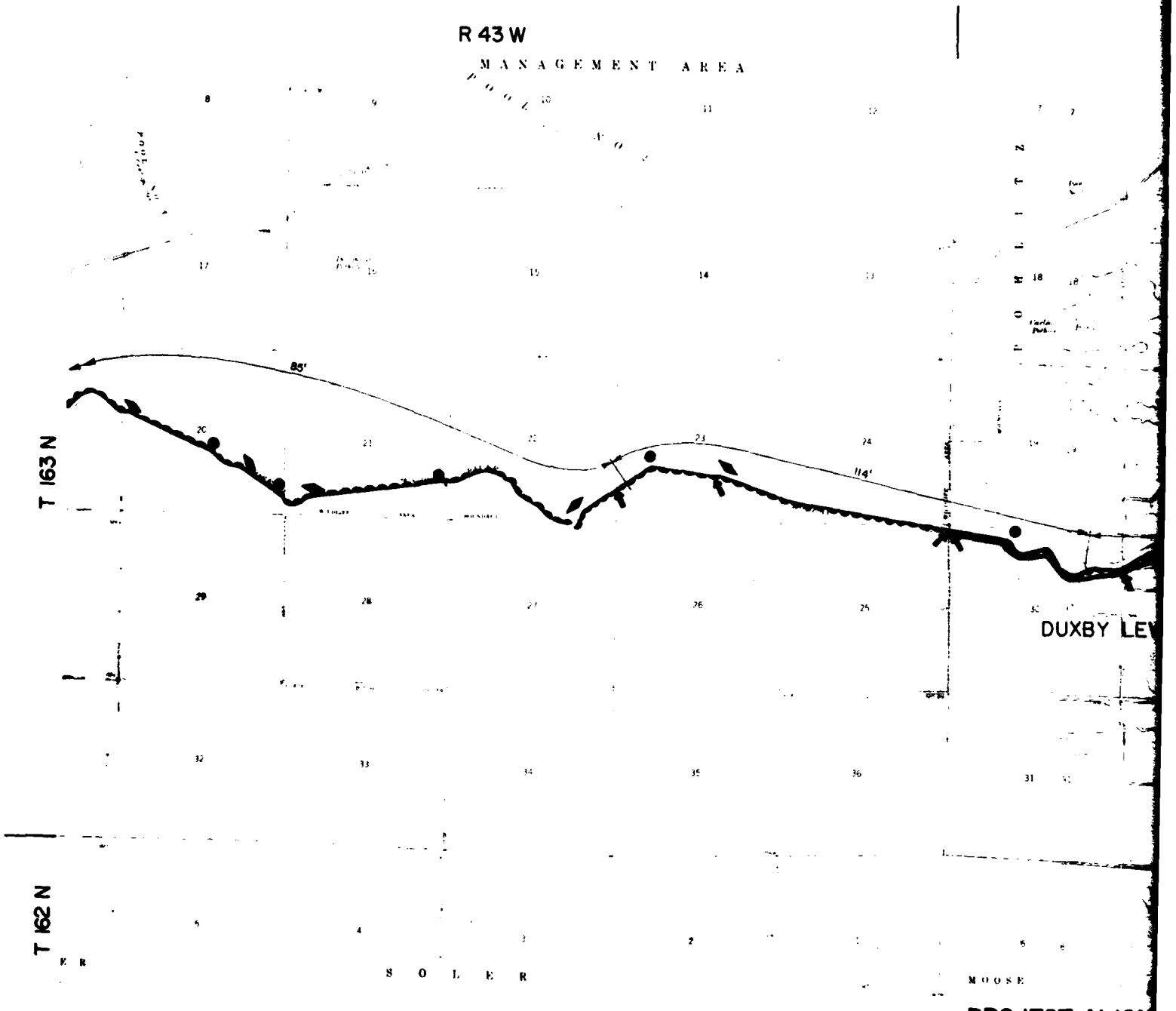
ST. PAUL DISTRICT

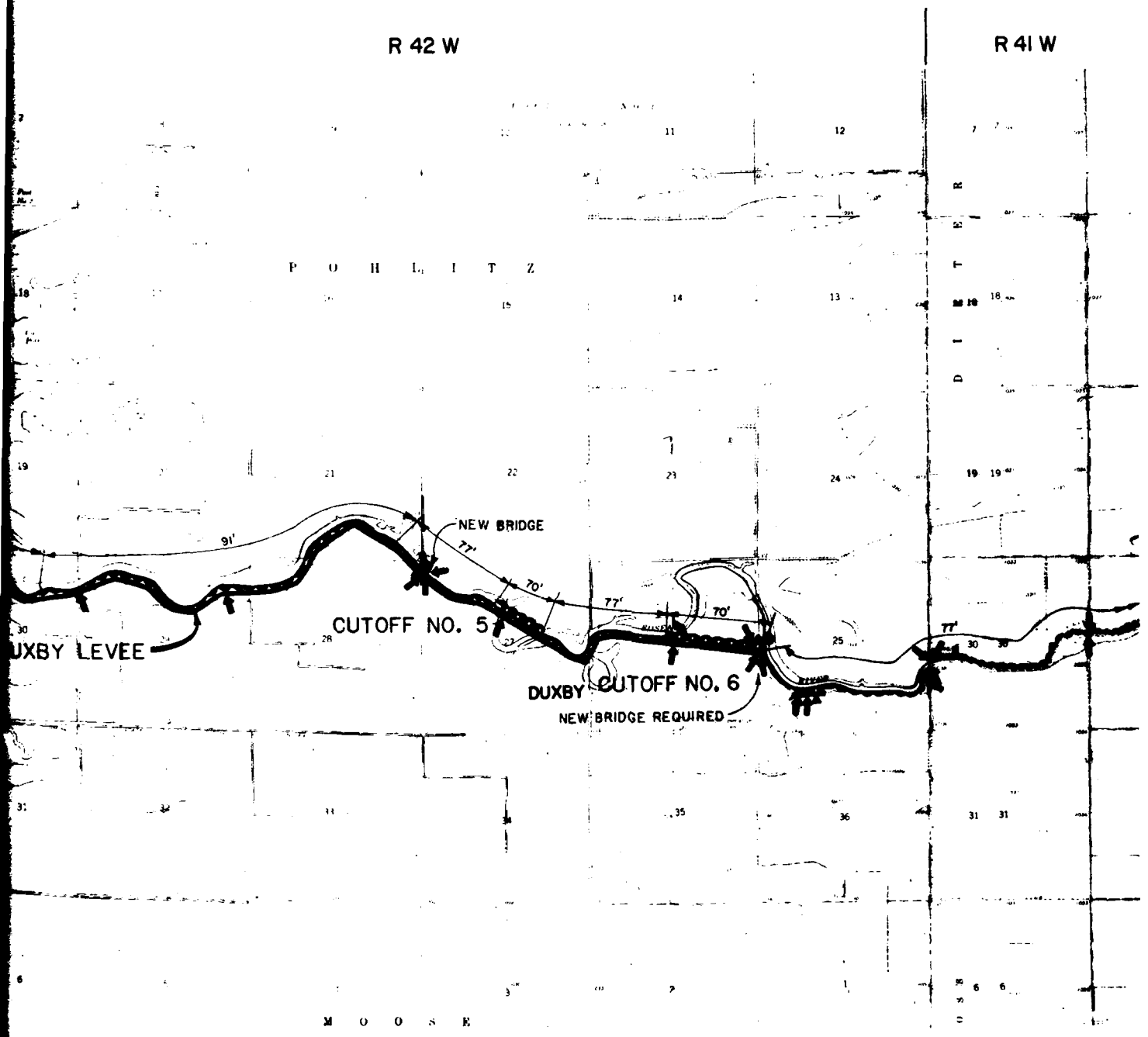
FLOOD CONTROL
ROSEAU RIVER, MINNESOTA

A-2

EXHIBIT 2

4 2


R 43 W
MANAGEMENT AREA
T 163 N
T 162 N
85'
114'
DUXBY LE
S O L E R
MOOSE
PROJECT ALIGN
MILE 106.0 - MILE
ABOVE MOUT
LEGEND
DOWNSTREAM CONSERVATION PLUG
UPSTREAM CONSERVATION PLUG
PLUG EXISTING CHANNEL
MODIFIED DITCH INLET
DISPOSAL AREA
NEW CHANNEL CUTOFF
LEVEE



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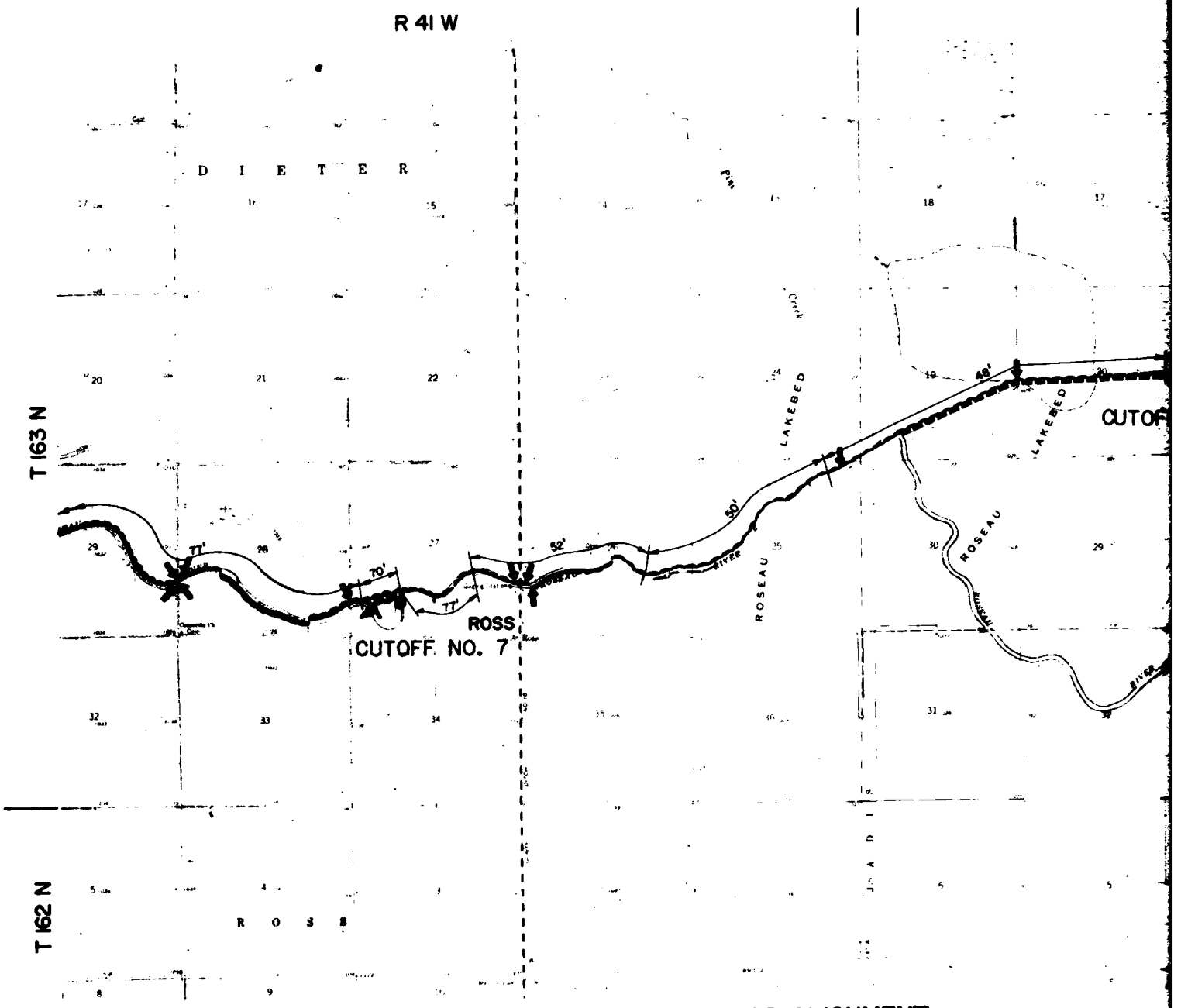
06.0 - MILE 120.1
OVE MOUTH

ST. PAUL DISTRICT

FLOOD CONTROL
ROSEAU RIVER, MINNESOTA

1 h

EXHIBIT 2



PROJECT ALIGNMENT

MILE 120.1 - MILE 137.4
ABOVE MOUTH

LEGEND

- UPSTREAM CONSERVATION PLUG
- DOWNSTREAM CONSERVATION PLUG
- PLUG EXISTING CHANNEL
- MODIFED DITCH INLET
- DISPOSAL AREA
- NEW CHANNEL CUTOFF
- LEVEE

ROSE

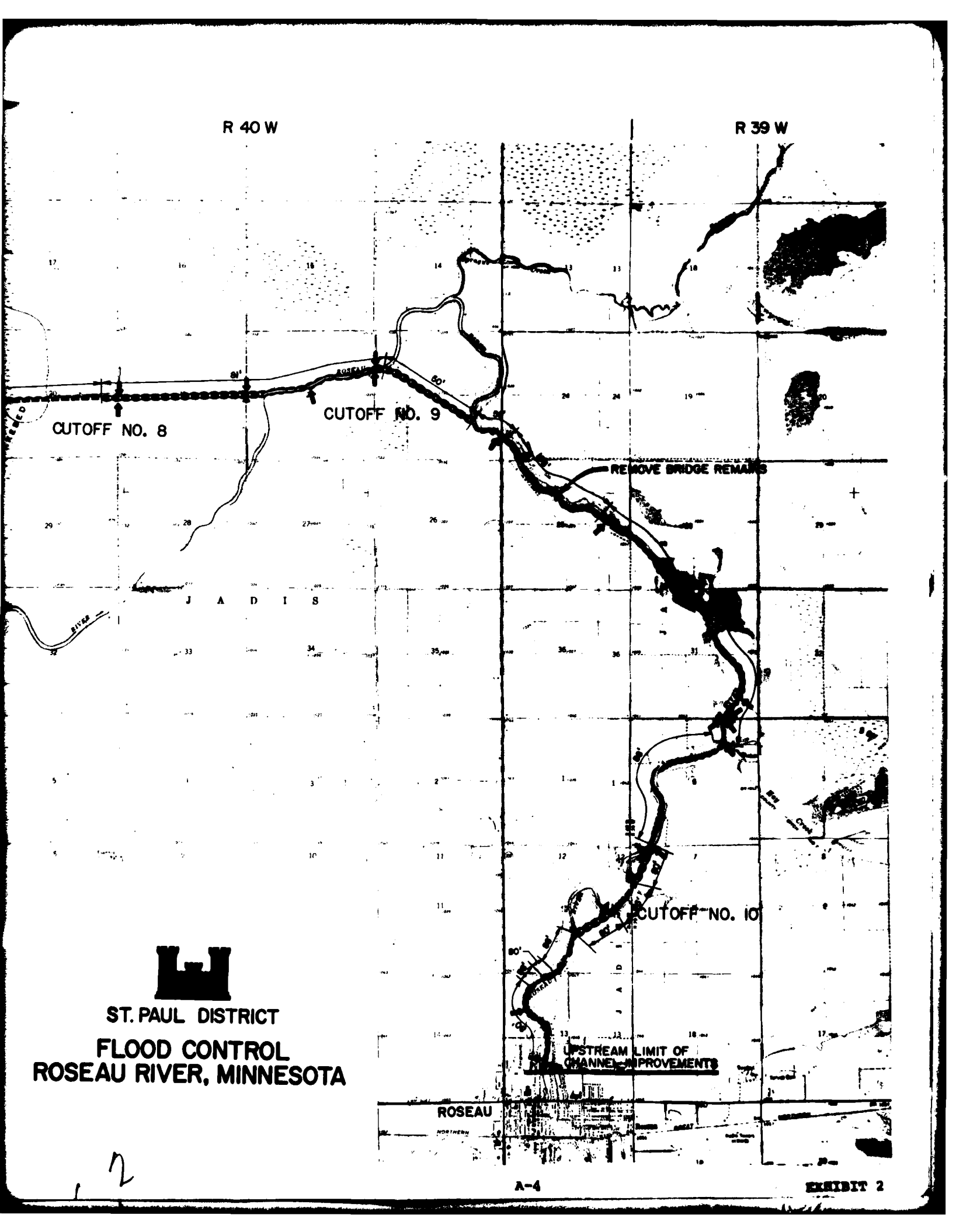
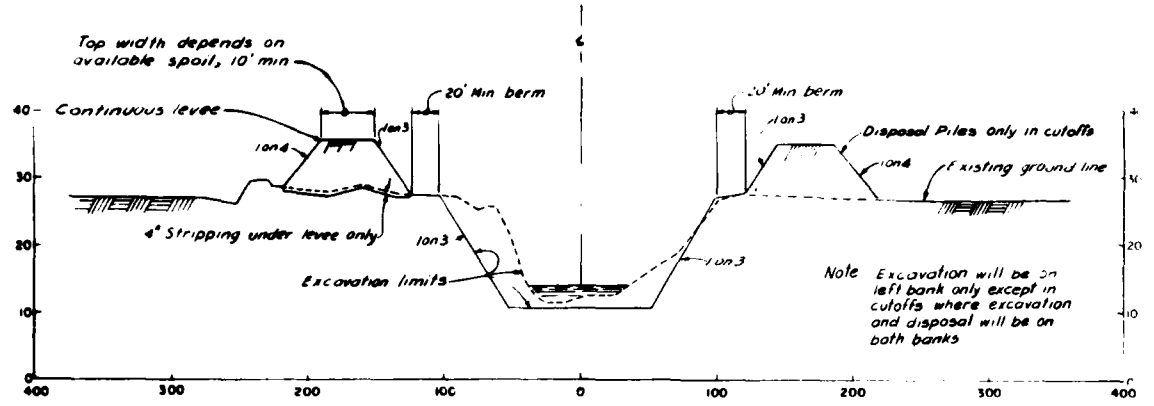
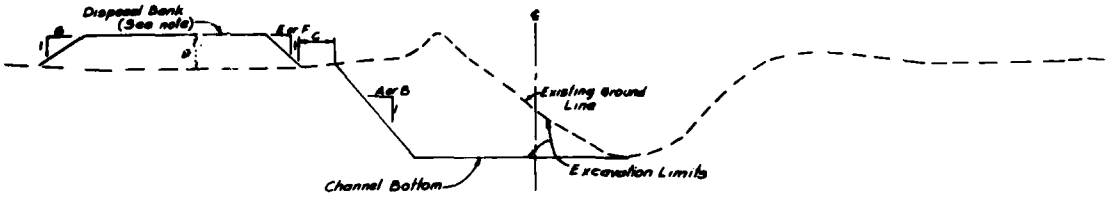

R 40 W
R 39 W
CUTOFF NO. 8
CUTOFF NO. 9
REMOVE BRIDGE REMAINS
CUTOFF NO. 10
UPSTREAM LIMIT OF CHANNEL IMPROVEMENTS
ROSEAU
J A D I S
ST. PAUL DISTRICT
FLOOD CONTROL
ROSEAU RIVER, MINNESOTA

EXHIBIT 2



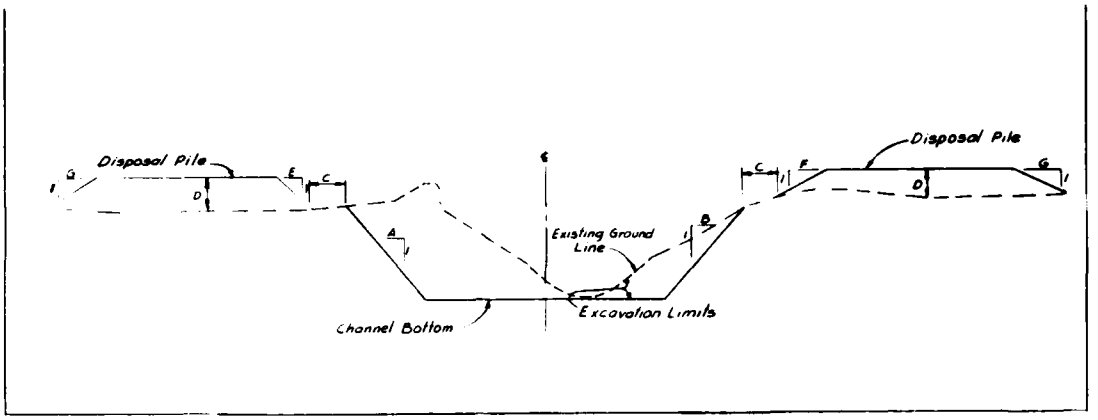
LEVEE AND CHANNEL SECTION – REACH I



TYPICAL CHANNEL SECTION WITHOUT LEVEE

EXCAVATION ON ONE BANK

NOT TO SCALE



TYPICAL CHANNEL SECTION WITHOUT LEVEE

EXCAVATION ON BOTH BANKS

NOT TO SCALE

ALLOWABLE CONFIGURATIONS

AS DEFINED BY TYPICAL CHANNEL SECTION ABOVE

REACH	STATION FROM	STATION TO	A LEFT BANK	B RIGHT BANK	C (MINIMUM)	D	E LEFT BANK	F RIGHT BANK	G
1	0+00	1612+00	3	3	20	8	3	3	4
2 *	1612+00	1904+00	4	4	85	8	5	5	5
					70	6	5	5	5
					47	4	5	5	5
3 *	1904+00	1971+00	4	4	92	8	3	5	5
					84	6	3	5	5
					62	4	3	5	5
4	1971+00	2018+00	4	4	92	8	5	5	5
5	2018+00	2056+00	3	3	60	8	5	5	5
6	2056+00	2316+55	3	3	30	8	3	3	4
7	2316+55	2320+80	3	2 1/2	—	—	—	—	—

* THE FINAL CONFIGURATION WILL BE DETERMINED BY THE CONTRACTOR PRIOR TO CONSTRUCTION ON THE BASIS OF MINIMUM CONSTRUCTION COST

NOTES

1 FOR PLAN, CHANNEL BOTTOM WIDTH AND DESIGNATED SIDE FOR EXCAVATION SEE EXHIBITS 2, 3, & 4

2 OPENINGS WILL BE PROVIDED IN DISPOSAL PILES FOR NATURAL DRAINAGE

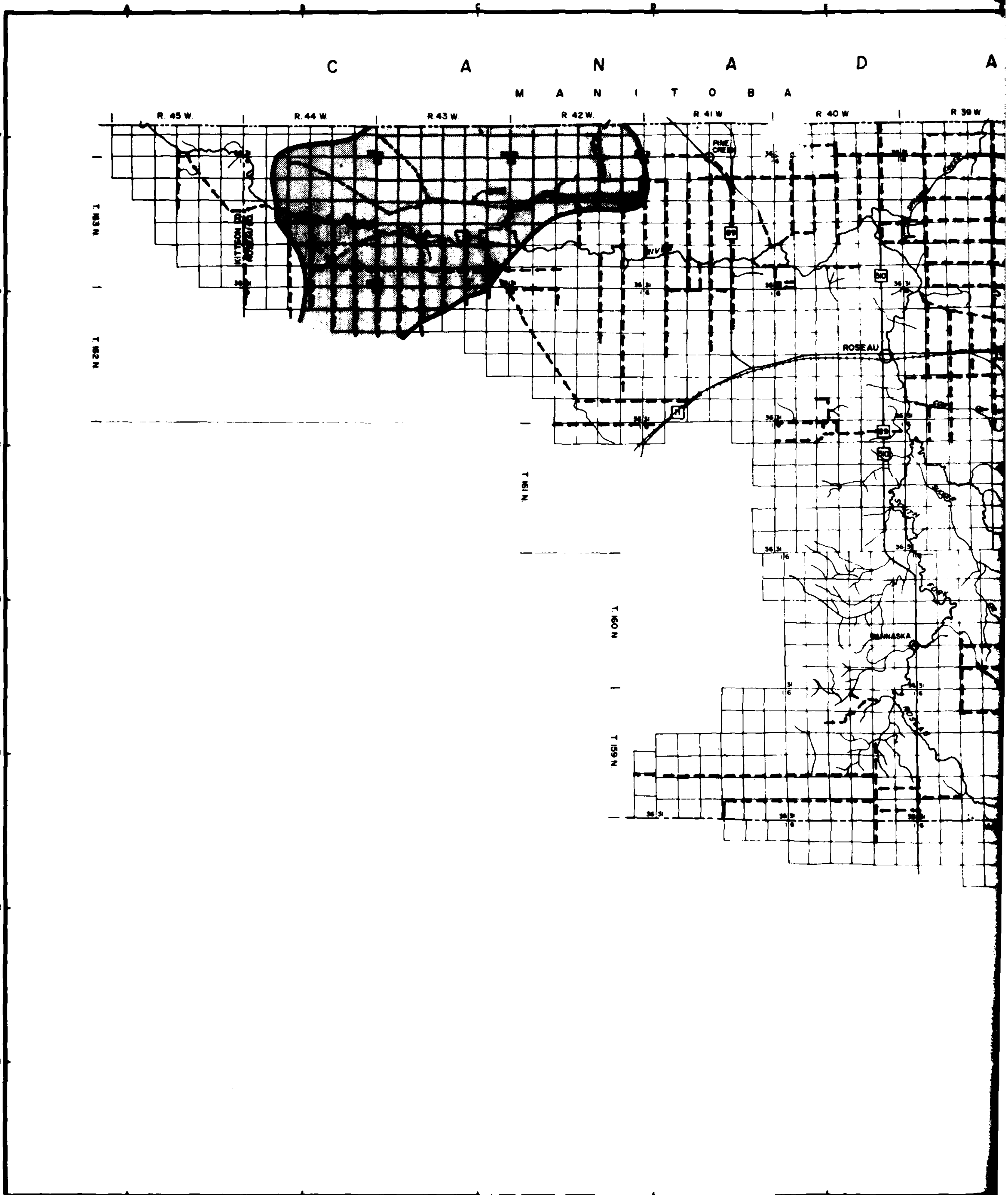
3 ALL EXCAVATED MATERIAL WILL BE PLACED ON CHANNEL SIDE DESIGNATED FOR EXCAVATION

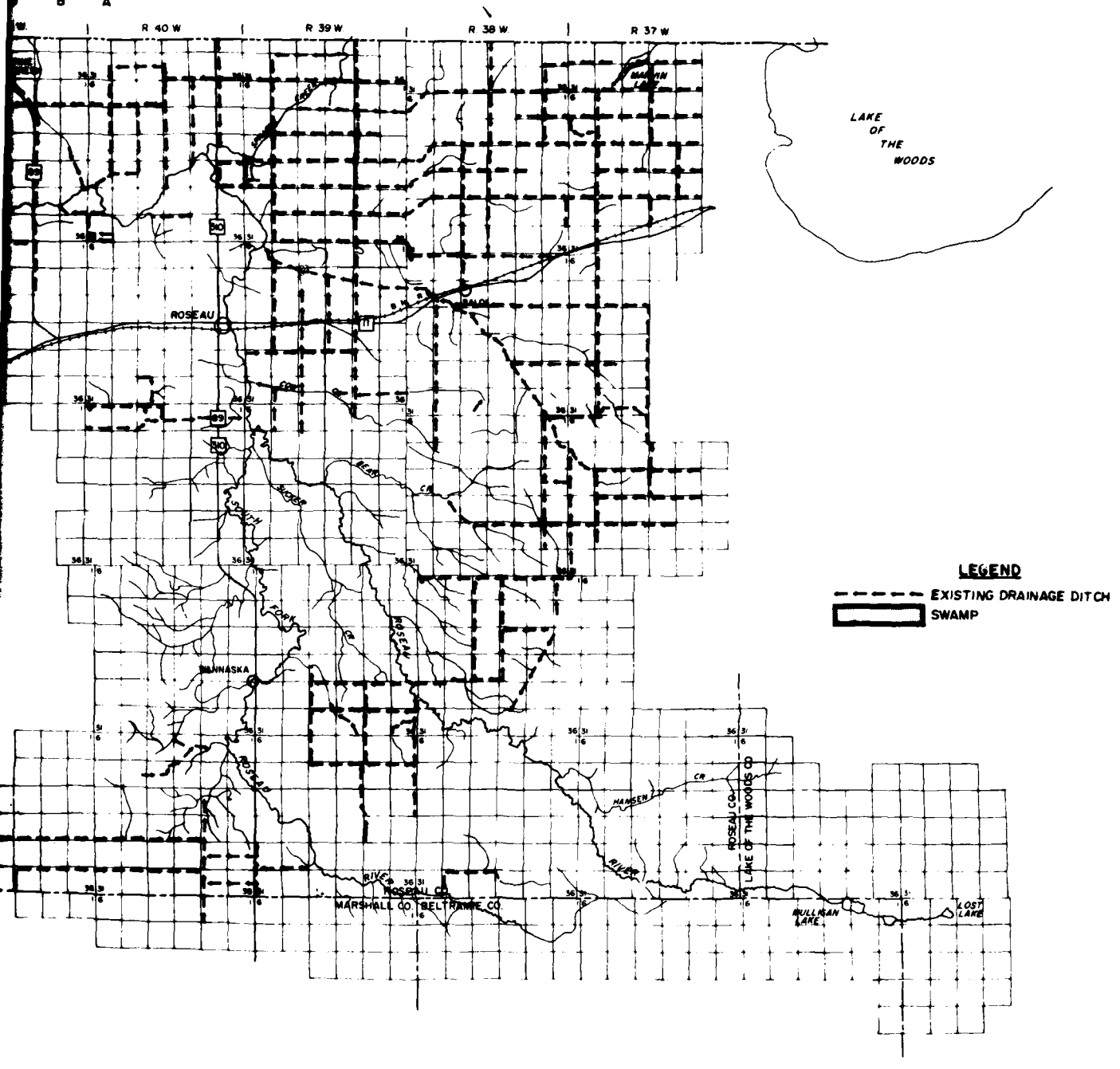
SAFETY DAYS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: JC, DT
DRAWN BY: BS
SUBMITTED BY:
APPROVED:
DATE:

FLOOD CONTROL
ROSEAU RIVER, MINNESOTA
TYPICAL CHANNEL SECTION
LEVEE AND CHANNEL SECTION-REACH I


C A N A D A
M A N I T O B A
R. 45 W.
R. 44 W.
R. 43 W.
R. 42 W.
R. 41 W.
R. 40 W.
R. 39 W.
T. 163 N.
T. 162 N.
T. 161 N.
T. 160 N.
T. 159 N.
PINE CREEK
ROSEAU
WANNASKA
89
310
11
A
B
C
D
E
7
6
5
4
3
2
1



ROSEAU RIVER WATERSHED DISTRICT
EXISTING DITCH SYSTEM

FEBRUARY 1976

EXHIBIT 4

Stream-gaging Stations and Pertinent Data Through April 1969, Roseau River and Tributaries

Station	River miles above mouth	Drainage area square miles	Period of record From	Period of record To	Gage zero[1]	Maximum discharge recorded Stage	Maximum discharge recorded Discharge cfs	Maximum discharge recorded Date of occurrence	Minimum discharge recorded Stage	Minimum discharge recorded Discharge cfs	Minimum discharge recorded Date of occurrence	Average Discharge cfs
Roseau River near Malung, Minn.	148.7	252	Oct 1939	Sept 1946	1,050[2]	9.85	1,750	10 Apr 1941		0		39.8
Roseau River at Malung, Minn.	147.3	252	Aug 1928	June 1938	1,039.98[2]	12.44	1,780	11 May 1938		0		
Roseau River below South Fork, near Malung, Minn.	145.2	573	Oct 1946	Date	1,029.67[2]	21.59[6]	5,110	11 April 1969		0	15 Jan 1952	150
Roseau River at Ross, Minn.	125.0	1,220	July 1928	Date	1,018.44	18.25	6,560	12 May 1950		0	28 Aug 1961	259
Roseau River at Caribou, Minn.	94.6	1,570	Apr 1917 Apr 1920	Oct 1917 Sept 1930	1,001.19 1,001.19	12.8	3,170	24 May 1927	3.15	4	Sept 1917	
Roseau River below State Ditch 51 near Caribou, Minn.	93.9	1,570	Apr 1929	Date	1,002.14	11.81	4,080	19 May 1950		0	13 Aug 1936	298[7]
South Fork Roseau River near Malung, Minn.[3]	0.5	312	May 1911 July 1928 Oct 1939	Sept 1914 June 1938 Sept 1946	 1,032.98[2] 1,032.98[2]	17.42	1,890	8 Apr 1941		0	Several times	26.1
Sprague Creek near Sprague, Manitoba, Canada[4]	8.0	151[5]	Sept 1928	Date	1,038.1	15.31	2,070	1 Sept 1942		0	Several times	61.3
Pine Creek near Pine Creek, Minn.	7.3	74.6	Aug 1928	Sept 1953	1,038.42	9.79	706	25 Sept 1941		0	5-14 Jan 1942	31.5
Badger Creek near Badger, Minn.	11.8	2.2	Apr 1929 Oct 1931	Sept 1930 Sept 1938	1,047.5 1,047.5	5.64	236	1 May 1937		0	Many months	2.3

[1] Elevation in feet above m.s.l. (1928 adj.) Canada unless otherwise noted

[2] Elevation in feet above m.s.l. (1912 adj.)

[3] Published as West Branch Roseau River, 1911-1914.

[4] Formerly known as Mud Creek.

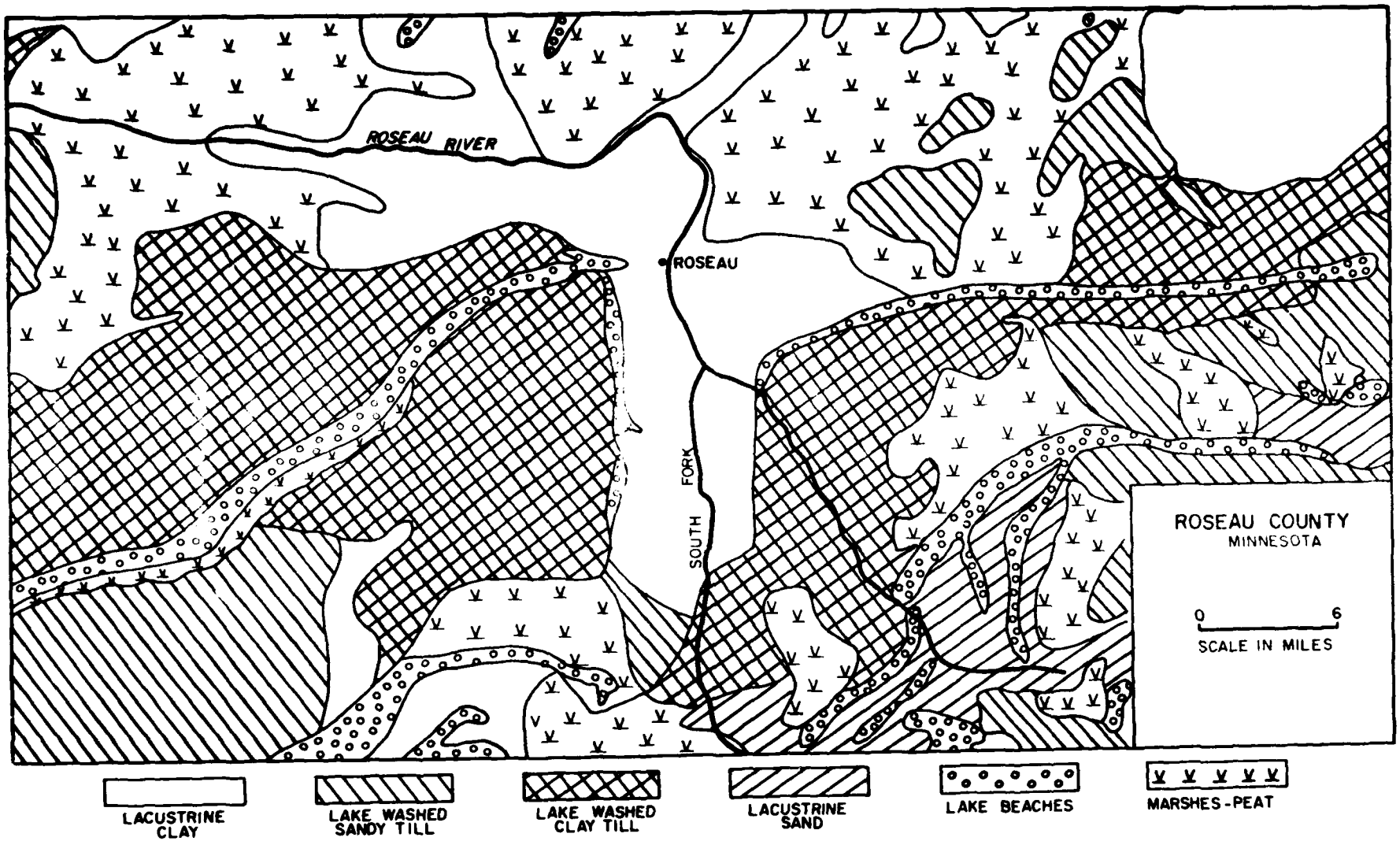
[5] Increased to 169 sq. mi. in Oct 1958 due to construction of drainage ditch

[6] In 1966 backwater effect from ice (stage 23.37 discharge 4750 cfs, 3 Apr 1966)

[7] Average for 15 years (1929-30, 1931-33, 1936-37, 1940-43).

Source: United States, 1971. "Flood Control Roseau River, Minnesota; General Design Memorandum." U.S. Army Corps of Engineers, St. Paul District.

EXHIBIT 6



Surficial geology of Roseau County, Minnesota (after Leverett, 1914).

Source: IES Assessment, 1973

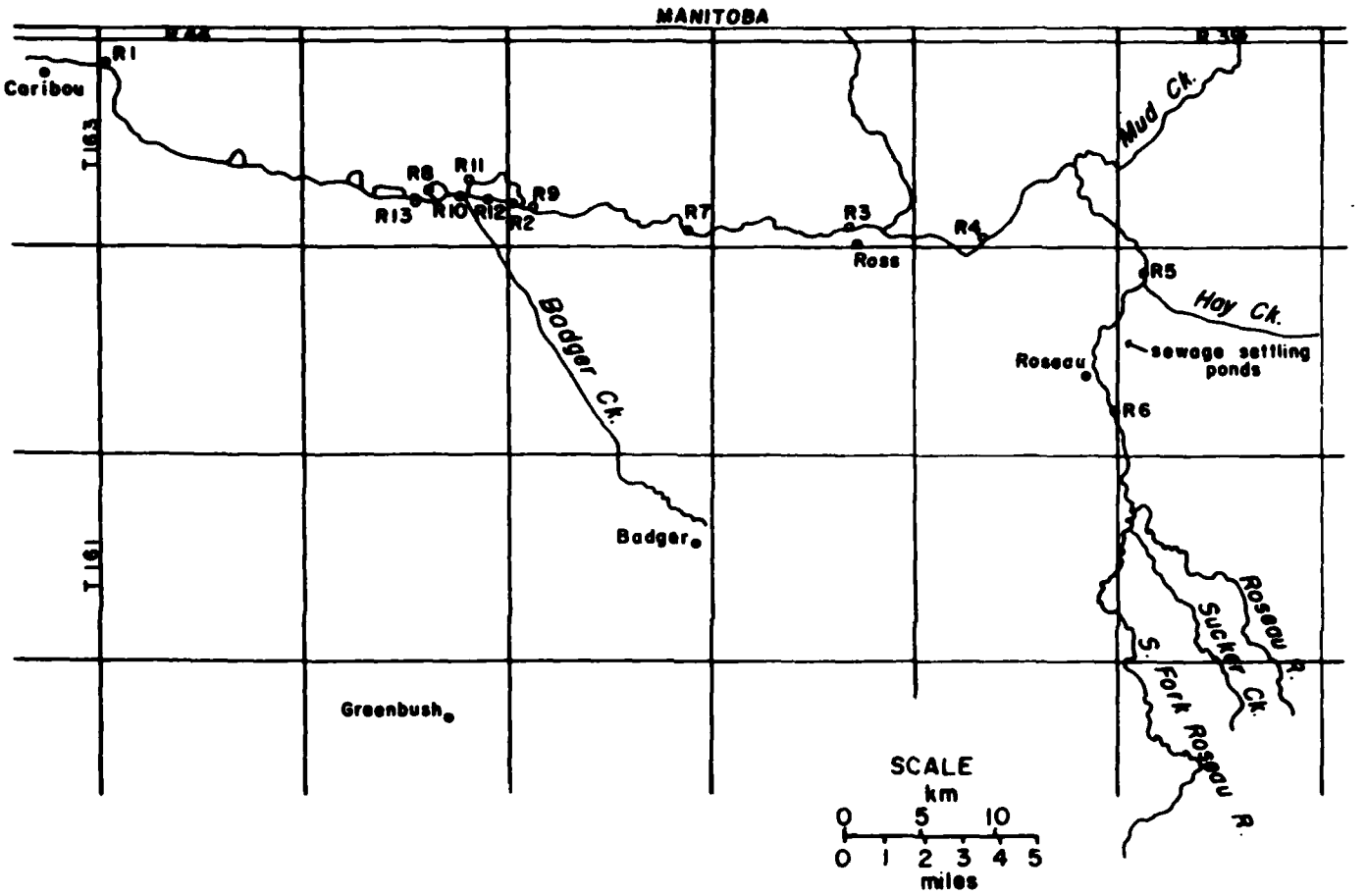
Soil and sediment types adjacent to the Roseau River between the city of Roseau and the Canadian border.

Soil	Percentage of River length	Parent sediment	Classification
Peat	30%	swamp peat (usually over clay)	Azonal
Fargo	27%	lacustrine clay and silt	Humic Gley or Solonchak
Bearden	17%	lacustrine silts	Solonchak and Chernozem
Pelan and Kittson (Undiff.)	6%	glacial till	Chernozem
Malung	5%	lacustrine silts	Degraded Chernozem
Arveson	4%	lacustrine and slough sands	$CaCO_3$ Solonchak
Poppleton	4%	lacustrine sands	Degraded Chernozem
Alluvium	4%	floodplain silts	Azonal
Ulen	3%	lacustrine sands	Chernozem
Maple	2%	lacustrine clays	Solonchak
Kittson	0.5%	glacial till	Chernozem

Source: IES Assessment, 1973

EXHIBIT 7

EXHIBIT 8



Location of sampling points on the Roseau River, northwestern Minnesota.

Source: IES Assessment, 1973

DESCRIPTIONS OF WATER, PLANKTON, FISH AND BOTTOM SEDIMENT SAMPLING SITES

R1: Roseau River, 18 miles west of Highway 3 and 5 miles north of Highway 10, several miles downstream from the Roseau River Wildlife Management Area, only 1.5 miles before the stream enters Canada

R2: Roseau River, 6.5 miles west of Highway 3 and 1 mile north of Highway 10, dredged channel adjacent to oxbow # 1

R3: Roseau River at Ross, Minnesota

R4: Roseau River, 3 miles west and 4 miles north of Roseau, Minnesota, at County Highway 123

R5: Roseau River at County Highway 28, just below the junction of Hay Creek and just downstream from the Roseau municipal sewage settling ponds

R6: Roseau River, 1 mile southeast of Roseau, Minnesota

R7: Roseau River, 1 mile west of Highway 3 and 0.5 miles north of Highway 10

R8: Roseau River, 8.5 miles west of Highway 3 and 1.5 miles north of Highway 10, oxbow # 2

R9: Roseau River, 6 miles west of Highway 3 and 1 mile north of Highway 10, just above oxbow # 1

R10: Roseau River 7.5 miles west of Highway 3 and 1.5 miles north of Highway 10, between oxbows 1 and 2

R11: Roseau River, 7.25 miles west of Highway 3 and 1.5 miles north of Highway 10, oxbow # 1

R12: Roseau River, 7 miles west of Highway 3 and 1.25 miles north of Highway 10, dredged channel adjacent to oxbow # 1

R13: Roseau River, 9 miles west of Highway 3 and 1 mile north of Highway 10

Three sets of water samples were collected for chemical analysis on July 20, August 12 and September 20, 1973. In each case, water was collected from the center of the channel at a depth of about 0.5 meter

WATER QUALITY DATA

Site-Agency	Samples	Period	Range	Mean	Median
Temperature - Degrees Fahrenheit					
Malung-MPCA	8	5/23/67-6/25/68	76.0-31.0	52.2	59.0
Below Roseau-USGS	27	10/26/72-9/8/75	79.7-32.0	46.0	39.2
Ross-USGS	3	9/20/66-9/25/68	58.0-48.2	52.7	51.8
Caribou-MPCA	9	5/23/67-6/25/68	76.0-32.0	50.1	58.0
Below St.Ditch 51-USGS	29	10/25/72-4/30/75	77.0-32.0	14.5	33.0
Turbidity - JTU					
Malung[1]	8	5/23/67-6/25/68	50.0-5.0	21.9	19.0
Below Roseau	1	11/14/74	-	5.0	5.0
Ross	-	-	-	-	-
Caribou	8	5/23/67-6/25/68	100.0-1.0	27.0	21.5
Below St. Ditch 51	6	10/1/74 -4/30/75	11.0-3.0	6.3	6.5
pH					
Malung	8	5/23/67-6/25/68	8.2-7.2	7.7	7.7
Below Roseau	32	10/26/72-9/8/75	9.8-7.2	8.1	8.1
Ross	6	9/26/62-9/25/68	8.1-7.1	7.8	7.8
Caribou	8	5/23/67-6/25/68	8.2-7.0	7.6	7.5
Below St. Ditch 51	32	10/25/72-4/30/75	9.7-6.9	8.0	7.8
Color - Platinum-Cobalt Units					
Malung	8	5/23/67-6/25/68	70-10	34	-
Below Roseau	26	10/26/72-9/8/75	90-30	43	-
Ross	6	9/29/62-9/25/68	70-32	47	-
Caribou	8	5/23/67-6/25/68	100-25	46	-
Below St. Ditch 51	25	10/25/72-4/30/75	90-30	61	-
Conductivity - µmhos at 25°C					
Malung	8	5/23/67-6/25/68	560-96	362	-
Below Roseau	34	10/26/72-9/8/75	690-255	455	-
Ross	6	9/29/62-9/25/68	926-389	520	-
Caribou	8	5/23/67-6/25/68	730-260	400	-
Below St. Ditch 51	34	10/25/72-4/30/75	830-220	454	-
Total Alkalinity - mg/l as $CaCO_3$					
Malung	8	5/23/67-6/25/68	330-28	195	-
Below Roseau	26	10/26/72-9/8/75	304-103	211	-
Ross	3	9/20/66-9/25/68	271-210	232	-
Caribou	8	5/23/67-6/25/68	450-64	202	-
Below St. Ditch 51	25	10/25/72-4/30/75	436-94	226	-

[1] The agency which tested at each of the five sites was the same for all parameters in this exhibit as listed under the parameter temperature.

WATER QUALITY DATA (cont)

Site-Agency	Samples	Period	Range	Mean	Median
Dissolved Oxygen - mg/l					
Malung	8	5/23/67-6/25/68	12.1-6.0	8.2	8.0
Below Roseau	33	10/26/72-9/8/75	14.4-0.8	8.6	9.2
Ross	-	-	-	-	-
Caribou	8	5/23/67-6/25/68	13.4-0.0	7.2	6.6
Below St. Ditch 51	33	10/25/72-4/30/75	12.9-0.4	6.3	6.9
BOD_5 - mg/l					
Malung	8	5/23/67-6/25/68	4.5-1.3	2.6	-
Below Roseau	26	10/26/72-9/8/75	16.0-1.2	3.4	-
Ross	-	-	-	-	-
Caribou	8	5/23/67-6/25/68	7.5-0.8	3.1	-
Below St. Ditch 51	25	10/25/72-9/9/75	7.0-0.8	2.7	-
Fecal Coliform Bacteria - MPNECMED and MFM-FCBR***					
Malung **	8	5/23/67-6/25/68	80-20	31	20
Below Roseau *	26	4/17/73-9/8/75	1800-12	311	115
Ross	-	-	-	-	-
Caribou **	8	5/23/67-6/25/68	11000-20	1399	20
Below St. Ditch 51 *	25	4/18/73-9/9/75	78-0	23	19
Total Phosphorus - mg/l					
Malung	8	5/23/67-6/25/68	.16-.03	.08	-
Below Roseau	26	10/26/72-9/8/75	1.80-.00	.36	-
Ross	-	10/19/67-9/25/68	.73-.10	.42	-
Caribou	8	5/23/67-6/25/68	.97-.04	.22	-
Below St. Ditch 51	25	10/25/72-4/30/75	1.10-.04	.24	-
Ammonia total - mg/l as N					
Malung	8	5/23/67-6/25/68	0.32-0.05	.11	-
Caribou	8	5/23/67-6/25/68	1.90-0.05	.35	-
Chromium total - mg/l					
Below St. Ditch 51	2	10/1/74-2/4/75	0.00-0.00	.00	0.00
Copper total - mg/l					
Below St. Ditch 51	2	10/1/74-2/4/75	3.40-0.01	1.70[2]	-

[2] Essentially occurred as suspended Cu.

WATER QUALITY DATA (cont)

Site-Agency	Samples	Period	Range	Mean	Median
Calcium dissolved - mg/l					
Malung	-	-	-	-	-
Below Roseau	26	10/26/72-9/8/75	73.0-27.0	53.8	-
Ross	6	9/29/62-9/25/68	118.0-39.0	64.3	-
Caribou	-	-	-	-	-
Below St. Ditch 51	25	10/25/72-4/30/75	96.0-29.0	55.5	-
Magnesium dissolved - mg/l					
Malung	-	-	-	-	-
Below Roseau	26	10/26/72-9/8/75	29.0-11.0	19.7	-
Ross	6	9/29/62-9/25/68	42.0-13.0	24.3	-
Caribou	-	-	-	-	-
Below St. Ditch 51	25	10/25/72-4/30/75	39.0-9.9	22.4	-
Sodium dissolved - mg/l					
Malung	-	-	-	-	-
Below Roseau	26	10/26/72-9/8/75	78.0-2.0	13.8	-
Ross	6	9/29/62-9/25/68	36.0-2.8	13.0	-
Caribou	-	-	-	-	-
Below St. Ditch 51	25	10/25/72-4/30/75	25.0-2.5	8.2	-
Potassium dissolved - mg/l					
Malung	-	-	-	-	-
Below Roseau	26	10/26/72-9/8/75	8.5-0.8	2.4	-
Ross	6	9/29/62-9/25/68	3.9-1.2	2.5	-
Caribou	-	-	-	-	-
Below St. Ditch 51	25	10/25/72-4/30/75	5.1-0.8	2.4	-
Chloride - mg/l					
Malung	8	5/23/67-6/25/68	5.0-1.0	2.7	-
Below Roseau	26	10/26/72-9/8/75	110.0-1.6	11.1	-
Ross	6	9/29/62-9/25/68	26.0-0.6	8.6	-
Caribou	8	5/23/67-6/25/68	22.0-1.0	5.1	-
Below St. Ditch 51	25	10/25/72-4/30/75	22.0-1.5	4.9	-

WATER QUALITY DATA (cont)

Site-Agency	Samples	Period	Range	Mean	Median
Sulfate total - mg/l					
Malung	-	-	-	-	-
Below Roseau	26	10/26/72-9/8/75	37.0-7.0	16.4	-
Ross	6	9/29/62-9/25/68	45.0-13.0	26.0	-
Caribou	-	-	-	-	-
Below St. Ditch 51	25	10/25/72-4/30/75	26.0-7.2	15.7	-
Nitrate & Nitrite dissolved - mg/l as N					
Malung	-	-	-	-	-
Below Roseau	10	10/26/72-10/3/73	0.66-0.00	0.20	-
Ross	6	9/29/62-9/25/68	1.85-0.04	0.47	-
Caribou	-	-	-	-	-
Below St. Ditch 51	11	10/25/72-4/30/75	0.33-0.00	0.08	-

EXHIBIT 10

Roseau River Chemistry Data, 1973, Assessment Study

Date	Station	Ca mg/l	Mg mg/l	K mg/l	Na mg/l	HCO_3^- mg/l	Total P ppb	Ortho P ppb	NO_3^--N ppb	NO_2^--N ppb	NH_3^--N ppb	Specific Conductance umhos/cm	Chlorophyll a mg/m^3	Total Suspended Solids mg/l	pH	O_2 mg/l	T°C
7/20	R1	46.0	21.4	1.27	7.0	241	346	226	1		300	264	8.65	41	8.0	4.5	19.5
	R2	36.9	16.6	1.22	4.9	173	246	158	9		120	222	4.55	25	8.0	7.0	22
	R3	34.5	17.8	1.17	4.7	160	246	140	9		150	210	5.61	35	7.6	9.0	21.5
	R4	36.0	17.5	1.04	6.3	152	230	119	13		80	209	15.07	28	7.6	7.0	23
	R5	57.2	28.7	2.40	23.1	282	1448	990	13	62	130	425	5.12	13	8.2	7.5	21.5
	R6	59.7	25.1	2.02	9.0	274	103	58	4		60	334	3.29	1	7.9	7.5	21.5
	R7	36.7	17.6	1.16	4.7	177	230	160	22		160	220	2.86	18	8.0	7.5	21.5
	R8	42.5	20.3	1.16	5.5	195	229		4		60	244	1.26	9	8.0	4.0	19.5
8/13	R1	36.2	16.5	1.36	3.7	166	254	94	34	5		212	4.62	29	7.5		23
	R2	36.0	15.6	1.42	3.9	155	268	74	66	5		208	5.41	33	7.5		19
	R3	34.5	16.3	1.38	4.0	155	360	76	48	4		201	2.29	75	7.6		21.5
	R4		16.0	1.40	5.9	143	492	130	38	4		200	2.03	57	7.2		21.5
	R5	55.0	24.9	2.38	8.4	228	602	420	13	8		301	3.40	49	8.2		23.5
	R6	48.3	23.2	3.80	7.2	234	184	70	2	0		298	1.37	3	8.0		21.5
	R7	36.2	16.8	1.42	4.0	157	326	90	14	4		208	3.02	57			
	R9	36.4	16.5	1.38	3.8	154	258	96	56	6		207	4.42	32	7.4		21.5
	R10	38.0	16.9	1.46	4.6	155	172	86	16	5		208	2.53	34	7.3		22
	R11	28.0	23.1	1.40	6.6	166	86	28	3	0		194	1.38	1	9.1		24
9/23	R1	38.5	13.4	1.56	4.3	171	126	120	27	7		224	2.49	5.6	7.9		11.0
	R2	38.5	12.2	1.46	4.6	166	193	163	124	16		222	1.71	11.4	7.4		11.5
	R3	39.8	12.5	1.46	5.0	171	176	138	156	24		225	2.50	22.6	7.3		9.5
	R4	37.2	11.8	1.68	3.3	161	113	78	78	12		212	2.92	32.4	7.2		9.5
	R5	37.6	10.7	1.72	3.1	168	134	85	162	18		207	1.12	11.8	7.2		10.0
	R6	37.6	10.6	1.43	2.8	149	60	31	97	13		191	5.09	7.8	7.4		10.5
	R7	39.4	12.6	1.49	4.6	177	156	146	136	20		223	2.85	19.6	7.6		9.5
	R11	31.6	16.1	1.36	4.4	175	17	11		1		218	18.29	19.6	7.6		12.5

Rules, Regulations, Classifications and Water Standards.
Minnesota Pollution Control Agency
Minnesota Reg. WPC-15 - 1968 Edition, 1973 Supplement

Class B The quality of this class of the interstate waters of the state shall be such as to permit the propagation and maintenance of cool or warm water sport or commercial fishing and be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. Limiting concentrations or ranges of substances or characteristics which should not be exceeded in the interstate waters are given below:

Substance or Characteristic	Limit or Range
Dissolved oxygen	Not less than 6 milligrams per liter from April 1 through May 31, and Not less than 5 milligrams per liter at other times.
Temperature *	5°F above natural in streams and 3° F above natural in lakes, based on monthly average of the maximum daily temperature, except in no case shall it exceed the daily average temperature of 86°F.
Ammonia (N)	1 milligram per liter
Chromium (Cr)	0.05 milligram per liter
Copper (Cu)	0.01 milligram per liter or not greater than 1/10 the 96 hour TLM value.
Cyanides (CN)	0.02 milligram per liter
Oil	0.5 milligram per liter
pH value	6.5-9.0
Phenols	0.01 milligram per liter and none that could impart odor or taste to fish flesh or other freshwater edible products such as crayfish,clams, prawns, and like creatures. Where it seems probable that a discharge may result in tainting of edible aquatic products, bioassays and taste panels will be required to determine whether tainting is likely or present.

Substance or Characteristic	Limit or Range
Turbidity value	25
Fecal coliform organisms	200 most probable number per 100 milliliters as a monthly geometric mean based on not less than 5 samples per month, nor equal or exceed 2000 most probable number per 100 milliliters in more than 10% of all samples during any month.
Radioactive materials	Not to exceed the lowest concentration permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.

Classifications

Interstate Waters ----------Listed in WPC 25
Roseau R. from source to international border ----------2B, 3B
Pine Creek----------2B, 3B
Pine Creek Diversion----------2B, 3B
Sprague Creek----------2B, 3C

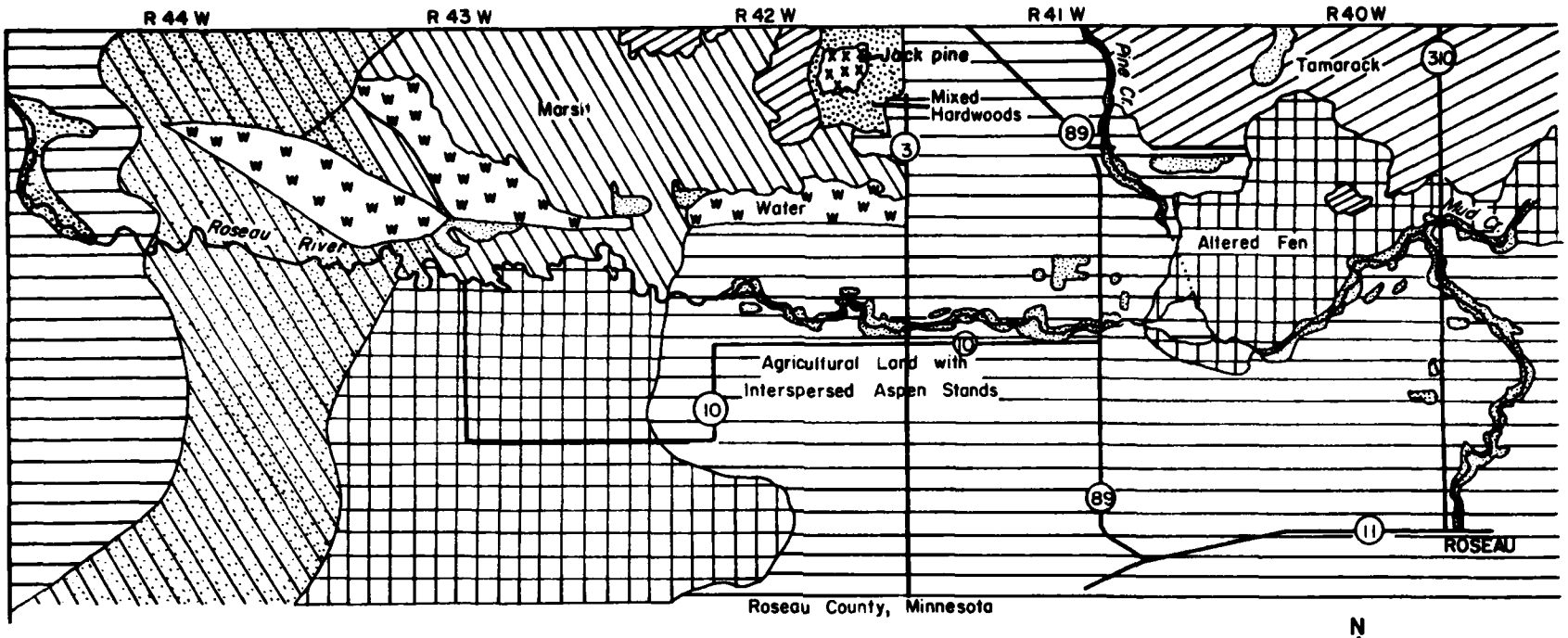
Groundwater Chemistry of Roseau County (in parts per million).
Data from Allison (1932).

	Lower Part of Glacial Drift			Decomposed Rock		
	1	2	3	4	5	6
Depth in feet	114	120	135	140	180	230
Suspended matter	-	-	-	246	-	-
Total Fe	.6	.2	tr*	1.9	tr	4.6
SiO_2	12.0	15.0	13.0	11.0	9.0	12.0
Fe	.6	.2	tr	1.9	tr	4.6
Al	.9	.3	2.1	tr	2.1	-
Ca	60.0	50.0	70.0	24.0	27.0	23.0
Mg	38.0	20.0	60.0	23.0	27.0	14.0
Na	60.0	33.0	75.0	123.0	97.0	99.0
K	10.0	9.0	12.0	14.0	25.0	8.0
CO_3	-	2.4	tr	9.6	4.8	2.4
HCO_3	464.0	298.0	451.0	310.0	307.0	288.0
SO_4	23.0	4.0	168.0	118.0	104.0	47.0
Cl	5.3	3.5	10.0	10.0	18.0	25.0
NO_3	-	tr	tr	tr	-	tr
H_3PO_4	tr	3.9	tr	tr	1.4	2.8
Volatile and organic matter	96.0	60.0	80.0	112.0	86.0	56.0
Total dissolved solids	454.0	280.0	646.0	512.0	490.0	400.0
Total hardness (calculated)	305.8	207.0	421.0	154.3	178.2	114.9

*tr=trace

1. Flowing well at Warroad school
2. Well of Ed Grill in Roosevelt
3. Badger creamery well
4. Roseau creamery well
5. Greenbush creamery well
6. Well of Ebert Lundemo, SE¼ Sec. 6, Noreson Twp. (T. 160 N., R. 41 W.).

EXHIBIT 12



General vegetation map of Roseau River watershed

- Water
- Altered fen
- Jack pine
- Tamarack
- Mixed hardwoods
- Marsh
- Agricultural land with interspersed Aspen stands

Source: IES Assessment, 1973

Description of Vegetation Community Types

a. Black Ash-Basswood Community

This is generally found from Roseau north to the old Roseau Lake area and is predominantly a floodplain type of vegetation. This type of community is found on lacustrine parent materials and soils belonging to the Bearden clay loam series. Characteristic of the community, in addition to the dominant tree species, are wood nettle (Laportea canadensis), which almost blankets the understory, and bloodroot (Sanguinaria canadensis), which was restricted to this community type. Also characteristic of this type are St. John's wort (Hypericum virginicum), thimbleweed (Anemone virginiana) and nodding trillium (Trillium cernuum).

b. Aspen-Balsam Poplar Community

This type of community is very common throughout the Roseau River basin. The parent materials are predominantly lacustrine silts and clay, and the soils belong to the Fargo series. In addition to the dominant tree species, characteristi shrubs of this community type are American hazelnut (Corylus americana), beaked hazelnut (C. cornuta), nannyberry (Viburnum lentago), downy arrowwood (V. rafinesquianum) and highbush cranberry (V. trilobum). Typical of the herb layer are red baneberry (Actaea rubra), wild rye (Elymus sp.) and vetchling (Lathyrus palustris). Loosestrife (Lysimachia ciliata), wild lily-of-the-valley (Maianthemum canadense), spirea (Spiraea alba) and golden alexanders (Zizia aurea) were restricted to this community type.

c. Bur Oak-Green Ash Community

This community is typical of high ground bordering the river between the old Roseau Lake area and the old channel cutoffs west of Duxby. Th soils characteristic of this community are clay loams belonging to the Fargo series. Parent materials of these soils are lacustrine clays. Floristic elements characteristic of this community besides the dominant tree species include hawthorne (Crataegus rotundifolia), stinging nettle (Urtica divica) and thimbleweed.

d. Green Ash-Elm Community

This type is common on the old dredge disposal sites of the channelization completed between 1908 and 1918, and along the river banks from the old Roseau Lake area to the old channel cutoffs west of Duxby. In addition to the dominant species, grasses including reed canary-grass (Phalaris arundinacea) and Kentucky bluegrass (Poa pratensis) and the sedges, Carex retrorsa and C. teneca, are characteristic of this community type. The soils of this community are clay loams that have developed on lacustrine parent materials.

e. Jack Pine Community

This community is located in the Roseau River Wildlife Management Area and represents the northern- and westernmost stand of jack pine in Roseau County. The majority of these communities lie in the southeastern part of the county. Characteristic of this community are jack pine (Pinus banksiana), common bearberry (Arctostaphylos uva-ursi), strawberry (Fragaria virginiana) and low sweet blueberry (Vaccinium angustifolium). The soils of this community developed on lacustrine sands and silts.

f. Tamarack Community

The tamarack communities occur in some of the northern peatlands of the county. Three tamarack communities were examined by the assessment team. The first is located in the Mud Creek swamp area north of Roseau, the second is southeast of Pine Creek and the third is located in the Roseau River Wildlife Management Area. Characteristic of this community type, besides the dominant tamarack, are swamp birch (Betula pumila), common burdock (Arctium minus), marsh marigold (Caltha palustris), leatherleaf (Chamaedaphne calyculata), dwarf cornel (Cornus canadensis), bedstraw (Galium labradoricum and Galium triflorum), and Labrador tea (Ledum groenlandicum), pitcher plant (Sarracenia purpurea) and a number of Sphagnum mosses. Soils are characteristic peat and are underlain by mineral soils or by sand or clay of lacustrine origin.

g. Grassland Community

Grassland communities are common in western Roseau County. Some characteristic floristic elements of this type include smooth bromegrass (Bromus inermis), timothy (Phleum pratense), goldenrod (Solidago rigida) and fringed gentian (Gentiana crinita). Soils of this community are clays which probably belong to the Fargo series. Parent materials on which these soils have developed are lacustrine deposits.

h. Altered Fen

This type is also common in western areas of the drainage basin, especially in the Big Swamp area. Species characteristic of this type are Aster ericoides, marsh bluebell (Campanula aparinoides), Gerardia tenuifolia, silverweed (Potentilla anserina) hard-stem bulrush (Scirpus acutus) and cattail (Typha sp.). Soils characteristically are clays overlain by a shallow layer of peat.

Source: IES Assessment, 1973

EXHIBIT 14

Tree Mensuration Data

The mensuration data presented below provides insight into the size and age distribution of nine forest species. Black ash, bur oak and tamarack are the oldest species in the watershed. Black ash is also the tallest species. It appears sparsely in the shrub layer and shows an absence of younger trees. Green ash, quaking aspen and balsam poplar are the youngest species present, which may reflect the invading nature of these species.

Mensuration Data for the Tree Species

Species	Age Years	Diameter cm	Height m.
Black Ash (Fraxinus nigra)	84-125	12.9-40.6	11-19
Green Ash (Fraxinus pennsylvanica)	37-50	3.8-22.9	3-11
Tamarack (Larix laricina)	43-121	6.4-23.1	3-12
Black spruce (Picea mariana)	15-81	7.4-11.2	3-11
Jack pine (Pinus banksiana)	19-52	5.3-26.2	5-14
Balsam poplar (Populus balsamifera)	25-55	8.6-26.9	5-12
Quaking aspen (Populus tremuloides)	24-50	5.3-27.2	5-12
Bur oak (Quercus macrocarpa)	55-116	5.3-50.0	3-12
American elm (Ulmus americana)	31-70	5.3-33.5	3-14

Source: IES Assessment, 1973

LOCATION OF MINNESOTA DNR FISH CENSUS AREAS

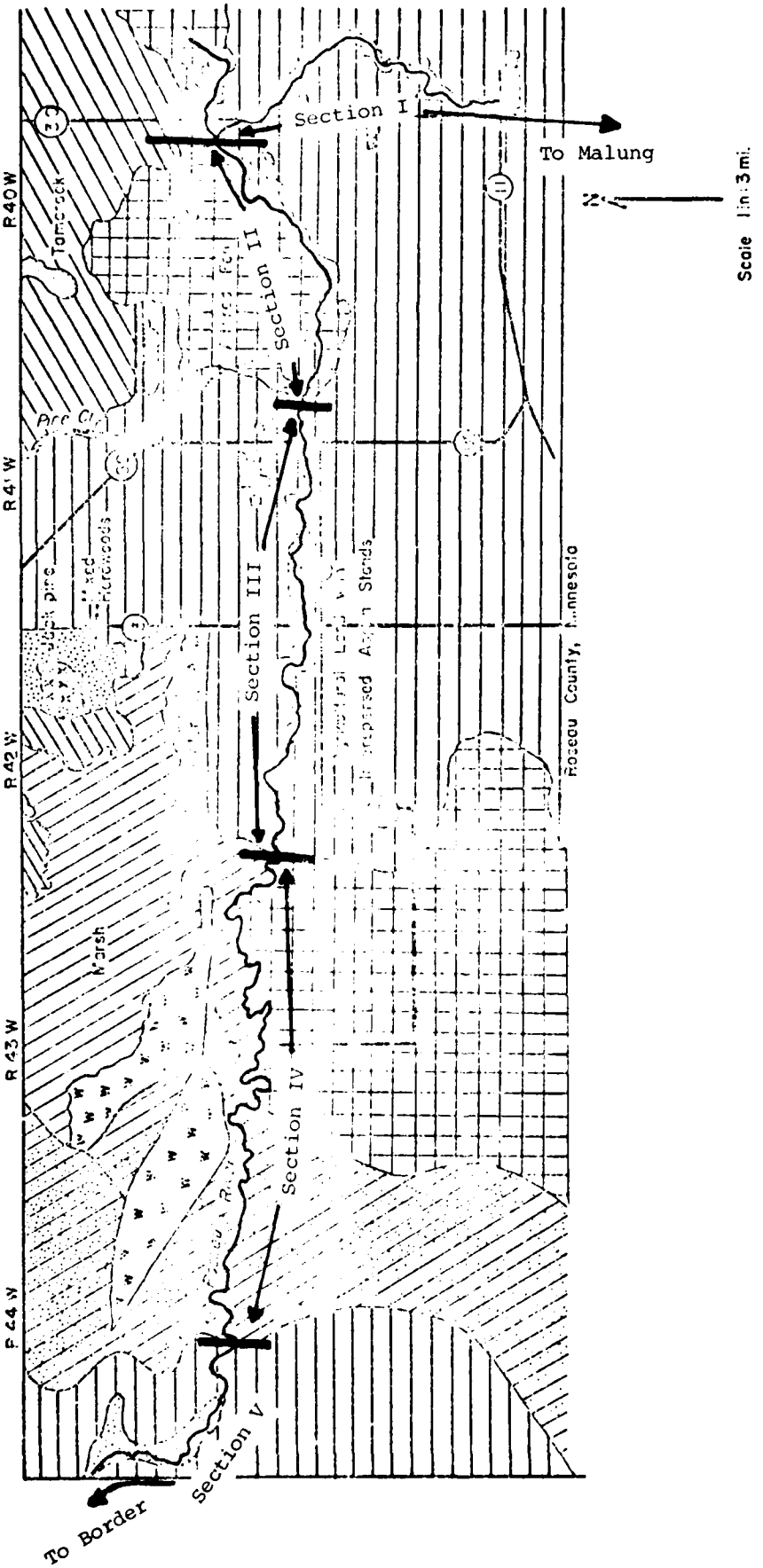


EXHIBIT 16

Exhibit 17. Physical Data Collected During MDNR Fish Census of Roseau River, September 1975.

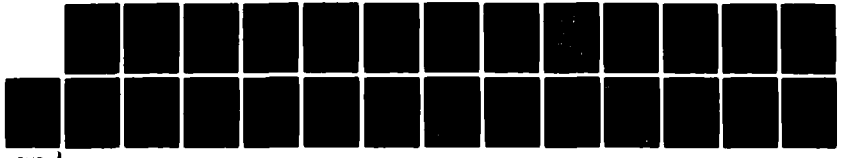
Parameters [2]		Stream Section[1] I	II	III	IV	V
Water Depth (feet)	Maximum	6	12	5	3	6
	Minimum	2	3	1	1	2
	Average	4	6	2.25	2	3
Turbidity		light to moderate	moderate	light	light	light
Substrate Composition (percent)	Silt	40	60	-	-	-
	Sand	60	40	80	30	20
	Gravel	-	-	20	50	30
	Rubble	-	-	-	20	40
	Boulder	-	-	-	-	10
Stream Bed Alterations	Percent Type	None impounded by Roseau Dam	40% dredged in original channel	80% dredged in original channel	100% dredged in original channel	None Apparent
[illegible] type		Some fallen trees; sparse aquatic vegetation(pondweed)	Some fallen trees and debris, more than in section I	No fallen trees or debris. No aquatic veg. No undercut banks, some rocks	Little debris No aquatic veg. No undercut banks - few rocks	Little debris Little aquatic veg. Boulders

[illegible] 16 for locations.

[illegible] field observations.

AD-A121 895 FLOOD CONTROL ROSEAU RIVER ROSEAU AND KITTSON COUNTIES 3/3
MINNESOTA FINAL ENVIRONMENTAL IMPACT STATEMENT(U) CORPS
OF ENGINEERS ST PAUL MN ST PAUL DISTRICT DEC 76

UNCLASSIFIED F/G 13/2 NL



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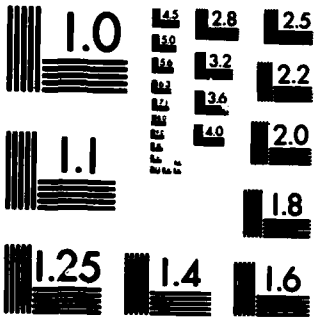


EXHIBIT 18. Roseau River Fish Survey Data. [1]

Stream Section [2]	I		II		III		IV		V		Species Totals	
Actual Hours Fished	1.08		1.08		1.83		0.23		0.70		4.92	
Species	Number [3]	CPE [4]	Number	CPE	Number	CPE	Number	CPE	Number	CPE	Number	CPE
White Sucker	46 (19.5)	41.8 (9.8)	27 (11.4)	25.0 (5.9)	76 (32.2)	41.5 (9.7)	54 (22.9)	270.0 (63.5)	33 (14.0)	47.1 (11.1)	236 (31.5)	425.4 (35.5)
Northern Pike	9 (3.2)	8.2 (2.2)	17 (6.0)	15.7 (4.1)	197 (69.4)	107.7 (28.4)	45 (15.8)	225.0 (59.3)	16 (5.6)	22.6 (16.0)	284 (37.9)	379.2 (31.6)
Walleye	21 (23.6)	19.1 (9.5)	11 (12.4)	10.2 (5.0)	6 (6.7)	3.3 (1.6)	27 (30.3)	135.0 (66.9)	24 (27.0)	34.3 (17.0)	89 (11.9)	201.9 (16.8)
Sauger	5 (13.5)	4.5 (5.6)	6 (16.2)	5.6 (7.0)	3 (8.1)	1.6 (2.0)	10 (27.0)	50.0 (62.3)	13 (35.1)	18.6 (23.1)	37 (4.9)	80.3 (6.7)
Shorthead (northern) redhorse	21 (63.6)	19.1 (52.8)	0 (0.0)	0.0 (0.0)	0 (0.0)	0.0 (0.0)	*	*	12 (36.4)	17.1 (47.2)	33 (4.4)	36.2 (3.0)
Chestnut lamprey	6 (31.6)	5.5 (19.2)	5 (26.3)	4.6 (16.0)	0 (0.0)	0.0 (0.0)	2 (10.5)	10.0 (34.8)	6 (31.6)	8.6 (30.0)	19 (2.5)	28.7 (2.4)
Freshwater drum (sheepshead)	5 (20.8)	4.5 (20.4)	19 (79.2)	17.6 (79.6)	0 (0.0)	0.0 (0.0)	0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	24 (3.2)	22.1 (1.8)
Rock bass	14 (93.3)	12.7 (93.4)	1 (6.7)	0.9 (6.6)	0 (0.0)	0.0 (0.0)	0 (0.0)	0.0 (0.0)	0 (0.0)	0.0 (0.0)	15 (2.0)	13.6 (1.1)
Carp	1 (11.1)	0.9 (10.8)	8 (88.9)	7.4 (89.2)	0 (0.0)	0.0 (0.0)	0 (0.0)	0.0 (0.0)	0 (0.0)	0.0 (0.0)	9 (1.2)	8.3 (0.7)
Burbot	1 (25.0)	0.9 (21.4)	2 (50.0)	1.9 (45.3)	0 (0.0)	0.0 (0.0)	0 (0.0)	0.0 (0.0)	1 (25.0)	1.4 (33.3)	4 (0.5)	4.2 (0.4)
Section Totals	129 (17.2)	117.2 (9.8)	96 (12.8)	88.9 (7.4)	282 (37.6)	154.1 (12.8)	138 (18.4)	690.0 (57.5)	105 (14.0)	149.7 (12.5)	750 (100.0)	1199.9 (100.0)

Species

[1] Data collected by MDNR, September 1975.
[2] See exhibit 16 for sample locations.
[3] Actual number of fish caught. Numbers in parentheses represent percentage of total for that species,
[4] Catch per unit of effort. All values converted to 1 hour of fishing effort. Numbers in parentheses represent percentage of total CPE for that species
* Sighted but not captured

Exhibit 19 Size Distribution of Walleye, Sauger, and Northern Pike by Sample Section of Roseau River, September 1975.

Section	Species	Size Class (inches) 4.0-8.0	8.1-12.0	12.1-16.0	16.1-20.0	20.1-24.0	24.1-28.0
I	Walleye	6	4	5	6	-	-
	Sauger	-	1	4	-	-	-
	Northern Pike	1	-	5	-	8	-
II	Walleye	-	3	6	1	-	1
	Sauger	-	2	4	-	-	-
	Northern Pike	3	1	-	4	8	1
III	Walleye	3	3	2	-	-	-
	Sauger	-	2	1	-	-	-
	Northern Pike	64	85	21	26	-	1
IV	Walleye	15	-	10	2	-	-
	Sauger	-	4	6	-	-	-
	Northern Pike	3	5	17	20	-	-
V	Walleye	5	-	19	-	-	-
	Sauger	-	6	7	-	-	-
	Northern Pike	4	2	4	4	2	-

Source: Extracted from Minnesota DNR data, 1975

EXHIBIT 20

Distribution of Invertebrate Organisms Through Taxa and Sampling Sites.

Middle of river bottom: Downstream ⟶

	R6	R4	R3	R7	R9	R2	R12	R11	R10	R8	R13	R1	Total # in Taxon
Nematodes												17	17
Oligochaetes			17		3	3	6	224	4			4	261
Leeches			4		3	1	5		3				16
Crustaceans	3		24	28	1		3			1	2	21	83
Mayflies	4		28	42	20	29	10	1		48	23	42	224
Stoneflies												2	2
Alderflies													
Caddisflies	1		2	14							2	107	124
Beetles	7		6	4			1		7	1	4	66	92
Fly larvae	5	37	15	40	6	14	7	33	18	44	12	67	286
Snails	32		21	17	21	45	22		49		20	135	342
Clams	—	—	18	4	12	16	3	—	6	5	—	17	81
TOTAL #/sample:	55	37	135	149	166	108	57	258	87	99	163	478	
TOTAL # TAXA:	6	1	9	7	7	6	8	3	6	5	6	10	

Edge of river bottom:

	R6	R4	R2	R13	Total # in Taxon
Nematodes					
Oligochaetes	11	13	14		38
Leeches			2		2
Crustaceans	2	2	2	2	8
Mayflies	11	1	37	23	72
Stoneflies	2				2
Alderflies	1				1
Caddisflies			2	2	4
Beetles	1	1	1	4	7
Fly larvae	123	41	13	12	189
Snails	8		81	20	109
Clams	1	—	80	—	81
TOTAL #/sample:	160	58	232	63	
TOTAL # TAXA:	9	5	9	6	

Source: IES Assessment, 1973

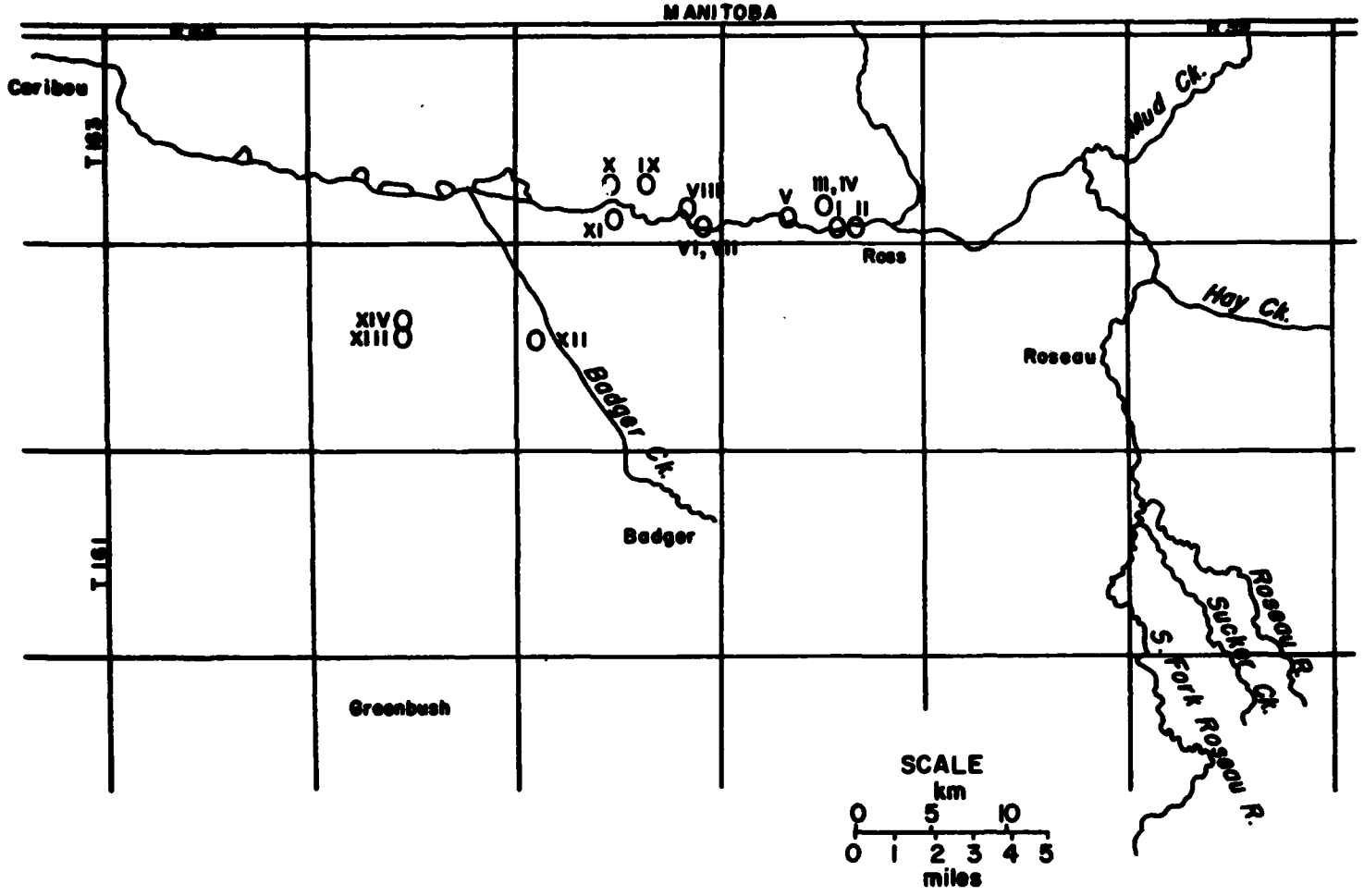
Abundance Categorization Based on Number of Sites Where Found and the Total Number of Invertebrate Organisms in Taxon.

	Number of sites (out of 12) where found	Total # in taxon
Nematodes	1	17
Oligochaetes	7	261
Leeches	5	16
Crustaceans	7	83
Mayflies	10	224
Stoneflies	1	2
Alderflies	1	2
Caddisflies	5	124
Beetles	8	92
Fly larvae	12	286
Snails	9	342
Clams	8	81

Abundance based on:

	Number of sites where found	Total # in taxon
Nematodes	Rare	Rare
Oligochaetes	Intermediate	Common
Leeches	Intermediate	Rare
Crustaceans	Intermediate	Intermediate
Mayflies	Common	Common
Stoneflies	Rare	Rare
Alderflies	Rare	Rare
Caddisflies	Intermediate	Intermediate
Beetles	Intermediate	Intermediate
Fly larvae	Common	Common
Snails	Intermediate	Common
Clams	Intermediate	Intermediate
	Rare: 1-3 Intermediate: 4-9 Common: 10-12	Rare: 1-50 Intermediate: 51-199 Common: 200-

Source: IES Assessment, 1973



Location of study areas for vertebrate analysis.

Source: IES Assessment, 1973

Bur oak-Green ash Community (I, VI, VIII)
Green ash-elm Community (II, V, VII)
Grasslands (III, IX, X)
Aspen-Balsam poplar Community (IV XI)
Altered Fen XII
Short grass marsh XII
Lowland wood edge XIV

Breeding Bird Species Diversity Per Habitat Type

Habitat	# Census Trails	Mean No. (Range)	Dates
Bur Oak-Green Ash Community	3	33(32-35)	28 May-5 July
Green Ash-Elm Community	3	33(26-38)	28 May-5 July
Grassland Community	3	14(13-16)	28 May-5 July
Aspen-Balsam Poplar Community	2	26(24-28)	28 May-5 July
Altered Fen Community	1	25	31 May-24 June
Short Grass Marsh	1	12	31 May-24 June
Lowland Wood Edge	1	28	31 May-24 June

Source: IES Assessment, 1973

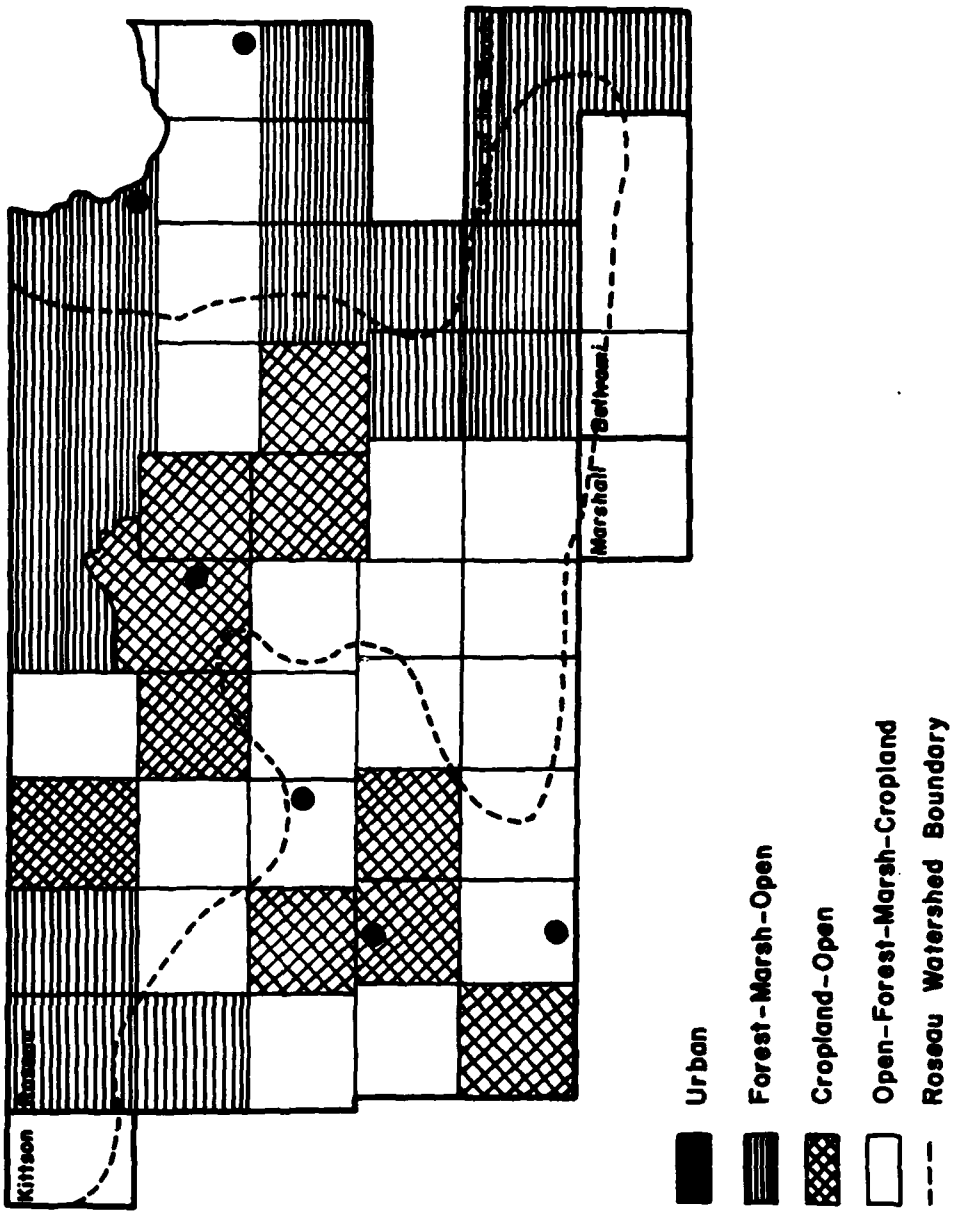
EXHIBIT 23

Small Mammal Captures in Major Habitat Types

	Bur Oak-Green Ash	Green Ash-Elm	Grassland	Aspen-Balsam Poplar	Altered Fen	Short Grass Marsh	Lowland Wood Edge
Trap Nights Available	799	756	782	526	293	296	300
Species:							
Short-tailed shrew (*Blarina brevicauda*)	4 (5)*	2 (3)	2 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Masked shrew (*Sorex cinereus*)	2 (2)	2 (3)	1 (1)	2 (4)	0 (0)	2 (7)	5(17)
Arctic shrew (*Sorex arcticus*)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	1 (3)	0 (0)
Striped ground squirrel (*Citellus tridecemlineatus*)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Meadow vole (*Microtus pennsylvanicus*)	11(14)	24(32)	14(18)	2 (4)	0 (0)	7(24)	5(17)
Red-backed vole (*Clethrionomys gapperi*)	13(16)	7 (9)	2 (3)	8(15)	3(10)	0 (0)	8(27)
Deer mouse (*Peromyscus maniculatus*)	2 (2)	4 (5)	0 (0)	0 (0)	2 (7)	0 (0)	0 (0)
Meadow jumping mouse (*Zapus hudsonius*)	14(18)	4 (5)	5 (6)	1 (2)	5(17)	0 (0)	0 (0)
TOTAL	46(58)	43(57)	26(33)	13(25)	10(34)	10(34)	18(60)

*Figures in parenthesis are indices of relative abundance based upon captures per 1,000 trap nights.

Source: IES Assessment, 1973



Land types in the Roseau River Watershed (source: Orning and Maki, 1972).

Population and Population Changes--Roseau, Beltrami, Kittson, Lake of the Woods, and Marshall Counties and Minnesota, 1930-1970

	1930	1940	1950	1960	1970
Roseau					
Rural Nonfarm & Urban	3,465	4,523	5,712	5,755	6,932
Farm	9,156	10,580	8,793	6,399	4,637
County Total	12,621	15,103	14,505	12,154	11,569
		Percent Change from Previous Census			
Rural Nonfarm & Urban	-	+30.5	+26.3	+ 0.8	+20.4
Farm	-	+15.6	-16.9	-27.2	-27.5
County Total	-	+19.7	- 4.0	-16.2	- 4.8
Beltrami					
Rural Nonfarm & Urban	11,562	14,914	17,164	18,575	23,295
Farm	9,145	11,193	7,798	4,850	3,111
County Total	20,707	26,107	24,962	23,425	26,373
		Percent Change from Previous Census			
Rural Nonfarm & Urban	-	+29.0	+15.1	+ 8.2	+25.4
Farm	-	+22.4	-30.3	-37.8	-35.8
County Total	-	+26.1	- 4.4	- 6.2	+12.6

Exhibit 26. Population and Population Changes (Continued)

	1930	1940	1950	1960	1970
Kittson					
Rural Nonfarm & Urban	2,955	3,979	4,871	3,842	4,578
Farm	6,733	6,738	4,778	4,501	2,275
County Total	9,688	10,717	9,649	8,343	6,853
		Percent Change from Previous Census			
Rural Nonfarm & Urban	-	+34.6	+22.4	-21.1	+19.2
Farm	-	+ .1	-29.1	- 5.8	-49.4
County Total	-	+10.6	-10.0	-13.5	-17.9
Lake of the Woods					
Rural Nonfarm & Urban	1,632	2,164	2,289	2,785	3,002
Farm	2,562	3,811	2,666	1,519	985
County Total	4,194	5,975	4,955	4,304	3,987
		Percent Change from Previous Census			
Rural Nonfarm & Urban	-	+32.6	+ 5.8	+21.7	+ 7.8
Farm	-	+48.8	-30.0	-43.0	-35.2
County Total	-	+42.5	-17.1	-13.1	- 7.4
Marshall					
Rural Nonfarm & Urban	4,598	5,320	6,061	6,390	7,026
Farm	12,405	13,044	10,064	7,872	6,034
County Total	17,003	18,364	16,125	14,262	13,060
		Percent Change from Previous Census			
Rural Nonfarm & Urban	-	+15.7	+13.9	+ 5.4	+10.0
Farm	-	+ 5.2	-22.8	-21.8	-23.3
County Total	-	+ 8.0	-12.2	-11.6	- 8.4
Minnesota					
Rural Nonfarm & Urban	1,675,904	1,886,860	2,242,684	2,826,316	3,351,541
Farm	888,049	905,440	739,799	587,548	453,430
State Total	2,563,953	2,792,300	2,982,483	3,413,864	3,805,069
		Percent Change from Previous Census			
Rural Nonfarm & Urban	-	+12.6	+18.8	+26.0	+18.6
Farm	-	+ 2.0	-18.3	-20.6	-22.8
State Total	-	+ 8.9	+ 6.8	+14.5	+11.5

Source: U.S. Bureau of the Census, Census of Population, 1930, 1940, 1950, 1960, and 1970.

Note: For Beltrami County and Minnesota in 1970, the total population does not equal the two subcomponents due to a slight error in the census data.

Population Relationships for Roseau, Beltrami, Kittson, Lake of the Woods and Marshall Counties and Minnesota, 1930-1970

	1930	1940	1950	1960	1970
Percent of Farm Population to Total Population of Area					
Roseau	72.5	70.0	60.6	52.6	40.1
Beltrami	44.2	42.9	31.2	20.7	11.8
Kittson	69.5	69.9	49.5	53.9	33.2
Lake of the Woods	61.1	63.8	53.8	35.3	24.7
Marshall	73.0	71.0	62.4	55.2	46.2
Minnesota	34.6	32.4	24.8	17.2	11.9
Percent of County Population to Minnesota Population					
Roseau	0.5	0.5	0.5	0.4	0.3
Beltrami	0.8	0.9	0.8	0.7	0.7
Kittson	0.4	0.4	0.3	0.2	0.2
Lake of the Woods	0.2	0.2	0.2	0.1	0.1
Marshall	0.7	0.6	0.5	0.4	0.3
Population Per Square Mile					
Roseau	7.5	9.0	8.7	7.3	6.9
Beltrami	8.2	10.4	9.9	9.3	10.5
Kittson	8.6	9.5	8.6	7.4	6.1
Lake of the Woods	3.2	4.6	3.8	3.3	3.0
Marshall	9.4	10.2	9.0	7.9	7.3
Minnesota	32.0	34.9	37.3	42.7	48.0

Source: U.S. Bureau of the Census, Census of Population, 1930, 1940, 1950, 1960 and 1970.

Age Relationships for Roseau, Beltrami, Kittson, Lake of the Woods, and Marshall Counties and Minnesota, 1950-1970

	Roseau	Beltrami	Kittson	Lake of the Woods	Marshall	Minnesota
1970						
Median Age	29.8	23.5	35.8	29.8	31.1	26.8
Percent under 18	38.3	34.3	34.4	35.5	38.0	36.3
Percent 18-64	48.7	55.3	50.2	52.1	47.8	52.9
Percent 65+	13.0	10.4	15.5	12.4	14.2	10.7
1960						
Median Age	29.5	25.6	32.1	28.8	30.7	28.6
Percent under 18	39.9	39.4	38.1	38.7	38.5	37.6
Percent 18-64	49.2	49.7	49.3	49.7	50.2	52.0
Percent 65+	10.9	10.9	12.6	11.5	11.3	10.4
1950						
Median Age	26.8	26.4	29.3	30.0	28.3	30.6
Percent under 18	38.4	37.9	35.6	36.3	36.6	31.8
Percent 18-64	53.8	53.1	55.6	53.9	55.7	59.2
Percent 65+	7.8	9.0	8.8	9.8	7.7	9.0

Source: U.S. Bureau of the Census, Census of Population, 1950, 1960 and 1970.

EXHIBIT 29

A-38

Total Personal Income and Per-Capita Personal Income: Roseau, Beltrami, Kittson, Lake of the Woods and Marshall Counties and Minnesota, 1950-1971

	1950	1959	1962	1965	1966	1967	1968	1969	1970	1971	Percent Change 1950-1971	Percent Change 1962-197
Roseau												
Total Personal Income (millions of $)	11.4	14.0	16.0	15.3	16.6	19.9	22.6	26.7	31.9	35.4	210.5	121.2
Per-Capita Personal Income	782	1,165	1,346	1,308	1,484	1,742	1,915	2,250	2,741	3,065	291.9	127.7
Beltrami												
Total Personal Income (millions of $)	20.1	26.5	31.3	32.3	35.3	39.2	46.7	47.3	52.7	58.8	192.5	87.9
Per-Capita Personal Income	800	1,145	1,359	1,396	1,510	1,690	1,940	1,979	1,990	2,197	174.6	61.7
Kittson												
Total Personal Income (millions of $)	12.3	10.9	14.8	16.1	16.7	20.1	18.2	21.3	27.7	27.2	121.1	83.8
Per-Capita Personal Income	1,273	1,320	1,785	2,114	2,254	2,760	2,404	2,833	4,029	4,026	216.3	125.6
Lake of the Woods												
Total Personal Income (millions of $)	4.0	5.6	6.4	5.9	6.3	7.2	7.7	8.4	9.5	9.9	147.5	54.7
Per-Capita Personal Income	803	1,330	1,474	1,532	1,728	1,824	2,123	2,216	2,370	2,517	213.4	70.8
Marshall												
Total Personal Income (millions of $)	15.5	16.9	22.1	22.5	23.6	29.0	25.9	30.5	39.3	39.8	156.8	80.1
Per-Capita Personal Income	955	1,203	1,582	1,592	1,753	2,061	1,960	2,288	3,000	3,052	219.6	92.9
Minnesota												
Total Personal Income (millions of $)	4,227	6,798	7,874	9,545	10,390	11,181	12,185	13,448	14,732	15,564	268.2	97.7
Per-Capita Personal Income	1,410	2,020	2,254	2,678	2,898	3,084	3,341	3,579	3,855	4,032	186.0	78.9

Source: U.S. Department of Commerce, Social and Economic Statistics Administration, No Title, August 8, 1973.

Per-Capita Personal Income Relationships: Roseau, Beltrami, Kittson, Lake of the Woods and Marshall Counties, 1950-1971

	1950	1959	1962	1965	1966	1967	1968	1969	1970	1971
Roseau										
County Per-Capita Personal Income as a Percent of Minnesota Per-Capita Personal Income	55	58	60	49	51	56	57	63	71	76
County Per-Capita Personal Income as a Percent of U.S. Per-Capita Personal Income	52	54	57	47	50	55	56	61	70	74
Beltrami										
County Per-Capital Personal Income as a Percent of Minnesota Per-Capita Personal Income	57	57	60	52	52	55	58	55	52	54
County Per-Capita Personal Income as a Percent of U.S. Per-Capita Personal Income	53	53	57	50	51	53	56	53	51	53
Kittson										
County Per-Capita Personal Income as a Percent of Minnesota Per-Capita Personal Income	90	65	79	79	78	89	72	79	104	100
County Per-Capita Personal Income as a Percent of U.S. Per-Capita Personal Income	85	61	75	76	76	87	70	76	102	97

(continued)

	1950	1959	1962	1965	1966	1967	1968	1969	1970	1971
Lake of the Woods										
County Per-Capita Personal Income as a Percent of Minnesota Per-Capita Personal Income	57	66	65	57	60	59	64	61	61	62
County Per-Capita Personal Income as a Percent of U.S. Per-Capita Personal Income	54	62	62	55	58	58	62	60	60	61
Marshall										
County Per-Capita Personal Income as a Percent of Minnesota Per-Capita Personal Income	68	60	70	59	60	67	59	64	78	76
County Per-Capita Personal Income as a Percent of U.S. Per-Capita Personal Income	64	56	67	58	59	65	57	62	76	73

Source: U.S. Department of Commerce, Social and Economic Statistics Administration, No Title, August 8, 1973

EXHIBIT 31 : REVIEW OF DRAINAGE PLANS DEVELOPED BY U.S. SOIL CONSERVATION SERVICE (1)

Purpose and Scope: The purpose of this drainage plan is to present a program of local drainage improvement for a portion of the Roseau River Watershed. The plan contains recommendations for installing and maintaining the drainage facilities, together with an analysis of the cost and the agricultural benefits derived from the program.

The entire program, costs, and benefits have been calculated. It is believed that only 90 percent of the program will be accomplished. The construction period for 90 percent of the program will be considered as 15 years. The final figures used covering installations, maintenance, and benefits are based upon these two assumptions.

The drainage plan presents a program of local drainage improvement for the portion of the Roseau River Watershed within Roseau County lying downstream from the city of Roseau, with the exception of the State-owned land in the northwest part of the county which is now being used as a conservation area for wildlife. The analysis of agricultural benefits is applied to the same area as the local drainage improvement plan.

The local drainage program includes all the necessary tributary outlet drains, both existing and proposed. It includes all the farm drainage required for the growing of crops. Only surface drainage has been considered in the drainage program. The success of the local drainage program depends upon adequate major drainage improvements of the Roseau River and its cutoffs which are used by some of the tributaries for an outlet.

Drainage Problems: The channel of the tributaries, both natural and constructed, has inadequate capacities and depth to provide good drainage for their watershed. The present condition of some of the channels, due to lack of maintenance, aggravates the situation. Insufficient capacity of the Roseau River causes frequent flooding to the tributaries. The flooding of the land and insufficient drainage cause a delay in spring planting. Reduction in agricultural production on many acres of crop land is the result of this condition. In addition, many acres of crop land or potential crop land are kept out of production.

A great many acres of peat lands have been and are being burned off. It is thought that at the present rate of burning, the greater part of the peat could be burned in the near future. The reduction of peat areas by fire lowers the land surface elevation. Ditches in these areas formerly had some depth and took care of the drainage to some extent, but now the ditches are too shallow and have very little capacity. These outlet ditches must be deepened to provide outlets for the necessary farm drainage.

(1) This discussion essentially follows verbatum the 1956 Soil Conservation Service "Survey Report on Major and Local Drainage for the Roseau River in Roseau County, Minnesota."

DRAINAGE PLANS (Continued)

The expansion of farm drainage is needed on all the farm land. This expansion cannot take place until the outlet ditches tributary to the Roseau River are improved in depth and capacity and additional tributary ditches installed. These improvements will not progress until the major drainage outlet is adequate to reduce the extent and duration of the flooding and to provide adequate drainage. Idle, wet land, reduced crop production, poor land utilization, and crop loss have resulted from poor outlet systems and poor farm drainage.

Major Drainage: Major drainage improvements are required to produce the estimated annual agricultural benefits as estimated in this report, and their cost should be considered a part of the cost to produce the agricultural benefits. The Roseau River channel will be improved to provide an adequate outlet for local drainage.

Local Drainage: The recommended program for the improvement of local drainage includes the reconstruction of present drains and the installation of additional drains to provide an adequate drainage system for the area. It also includes the installation of farm drainage systems.

Ditch Studies: All the profiles available on the existing channels were procured. Where profiles were not available, they were constructed by the use of a topographic map with 2-foot intervals, prepared in 1930 by the U.S. Geological Service. Drainage areas for the various channels were determined. Additional new ditches were recommended and profiles for these were prepared by use of the topographical map. In areas where topographic information was not available, ditch estimates were projected from the adjacent ditch information available.

Design Data: The ditch design provides for a minimum depth of flow of 4 feet in order to permit the installation of farm drainage. The side slopes varied from 1-1/2:1 to 2:1. In most cases, a minimum grade of .05 percent was used as being the least grade desirable; however, in some cases, lesser grades were used in the design. The outlet elevation of the channels at the junction with Roseau River, is based on minimum grades. In designing the major outlet, Roseau River, it might be desirable to consider the elevation of the tributary channels to be 2 or 3 feet below the ditch elevation to permit flexibility in the final design of these channels.

The number of road crossings, pipe and bridges, was determined from the map and includes estimated future requirements. The earth and pipe structures were estimated as the number needed to protect the ditches from erosion caused by the entrance of concentrated water. The concrete structures were to protect overfalls at the junction of some tributaries and Roseau River.

Maintenance of Tributaries: The estimated average annual maintenance cost of the program is estimated to be $220,300. The maintenance includes the cleaning out of the channels every 15 years. The average annual cost of maintenance was based on a 50-year economic life of the program.

DRAINAGE PLANS (Continued)

Farm Drainage Program: Investigation into the need of farm drainage was made by sampling. The amount of farm drainage needed and the extent of other work needed, which was necessary to the improvement was obtained from samples and expanded. The farm ditches recommended were shallow varying from 1 to 3 feet deep. Estimate of cost for the work involved was obtained locally.

Maintenance of Farm Drainage: The portion of the Roseau River watershed covered by this plan lies in Roseau County, Minnesota. This plan covers 295,232 acres of 461.3 square miles of land.

Time of Installation of the Program: This report is based upon the assumption that 90 percent of the measures will be installed over a period of 15 years. The average annual benefits from the installed program will increase in proportion to the amount of the program installed. After the 15-year construction period, the benefits will remain constant.

Cost of the Program: The cost of installing 90 percent of the recommended program is $22,142,000 based on January 1975 construction costs. The installation cost based on a 15-year construction period amortized for a 50-year period at 4 percent amounts to an average annual cost of $550,000.

The estimated average annual maintenance cost of tributary outlet channels, based on a 15-year construction period and long-term prices, is $220,300. The estimated average annual maintenance cost of the local drainage, based on a 15-year construction period and long-term prices, is $42,450.

The total estimated annual cost of the local drainage improvements and maintenance amounts to $812,800.

Agricultural Benefits: The agricultural benefits estimated in this report depend upon the proper installation and maintenance of both local and major drainage improvements. The agricultural benefits are based upon the assumption that the agricultural land will have a 15-year frequency storm protection from the major drainage channel. The estimated average annual agricultural benefits, based upon a 15-year construction period and projected long-term prices, amount to $3,430,000.

Benefit - Cost: The benefit-cost ratio of the major and local drainage project will be based upon the total benefits and total cost of major and local drainage. The estimated annual cost of local drainage, based on projected long-term prices, is $812,800. The estimated average annual agricultural benefits, based on long-term projected prices, is $3,430,000.

Source: International Roseau River Engineering Board. September 1975. Joint Studies for Co-ordinated Water Use and Control in the Roseau River Basin. Appendix E.

Estimated Quantities for Considered Items for Local Drainage Program, Roseau River, Minnesota

Item	Unit	Quantity
Installation		
Right-of-Way Purchase	Acre	3,376
Clearing		
Light	Acre	1,248
Medium	Acre	751
Heavy	Acre	505
Channel Improvement	Cu. Yd.	6,519,705
Inlet Protection		
Surface Inlets (earth)	Cu. Yd.	165,000
Surface Inlets (pipe)	Each	360
Concrete Drop Structures	Each	7
Bridges		
County	Lin. Ft.	774
Township	Lin. Ft.	3,892
Private	Lin. Ft.	180
Pipe (Road Culverts)		
Concrete 48"	Lin. Ft.	5,184
Concrete 60"	Lin. Ft.	3,542
Annual Maintenance		
Outlet Ditch	Miles	490

Source: U.S. Department of Agriculture, Soil Conservation Service 1956, "Survey Report on Major and Local Drainage for Roseau River, in Roseau County, Minnesota.

United States Department of the Interior
NATIONAL PARK SERVICE
Office of Archeology and Historic Preservation
Interagency Services Division
Denver Field Office
P.O Box 25287
Denver, Colorado 80225

IN REPLY REFER TO

H3019-PI

Max W. Noah
Colonel, Corps of Engineers
District Engineer
St. Paul District, Corps of Engineers
1210 U.S Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

Thank you for your letter of August 20, 1974 regarding the Roseau River Flood Control Project, Roseau, Minnesota. I have no direct knowledge of the impact the project may or may not have on cultural resources. The nature of my comment is to advise you under Section 3 (f) of Executive Order 11593.

Archeological and historical remains are frequently found with river-bottom proveniences, or on flood terraces and at junctions of drainages. Since your project is chiefly concerned with such locations, it is highly likely that there will be such remains. This region was actively used by the voyageurs in the early days of trapping, and you will need to be aware of sites connected with their activities. In this region, the waterways were for a long period the primary transportation routes. This indicates a high likelihood that a majority of the sites will be found in the affected area. Additionally, this is an area where the archeological resources are poorly known, particularly on the United States side. This fact requires a professionally competent location and evaluation of sites in order to fulfull the requirements of the Executive Order and historic preservation legislation.

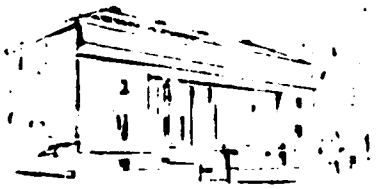
Section 1 (3) of the Executive Order directs Federal agencies to assure that their plans and programs "contribute to the preservation and enhancement of non-federally owned sites, structures and objects of historical, architectural or archeological significance." In order for these resources to be preserved and enhanced, they must first be identified. You will need to obtain a professional assessment of the cultural resources that exists in the area concerned. Anything found during this assessment must be evaluated according to criteria for nomination to the National Register. Those resources eligible for nomination will have to be

considered under the Advisory Council on Historic Preservation procedures for compliance with Executive Order 11593.

If I can be of further assistance, please let me know.

Sincerely yours,

Roy D. Reaves, III
Archeologist, Executive
Order Consultant (Denver)



MINNESOTA HISTORICAL SOCIETY

Fort Snelling Branch (Building 25), Fort Snelling, St. Paul, Minnesota 55111 • 612-726-1171

10 September 1974

Colonel Max W. Noah, District Engineer
Saint Paul District, Corps of Engineers
1210 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Noah:

RE: Request for Comment
Draft Supplement to Environmental Impact Statement
Roseau River Flood Control Project
Roseau, Minnesota

The project listed above has been reviewed by the Survey and Planning and Archaeology sections of the Minnesota Historical Society as per your request of 20 August 1974. A copy of the project description was also sent to Dr. Elden Johnson, State Archaeologist for his review. The result of these reviews indicates presence of archaeological sites not included in Kent Good's survey. Therefore, it is apparent that further work should be done in survey prior to the implementation of this project. It is suggested that you contact Dr. Johnson on this matter.

Respectfully,

Russell W. Fridley

Russell W. Fridley, Director
Minnesota Historical Society and
State Historic Preservation Officer

cc: Alan Woolworth, Chief Archaeologist
Minnesota Historical Society
Building 27, Fort Snelling
St. Paul, Minnesota 55111

Donn Coddington, Supervisor
Field Services, Historic Sites and Archaeology
Building 25, Fort Snelling
St. Paul, Minnesota 55111

RWF/fr

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

IN REPLY REFER TO
NCSED-ER

7 April 1976

Mr. Peter Vanderpoel, Director
Minnesota State Planning Agency
101 Capitol Square Building
550 Cedar Street
St. Paul, Minnesota 55101

Dear Mr. Vanderpoel:

We are currently preparing the Final Environmental Impact Statement for the proposed flood control project on the Roseau River. A copy of the Draft Environmental Impact Statement was sent to your agency in July 1975, but to date no comments regarding the project have been received from your office.

Please determine whether the proposed action would conform or conflict with any existing or proposed Federal, State or local land use plans, policies or controls that your agency may have reviewed or formulated for the affected area, including those plans developed in response to the Clean Air Act and the Federal Water Pollution Control Act Amendments of 1972.

We are requesting that you furnish your comments by 19 April 1976. If you have any questions, do not hesitate to contact this office.

Sincerely,

NORMAN C. HINTZ
Major, Corps of Engineers
Acting District Engineer

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

IN REPLY REFER TO
NCSED-ER

7 April 1976

Mr. Stan Wieber, Director
Northwest Regional Development Commission
114 West 2nd Street
Crookston, Minnesota 56716

Dear Mr. Wieber:

We are currently in the process of preparing the Final Environmental Impact Statement (EIS) concerning the proposed Corps of Engineers flood control project on the Roseau River in northwestern Minnesota.

Please determine whether the proposed action would conform or conflict with any existing or proposed Federal, State or local land use plans, policies or controls that your agency may have reviewed or formulated for the affected area, including those plans developed in response to the Clean Air Act and the Federal Water Pollution Control Act Amendments of 1972.

A Draft EIS on the proposed Roseau River flood control project was issued in July 1975, at which time, as we are informed, your commission was not yet in existence. We are, therefore, inclosing a copy of the Draft EIS to aid in your understanding of the proposed project.

We are requesting that you furnish your comments by 19 April 1976. If you have any questions, do not hesitate to contact this office.

Sincerely,

1 Incl.
as

NORMAN C. HINTZ
Major, Corps of Engineers
Acting District Engineer

EXHIBIT 34

Department of the Army
St. Paul District, Corps of Engineers
1135 U. S. Post Office and Custom House
St. Paul, Minn. 55101

Colonel Gay/pp/7501

NCSDE

9 August 1976

Mr. Robert L. Herbst
Commissioner
Minnesota Department of Natural Resources
Third Floor - Centennial Office Building
St. Paul, Minnesota 55155

Dear Commissioner Herbst:

I have just returned from a very productive meeting on 6 August 1976 with your Assistant Commissioner, Dick Myshak, on the Roseau Flood Control Project during which we discussed your letter of 16 June 1976. I would like to summarize my understanding of the commitments made and state my position in writing.

The State has concerns about additional drainage and land use changes which may occur because of the channel enlargement. The State is also concerned about the loss of wildlife habitat caused by project
127 construction.

To help to allay these concerns, I will discuss in the environmental impact statement and in the operating manual for the project the dangers inherent in draining additional land. Those dangers include inadequate channel capacity from increased flows greater than the design and an increase in flooded area. I will also place in the environmental impact statement a discussion concerning legal liabilities incurred by persons draining additional land if there is such liability.

I also agree that in the construction phase to study mitigation of lands that are disturbed during channel construction. This study will be undertaken with a full realization that any mitigative works will have to be funded separately and be authorized by the Office of Management and Budget, which may not choose to fund the extra work. I understand that the State is willing to take that risk.

I hope that with this position firmly stated here we can have your support of the project and will not have to reprogram funds now planned for its implementation in FY 1977.

EXHIBIT 35

NCSDE 9 August 1976
Mr. Robert L. Herbst

I sincerely appreciate the very fine, cooperative attitude that I find in your staff.

Sincerely,

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

EXHIBIT 35