REVISED

E-ND-771322-Drev-1

REVISED ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL

BURLINGTON DAM

SOURIS RIVER, NORTH DAKOTA

Prepared by

St. Paul District, Corps of Engineers
St. Paul, Minnesota 55101

Summary of costs and benefits - Souris River flood control [illegible]

Item	First costs			Average annual charges			Average annual benefits		Benefit-cost ratio	
	Federal	Non-Federal	Total	Federal	Non-Federal	Total	Without local employment benefits	With local employment benefits	Without local employment benefits	With local employment benefits
Minot channel improvements - reach 2	$14,960,000	$2,629,000	$17,589,000	$772,000	$163,000	$935,000	$1,150,000	$1,298,000	1.23	1.39
Burlington Reservoir and related works										
Dam and reservoir	44,000,000	-	44,000,000	2,902,000	-	2,902,000				
Levees										
Burlington to Minot-reach 1	5,225,000	825,000	6,050,000	295,000	53,000	348,000				
Sawyer-reach 4	484,000	88,000	572,000	27,000	8,000	35,000				
Velva-reach 5	1,870,000	165,000	2,035,000	106,000	15,000	121,000				
Private protection and nonstructural measures										
Bison Power Plant to Logan-reach 3	-	150,000	150,000	-	8,000	8,000				
Logan to J. Clark Salyer Refuge-reach 6	-	350,000	350,000	-	20,000	20,000				
Total Burlington Reservoir and related works	51,579,000	1,578,000	53,157,000	3,330,000	104,000	3,434,000	4,036,000	4,506,000	1.18	1.31
Des Lacs River diversion	13,000,000	-	13,000,000	800,000	-	800,000	200,000	355,000	0.25	0.45
Total Burlington Reservoir, related works, and Des Lacs diversion	64,579,000	1,578,000	66,157,000	4,130,000	104,000	4,234,000	4,236,000	4,861,000	1.00	1.15
Total project including Minot channel improvements	79,539,000	4,207,000	83,746,000	4,902,000	267,000	5,169,000	5,386,000	6,159,000	1.04	1.19

The above presents a summary of the costs and benefits for the proposed overall flood control plan including the separately authorized Minot channel improvement project. All channel and levee works below Burlington, including the Minot channel project, are required for optimum operation of the reservoir, and thus are considered to be integral elements of the reservoir plan. Both features, the Minot channel improvement and the reservoir and related channel works [illegible]

feasibility

SUMMARY

DRAFT REVISED

ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL

BURLINGTON DAM

SOURIS RIVER, NORTH DAKOTA

(X) Draft ( ) Final Environmental Statement

Responsible Office: U.S. Army Engineer District, St. Paul, Minnesota

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

2. Description of Proposed Action: The recommended plan for flood control in the Souris River basin provides for three principal structural measures including an earth dam near Burlington, N. Dak., on the Souris River, a diversion tunnel joining the Des Lacs River to the proposed Burlington Reservoir, and downstream channel works consisting of levee improvements in developed subdivision areas between Burlington and Minot, N. Dak., channel improvements through and below Minot[(1)] and levee improvements at the communities of Sawyer, N. Dak., and Velva, N. Dak. The plan also includes zoning of the residual floodplain between Burlington and the J. Clark Salyer National Wildlife Refuge and private and other nonstructural measures in sparsely developed areas and snagging and clearing from near Logan, N. Dak., to the J. Clark Salyer National Wildlife Refuge. The purpose of the recommended plan is to provide protection for floodplain residents, in particular at Minot and adjacent suburban areas, from floods originating from the Souris River, the Des Lacs River, and local coulees upstream from Minot.

(1) Authorized separately in accordance with the provisions of section 201 of the 1965 Flood Control Act.

There are no provisions for a permanent conservation pool behind the dam. The reservoir would be used only for the temporary impoundment of floodwater about once every 30 years on the average, or when flows in excess of 5,000 cfs threaten Minot. At full pool elevation 1620 the reservoir would have the capacity to control a Souris River flood having about 0.1-percent chance of occurring during any one year. The diversion tunnel would protect Minot against infrequently occurring Des Lacs River floods, and the downstream channel works would protect Minot from the local uncontrolled drainage area and would also serve to facilitate operation and drawdown of the reservoir.

3. a. Environmental impacts: The plan would provide protection from flooding for some 17,000 occupants of the Minot area floodplain and another 1,400 occupants of the Souris River floodplain downstream from Minot including the communities of Sawyer and Velva and some 70 scattered farms and rural residences from near Logan to the J. Clark Salyer Wildlife Refuge. In addition to providing flood control benefits, construction of the recommended reservoir plan would obviate the need, in the interest of public safety, to modernize the Federal dam at Lake Darling to current engineering standards; and recruitment of construction workers from the pool of available but unemployed manpower to build the dam and related improvements would alleviate an unemployment problem.

b. Adverse environmental impacts: The most significant adverse environmental impacts would occur upstream from the dam in the floodwater impoundment area. At full design pool elevation 1620 the reservoir would inundate about 25,000 acres of land and water surface area (Lake Darling) between the damsite and the Canadian-United States boundary including about 11,000 acres in Lake Darling and about 6,000 acres of other lands in the federally owned Upper Souris National Wildlife Refuge. The remaining 8,000 acres of lands are privately owned ranchlands and other river bottomlands. Approximately 33 ranchers and other rural residents. and the graves in McKinney Cemetery would have to be relocated out of the reservoir area. Required fee title purchases include 80 summer homes and cottages in Renville County Memorial Park and 1,500 acres of private lands needed for the dam and appurtenant structures, and a marsh impoundment proposed by the Bureau of Sport Fisheries and Wildlife to mitigate the loss of water-fowl. Flowage easements would be acquired on 5,700 acres of private lands. The periodic impoundment of floodwater would have temporary and near permanent adverse impacts on biological systems in the project area. Recreation including fishing areas and valley aesthetics would be adversely affected during periods of floodwater storage. Storage of a flood having a 1-percent chance of occurring during any one year, for example, would reverse ecological succession on about 700 acres of river fringe woodlands between the proposed dam and Lake Darling Dam, which include deer, small mammal, and bird habitat. In addition, waterfowl production on man-made marsh impoundments below Lake Darling Dam would be reduced during years requiring flood-water storage and for some 2 to 5 years thereafter.

4. Alternatives:

No Action

Nonstructural

Flood warning and emergency measures
Floodplain regulations
Flood insurance
Floodplain evacuation
Flood proofing

Structural

Channel improvements
Flood barriers - levees and floodwalls
Minot bypass tunnel
Souris River diversion
International boundary route
Lake Darling route
North Minot route
South Minot route

Souris River dams and storage impoundments
Confluence site
Baker Bridge site
Lake Darling site

Des Lacs River diversion
To reservoir at Baker Bridge site
To reservoir at Lake Darling site

Des Lacs River dam and storage impoundments
Tributary coulee sites
Kenmare site

5. Comments Received: Refer to paragraph 8.07 of draft revised environmental impact statement for a complete listing of Federal and State agencies, local units of government, organizations, and individuals from whom comments on this environmental impact statement have been requested.

6. Draft Revised Statement to CEQ 29 MAR 1974

Final Revised Statement to CEQ ____________

DEPARTMENT OF THE ARMY
St. Paul District, Corps of Engineers
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

DRAFT REVISED

ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL

BURLINGTON DAM

SOURIS RIVER, NORTH DAKOTA

TABLE OF CONTENTS

Paragraph		Page
1	DESCRIPTION OF PROPOSED ACTION	
1.01-1.02	General	1-2
1.03-1.17	Burlington Dam and Reservoir	2-11
1.18-1.22	Local Protection Measures	11-13
1.23	Des Lacs River Diversion	14-15
1.24	Project Economics	15
2	ENVIRONMENTAL SETTING WITHOUT THE PROJECT	
2.01-2.02	Climate	16-17
2.03-2.17	Physiography and General Geology	17-24
2.18	Economic Geology	24-27
2.19-2.25	Groundwater and Water Supply	27-30
2.26	Water Rights	31
2.27-2.29	Surface Waters	32-33
2.30-2.32	Streamflow	33-36
2.33-2.44	Water Quality	37-43
	Existing and Authorized Water Resource Projects	
2.45-2.49	U.S. Fish and Wildlife Service	43-47
2.50	Corps of Engineers Projects	47-48
2.51-2.54	U.S. Bureau of Reclamation Projects	48-49
2.55	U.S. Soil Conservation Service Projects	50
2.56	North Dakota State Water Commission Projects	50
	Vegetation and Wildlife	
2.57-2.60	General	50-52
2.61-2.71	Grasslands	53-56
2.72	Oak Savannah and Aspen Parkland	56
2.73-2.85	Floodplain Forest	56-62
2.86-2.97	Marsh	63-71
2.98-2.106	Open Water	71-73
2.107	Rare and Endangered Species	74

TABLE OF CONTENTS (CONT)

Paragraph		Page
2	ENVIRONMENTAL SETTING WITHOUT THE PROJECT (Cont)	
	Social and Economic Setting	
2.108-2.109	Settlement	74-75
2.110-2.117	Economic Environment and Employment	75-82
2.118	Land Use	83-84
2.119	Public Health and Safety	85
2.120	Sewage Disposal	85-86
2.121	Air Quality and Solid Waste	86-87
2.122-2.124	Transportation	88
2.125	Water Resource Problems and Needs	88-91
2.126	Recreation	91-99
2.127	Historical and Archeological Sites	100
3	ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION	
3.01-3.03	Introduction	101-102
3.05-3.06	Impact on Geology and Topography	102-103
3.07-3.09	Impact on Groundwater	
3.10	Impact on Surface Water and Streamflow	105
3.11	Impact on Water Quality	105-106
	Impact on Vegetation and Wildlife	
3.12-3.13	General	106-107
3.14-3.16	Grasslands	108-109
3.17-3.19	Woodlands	109-111
3.20-3.25	Wetlands	111-113
3.26-3.30	Open Waters	114-116
3.31	Downstream Areas	116
3.32	Impact on Rare and Endangered Species	116
	Economic Impacts	
3.33-3.36	Flood Control	117-121
3.37-3.40	Land Use	122-124
3.41	Employment	124-125
3.42-3.45	Impact on the Social Setting	125-127
3.46-3.51	Mitigating Features of the Recommended Plan	128-130
4	ADVERSE ENVIRONMENTAL IMPACTS WHICH	
4.01-4.07	COULD NOT BE AVOIDED WITH IMPLEMENTATION OF THE RECOMMENDED PLAN	131-133

TABLE OF CONTENTS (CONT)

Paragraph		Page
5	ALTERNATIVES TO THE RECOMMENDED ACTION	
5.01	General	134-135
5.02-5.03	No Action	136-137
	Nonstructural Measures	
5.04-5.06	Flood Warning and Emergency Measures	137-139
5.07-5.10	Floodplain Regulation	139-141
5.11	Floodplain Insurance	141-142
5.12-5.14	Evacuation	143-144
5.15	Flood Proofing	145
	Structural Measures	
5.16-5.21	Channel Improvements	146-150
5.22-5.27	Flood Barriers	150-154
5.28	Minot Bypass Tunnel	154-155
5.29-5.30	Souris River Diversion	155-156
5.31	Souris River Dams and Storage Impoundments	156-165
5.32-5.33	Des Lacs River Diversion	166-167
5.34-5.35	Des Lacs River Basin Storage Impoundments	167-168
6	RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF	
6.01-6.04	LONG-TERM PRODUCTIVITY	169-171
7	IRREVERSIBLE AND IRRETREIVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED	
7.01-7.03	ACTION SHOULD IT BE IMPLEMENTED	172-173
8	COORDINATION	
8.01-8.07		174-183

TABLES

Number		
1	Streamflow records and characteristics (USGS gaging stations) - Souris River basin	35
2	Selected water quality data, average concentrations (mg/1), Souris River, 1969	38
3	Dams and reservoirs in the Souris River basin	45-46
4	Relative density, relative dominance, relative frequency, and importance of selected flood-plain forest tree species	58
5	Estimated wintering deer populations of Souris and Des Lacs valleys	61
6	Average annual production of selected wildlife for subareas of Souris River basin	66

TABLE OF CONTENTS (CONT)

TABLES (CONT)

Number		Page
7	Recorded and projected population for Minot and the Souris River basin	76
8	Employment by industry, Minot, North Dakota, 1940-1970	78
9	Employment by industry, Ward County, North Dakota, 1940-1970	79
10	Major crops for Ward County for 1964 and 1969	80
11	Land use in Minot, North Dakota (1957-1966)	83
12	Land use for Souris and Des Lacs River valleys above Burlington, below elevation 1620	84
13	City of Minot, air quality data	87
14	Recreation demand, supply, and needs, North Dakota Recreation Region 2	93
15	Recreation use of existing public-use sites on the Upper Souris National Wildlife Refuge during 1972	94
16	Recreation lands administered by Federal and State agencies	98
17	Recreation Inventory, Ward County, North Dakota	99
18	Average annual benefits	120-121
19	Summary of approximate acreage, population, and developments in 100-year Souris River floodplain	136
20	Estimated costs and benefits of alternative reservoirs and related improvements	164
21	Summary of social and environmental impacts of Souris River reservoir alternatives	165

FIGURES

1	Major geologic features in the Souris River drainage basin	18
2	Elevation-duration-frequency-area curves Burlington Reservoir	107

PLATES

1	Authorized improvements
2	Recommended improvements
3	General plan of reservoir area
4	Considered alternative plans

TABLE OF CONTENTS (CONT)

APPENDIXES

Number	
A	BIOLOGICAL INVENTORY OF THE SOURIS RIVER BASIN
B	INVENTORY OF RECREATION SITES IN THE UPPER SOURIS RIVER VALLEY, BURLINGTON TO THE INTERNATIONAL BOUNDARY
C	VEGETATION MAPS OF THE UPPER SOURIS RIVER VALLEY, BURLINGTON TO THE INTERNATIONAL BOUNDARY
D	COORDINATION WITH OTHERS

DRAFT REVISED
ENVIRONMENTAL IMPACT STATEMENT
FLOOD CONTROL
BURLINGTON DAM
SOURIS RIVER, NORTH DAKOTA

1. DESCRIPTION OF PROPOSED ACTION

GENERAL

1.01 The project for flood damage reduction on the Souris River, recommended by the Chief of Engineers in House Document No. 321, 91st Congress, 2d session, provides for two major structural measures; one, channel improvement through the city of Minot, N. Dak., and the other upstream reservoir development as shown on plate 1. The channel improvement feature was approved by Senate and House Public Works Committee resolutions adopted 25 June and 14 July 1970, respectively, on the basis of its independent economic feasibility and the need for early protection from the smaller, more frequent floods. The reservoir feature was authorized later by the Flood Control Act, approved 31 December 1970 (Public Law 91-611). Preconstruction studies for the Minot channel project are well advanced, and a separate environmental impact statement covering that aspect of the overall program is available upon request from the St. Paul District, Corps of Engineers. This environmental impact statement represents a revision of the original statement which was submitted in final form to the Council on Environmental Quality (CEQ) on 25 March 1971, and it concerns only the reservoir and related works as recommended in "Flood Control, Burlington Dam, Souris River, North Dakota, Design Memorandum No. 2, General, Phase I, Plan Formulation." However, the Minot channel project is covered in this statement to the extent that it has a bearing on the reservoir scale of development and plan of operation.

1.02 In addition to the separately authorized Minot channel project, the principal features of the recommended plan, as described in Design Memorandum No. 2 and as illustrated on plate 2, include the dam at the authorized Burlington site on the Souris River; levee improvements in developed subdivision areas between Burlington and Minot; levee improvements in the communities of Sawyer, N. Dak., and Velva, N. Dak.; private improvements in the sparsely developed rural areas between the Bison Power Plant near Logan and the J. Clark Salyer Refuge; and regulation of the residual floodplain between Burlington and the J. Clark Salyer Refuge; and a diversion tunnel joining the Des Lacs River to the proposed Burlington reservoir.

BURLINGTON DAM AND RESERVOIR

1.03 The location and features of the proposed dam and reservoir, as shown on plate 3, are similar to the authorized plan except for changes resulting from updated hydrologic and hydraulic analyses. Located one-half mile northeast of Burlington on the Souris River, the earth-fill dam would have a maximum height of 77 feet above the stream bed, a crest length of 4,125 feet, and a top width of 20 feet. The crest elevation 1630 would provide 5 feet of freeboard above the spillway design flood. The embankment of the dam would consist of a central section primarily of compacted earth fill with 1 vertical on 2.5 horizontal side slopes. Uncompacted earth berms would be provided both upstream and downstream of the central section to insure stability of relatively weak clay soils in the foundation of the dam. The upstream face of the compacted embankment would be protected against wave action and erosion with a 21-inch-thick layer of dumped riprap on a filter blanket. Topsoil with grass cover would be provided to protect remaining embankment surfaces from erosion. The spillway would consist of a reinforced-concrete chute equipped with three 45- by 22-foot gates at the spillway crest for control of large floods exceeding the reservoir design flood and a reinforced-concrete stilling basin. The low-flow outlet works for the reservoir would consist of three rectangular-shaped, concrete conduits, 8 feet wide and 19 feet high, an intake structure with slide-gate controlled portals; and a flared stilling basin at the conduit outlet.

1.04 The Burlington Reservoir would include certain compensatory measures recommended by the Bureau of Sport Fisheries and Wildlife to prevent damages to their existing structures and to mitigate losses of waterfowl and damages to refuge habitat which might result from reservoir inundation. Such compensatory measures include:

a. Relocation of a secondary refuge headquarters at refuge dam No. 87 consisting of several frame buildings, including two residences, to adjacent higher ground above the reservoir design pool level and riprap protection for downstream slopes of Lake Darling Dam and refuge dams Nos. 87 and 96 to withstand wave erosion due to reservoir inundation.

b. Fisheries development including spawning areas and stocking.

c. Recreational access points for fishing and water-based recreation.

d. Development of a small satellite refuge or improvement of J. Clark Salyer National Wildlife Refuge by addition of another marsh.

e. Development of an 850-acre marsh unit downstream from the south boundary of the Upper Souris National Wildlife Refuge.

f. Development of a sediment pool above Lake Darling plus marsh development at the upper end of the project.

g. Periodic replacement of vegetation above Lake Darling to preserve deer habitat and aesthetic values.

Items a. and e. were included in the authorized project and following further consideration appear warranted to offset the losses which might result from periodic reservoir inundation. The other items, while they are included in the project plan and cost estimates, are preliminary. Further coordination with the Bureau of Sport Fisheries and Wildlife will be required during studies for Phase II of the general design memorandum.

1.05 Construction of the proposed Burlington Dam would require rerouting two county roads which cross the damsite, one on each edge of the Souris River valley. Federal-Aid Secondary Route 927 which borders the east edge of the valley floor serves as an access route to Minot Air Force Base and as a school bus route to Burlington and would be periodically inundated by the reservoir. Thus, existing unimproved roads located east of the reservoir would be upgraded to Federal-Aid secondary road standards to serve as a substitute route. At the west edge of the valley the county road would be rerouted on higher ground toward the west to connect with a road along the north edge of sec 34, T 156 N, R 84 W, which serves as a school bus route to Burlington. The Burlington Reservoir relocation plan also provides for raising Souris River valley crossings of major transportation routes to minimize interruption and detouring of cross-valley traffic during flood storage periods. Since State Highway 5 carries the most traffic across the valley and is not subject to flooding under existing conditions, this crossing would be raised to a level 5 feet above the reservoir design pool elevation. Anticipated settlement problems attributable to existing soft alluvial clays and silts would preclude bridge construction adjacent to high fills within the valley bottom area. Thus, the proposed highway raise would involve construction of a new bridge with a river diversion channel at the east edge of the Souris valley. The Soo Line Railroad valley crossing would also be raised 5 feet above the reservoir design pool elevation to avoid any interruption of rail traffic by reservoir flooding. However, the railroad track raise is based on preliminary negotiations with Soo Line Railroad officials. Since the track raise is estimated to cost in excess of $4 million (approximately 10 percent of the total reservoir costs), other alternatives such as rerouting rail traffic permanently or temporarily during periods of reservoir inundation, or due to the infrequency of inundation, raising the track to some intermediate elevation with allowances for increased maintenance and operation will be investigated during studies for Phase II of the general design memorandum.

1.06 Valley crossing raises were considered for several possible combinations of Federal-Aid secondary roads including FAS routes 932, 929, 752, and 471. Of these routes, FAS Route 932 on Lake Darling Dam is the most significant since it serves as a principal missile service route to Minot Air Force Base. However, a raise of this route would require a raise of Lake Darling Dam and modification of the spillway and outlet works. A raise of FAS Route 932 is not proposed since it is estimated that the Burlington Reservoir would overtop Lake Darling on an average of only once every 75 years. During periods of rare floods, it is expected that other valley crossings including State Highway 5 and U.S. Highway 83 at Minot could be utilized. Since FAS Routes 929, 471, and 752 would clear the estimated 40-year, 100-year, and 150-year flood pool levels, respectively, these crossings would also not be raised but existing timber bridges would be anchored as necessary to resist flotation and reduce costs of repair in the event of reservoir inundation.

1.07 Developments included within the reservoir area include about 26 ranches and about 7 other rural residences, McKinney Cemetery, and Renville County Memorial Park. Studies for this Phase I report provide for relocating the ranches and rural residences to high ground adjacent to the flood storage impoundment. Valley roads will be raised, extended, or otherwise modified to provide access to those who would be relocated. Also associated with the ranch relocations would be modifications to their existing water supply systems including drilling of new wells at the relocation site or constructing pipelines from existing wells to the relocation site. McKinney Cemetery is located about one-fourth mile south of State Highway 5 on the west edge of the Souris River valley and contains about 248 graves within a 4.3-acre tract. Since the cemetery exists within the flood pool limits for the reservoir, it must be relocated to higher ground above the maximum flood pool reservoir. Renville County Memorial Park is located in a loop of the Souris River about 2 miles north of State Highway 5 and includes about 80 summer cottages and other recreation buildings. The plan of development for the reservoir provides for fee title purchase of the cottages and all other developments in the parks. Development of a new park to mitigate the loss of the existing park has been deleted in accordance with the views of the Office of Management and Budget contained in the authorizing document.

1.08 The Burlington Reservoir would not have a conservation pool nor would it impound floodwater but on an average of once in about 30 years. Thus, studies for the phase I design memorandum are based on acquiring flowage easements in lieu of fee title on all private lands required for the reservoir exclusive of those lands required for structures and for fish and wildlife mitigation up to the full design pool contour elevation of 1620. Between Burlington and the south boundary of the Upper Souris National Wildlife Refuge, flowage easements would be acquired on about 2,300 acres of private lands and fee title would be acquired on about 200 acres of private lands needed for the dam and appurtenant structures and 1,300 acres of lands needed for the fish and wildlife mitigation impoundment located below Baker Bridge (see plate 3). Flowage easements would be acquired on lands vacated by McKinney Cemetery and Renville County Memorial Park and all other private lands located between the refuge and the international boundary, a total of 3,400 acres.

1.09 A 16-inch crude oil pipeline owned by the Portal Pipeline Company crosses the proposed reservoir about 1 mile north of the damsite. To insure continuous operation of this line during flood periods, the existing pipe would be replaced with pipe of greater wall thickness and a gate valve installation near the east edge of the valley would be relocated to adjacent higher ground above the maximum reservoir pool level.

1.10 Approximately 40 miles of electric power distribution lines, about 40 miles of telephone lines, and a valley crossing of a missile cable would be affected by the proposed Burlington Reservoir and would require removal or relocation.

1.11 The proposed reservoir operating plan provides for a sustained release rate of 500 cfs at Minot during summer months less Des Lacs River inflows. The combined flow including flow from the reservoir, the Des Lacs River, and local inflow below Minot could exceed the channel capacity of the lower Souris River, and cause damages to crops, especially in the vicinity of Towner where the channel capacity is limited to between 800 and 1,000 cfs. Thus, the proposed plan provides for selective snagging and clearing within a 163-mile river reach extending from the downstream limits of the Minot channel improvements near Logan, proposed in the separate authorization, to the south boundary of the J. Clark Salyer National Wildlife Refuge. The snagging and clearing would consist only of removing log jams, brush and debris piles from the channel, and leaning trees along the channel banks. It is estimated that the snagging and clearing will increase flow capacities by about 200 cfs.

1.12 The reservoir operating plan proposed in this design memorandum provides for regulating Souris River flows so that the combined flow including flow from the Des Lacs River and other uncontrolled drainage areas below the dam will not exceed the 5,000-cfs design channel capacity in the Minot area. Lake Darling Reservoir would continue to provide water supply and conservation storage but it would also be used to the maximum extent possible to reduce flood flows. Prior to the start of spring runoff, Lake Darling is assumed to be at a level 4 feet below spillway crest elevation 1598. At the start of the spring runoff, outflow from Lake Darling would be regulated in accordance with the magnitude of runoff from the Des Lacs River. During this time the outlet conduit gate on the Burlington Dam would be open to permit backwater from the Des Lacs River to prevent stage increases at Minot. The operation plan would be continued until Lake Darling Reservoir reaches spillway crest level at which time Lake Darling controlled outflow would equal inflow and regulation would be by the Burlington Reservoir. With increasing inflow, the Burlington Reservoir would continue to rise until the pool level reaches an elevation of 1598, at which time Lake Darling would no longer be regulated and the pools would rise simultaneously.

1.13 Regulation of Souris River flows by the Burlington Reservoir would not be provided until the flow at Minot reaches 5,000 cfs, which is equivalent to about a 30-year flood. For floods exceeding a 30-year flood but less than about a 200-year flood, the plan of reservoir operation provides for releasing 5,000 cfs or inflow, whichever is less, minus flow from the uncontrolled drainage area below the dam and above Minot. Inflow would continue to be released from the reservoir until such time as the flow at Minot drops to 500 cfs. During this period the level of the Burlington Reservoir would remain constant. When the flow at Minot falls below 500 cfs, the plan of operation would provide for evacuating the reservoir by maintaining the 500-cfs flow at Minot until 1 September. From September until 1 November the flow at Minot would be increased to 1,000 cfs. From 1 November until 15 March, the start of the next flood season, the flow at Minot would be decreased to an average of 700 cfs. Such a release rate schedule would permit total evacuation of the reservoir within a 1-year period.

1.14 For floods exceeding the 200-year flood up to the reservoir design flood equivalent to about 80 percent of the standard project flood,(1) the plan of operation would be to continue releasing from the reservoir beyond the 5,000-cfs recession inflow, with a limiting flow at Minot of 5,000 cfs. This reservoir release would continue until it is determined that the reservoir can be evacuated by March of the following year.

1.15 At design pool elevation the Burlington Reservoir would provide 595,000 acre-feet of usable flood control storage which is equivalent to an estimated 3.4 inches of runoff from the contributing 3,290 square-mile drainage area. The usable flood control storage includes 36,500 acre-feet of storage in Lake Darling Reservoir between elevation 1594.0 and spillway crest elevation 1598.0 and excludes 2,000 acre-feet required for sediment storage and 3,600 acre-feet required for fish and wildlife mitigation.

1.16 Due to the prolonged periods of low flow on the Souris River above the Des Lacs River, as regulated by releases from Lake Darling, a permanent conservation pool in the Burlington Reservoir is not practicable. The reservoir will be used relatively infrequently for temporary storage of floodwater and will be drawn down as rapidly as

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(1) The standard project flood is utilized in design analyses and is defined as the runoff that might be expected from occurrence of the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations.

possible after flood inflows subside. Without a permanent conservation pool and because of the limited need for additional recreational facilities in the Souris River basin, recreation is not included as a project purpose.

1.17 The project document plan included development of nature trails and recreation access facilities in conjunction with the Burlington Reservoir. The Office of Management and Budget, during its review of the survey report, found that provision of such features would require local cost-sharing in accordance with the cost-sharing provision of Public Law 89-72. Studies for the phase I design memorandum indicate that deletion of a permanent conservation pool from the reservoir precludes development of recreation facilities as a project purpose.

LOCAL PROTECTION MEASURES

1.18 To reduce environmental and social adverse effects in the reservoir area and also to increase the degree of Souris River protection, the proposed reservoir operating plan provides for releasing at a maximum rate of 5,000 cfs at Minot. To accommodate the 5,000-cfs release rate a combination of both nonstructural and structural measures is proposed along the Souris River from Burlington to the south boundary of the J. Clark Salyer Refuge. At Minot (reach 2), channel improvements with limited levees are proposed and are described in Design Memorandum No. 1 "Flood Control, Souris River at Minot, North Dakota."

1.19 Within the Burlington to Minot reach (reach 1) there are nine developed subdivisions at which emergency levees were constructed by the Corps of Engineers during the spring flood of 1970, to a protection level of about 3,600 cfs. The proposed plan provides for raising and upgrading approximately 4.9 miles of existing levee, channel widening within existing leveed reaches, construction of five channel cutoffs, and snagging and clearing within unimproved reaches of the channel to accommodate a flow of 5,000 cfs from the Burlington Reservoir. At three of the channel cutoff locations, channel barrier structures would be constructed to divert low flows around abandoned loops, similar to those proposed in the Minot Channel Improvement Design Memorandum. Interior drainage facilities within leveed areas would include pumping stations, ponding areas, and interceptor sewers and drainage ditches.

1.20 At Sawyer and Velva, emergency levees constructed by the Corps of Engineers during the spring floods of 1969 and 1970 provide temporary protection against flows of up to about 4,500 cfs plus about a 2-foot allowance for freeboard. The proposed plan of improvement provides for upgrading the levees at both communities to accommodate a flow of about 7,500 to 7,700 cfs, equivalent to the maximum 5,000-cfs release rate from the Burlington Reservoir plus an allowance for flow from the drainage area below Minot. Improvements would include raising and upgrading approximately 1.7 miles of levee at Velva and 0.7 mile at Sawyer, and associated interior drainage facilities consisting of pumping stations, ponding areas, interceptor sewers, and drainage ditches. Also, riprap slope protection would be provided in areas where severe stream erosion has occurred and bridges would be modified at both communities. All lands required for local improvements are based on fee title purchase at non-Federal expense.

1.21 With the proposed channel and levee improvements, Souris River valley areas below the dam will remain subject to a residual flood threat. The results of economic surveys indicate that with a discharge of 5,000 cfs, equivalent to the proposed maximum release rate from the reservoir, approximately 70 property owners along the lower Souris River between the Bison Power plant and the J. Clark Salyer Refuge would be affected by flooding. Private and nonstructural measures to protect existing property owners against flooding would have to be employed since structural measures including levees or channel improvements would not be feasible. Such measures would include on-farm levees, flood insurance, evacuation, raising of dwellings, and elimination of basements; raising of farm buildings; and raising of access roads. In accordance with discussions held with the Citizens Advisory Committee, it is expected that the Ward County Water Management Board will provide the necessary guidance toward implementing such measures.

1.22 Future development within the residual floodplain could greatly increase the flood damage potential particularly in the rapidly developing area upstream from the city of Minot, where it is estimated that approximately 1,200 acres will remain in the floodplain following construction of the project improvements. Thus, the proposed plan includes zoning of the intermediate regional (100-year) floodplain modified by the reservoir within a reach extending from the damsite downstream to the south boundary of the J. Clark Salyer Refuge to insure wise floodplain use, subdivision regulations to regulate future development of valley tracts, and building codes to control future construction of structures in the floodplain.

DES LACS RIVER DIVERSION

1.23 To provide the Minot area with a greater degree of protection from the Des Lacs River, above that which would be provided by the proposed channel and levee improvements alone, the overall plan includes diversion of the Des Lacs River via a conduit outletting into the proposed Burlington Reservoir. The diversion works would be located on the Des Lacs River, about 7.9 valley miles above Burlington and the outlet works would be located on the Souris River about 7.0 valley miles above Burlington. The general location of the diversion conduit is shown on plate 3. The diversion facilities that are proposed include a 7,500-foot, concrete-lined tunnel with inside diameter of 23 feet; a 2,000-foot, earth-filled diversion dam with outlet works consisting of four ungated 8- by 8-foot box culverts; a 286-foot horseshoe-shaped concrete weir and entrance channel to the tunnel portal and a conventional ogee-type spillway with stilling basin and channel to the Souris River within the reservoir area. The diversion structure would be designed to limit Des Lacs River flows to 4,000 cfs, equivalent to the 5,000-cfs design capacity of the channel at Minot minus a 1,000-cfs allowance for inflow from the uncontrolled drainage area below the point of diversion and below the proposed Burlington Dam. Diversion would begin when the discharge from the Des Lacs River reaches a 4-percent chance of occurring during any 1 year. However, the diverted flow would not be stored in the reservoir until the flow at Minot reaches 5,000 cfs. At full design capacity the tunnel would divert a flow of 9,000 cfs, which is equivalent to control of about 75 to 80 percent of the Des Lacs River standard project flood above Foxholm, and which is equivalent to the degree of Souris River control provided by the Burlington Reservoir. Approximately 60 acres of land will be required for the diversion dam and inlet channel and control structures. The purchase of these lands is based on fee title. Lands required for the outlet structures and channel are within the area required for the reservoir. The diversion impoundment would only store water on rare occasions. Thus, a flowage easement would be obtained on some 240 acres of land needed for the impoundment. In addition, an easement would be obtained on about 20 acres needed for deposition of spoil from the tunnel. Costs of all lands needed for the tunnel and appurtenant works are charged to the Federal Government.

PROJECT ECONOMICS

1.24 The total estimated first cost for the proposed project, based on price levels prevailing in July 1973, is $83,746,000 including $44,000,000 for the dam and reservoir; $9,157,000 for the local protection measures outside of Minot; $13,000,000 for the Des Lacs River diversion works; and $17,589,000 for the separately authorized Minot channel improvement project. Based on a discount rate of 5 5/8 percent for the dam and related improvements and a discount rate of 5 1/8 percent for the Minot channel improvement project, and an assumed economic life of 100-years, the overall project demonstrates economic feasibility with a benefit to cost ratio of 1.04 without benefits accruing from increased local employment and 1.19 with the inclusion of such benefits.

2. ENVIRONMENTAL SETTING WITHOUT THE PROJECT

CLIMATE

2.01 The Souris River basin has a northern continental climate, characterized by extreme variations in temperature, insufficient rainfall for crops during many years, and moderate snowfall. Records of the National Weather Service show that temperatures have varied from a low of -54° F to a high of 114° F (-49° F to 109° F at Minot). The mean annual temperature is 39° F, and annual precipitation averages 15.5 inches, approximately 75 percent of which falls during the crop season, normally late April through July or August. Average temperatures in Minot are about 66° F during the summer and 11° F during the winter. The average annual precipitation is about 15 inches, and total annual precipitation has ranged from 7 inches in 1934 to 25 inches in 1941. The average annual snowfall of 33 inches constitutes approximately 21 percent of yearly precipitation for the basin, with total annual snowfall in Minot ranging from 100 inches during the winter of 1949-1950 to less than 7 inches during the winter of 1930-1931. Average annual gross evaporation from lake areas in the Souris River basin is estimated at 33 inches, and the net evaporation (gross evaporation less precipitation) is about 18 inches. The growing season averages only 117 days but there are 15 hours of sunlight per day through the summer.

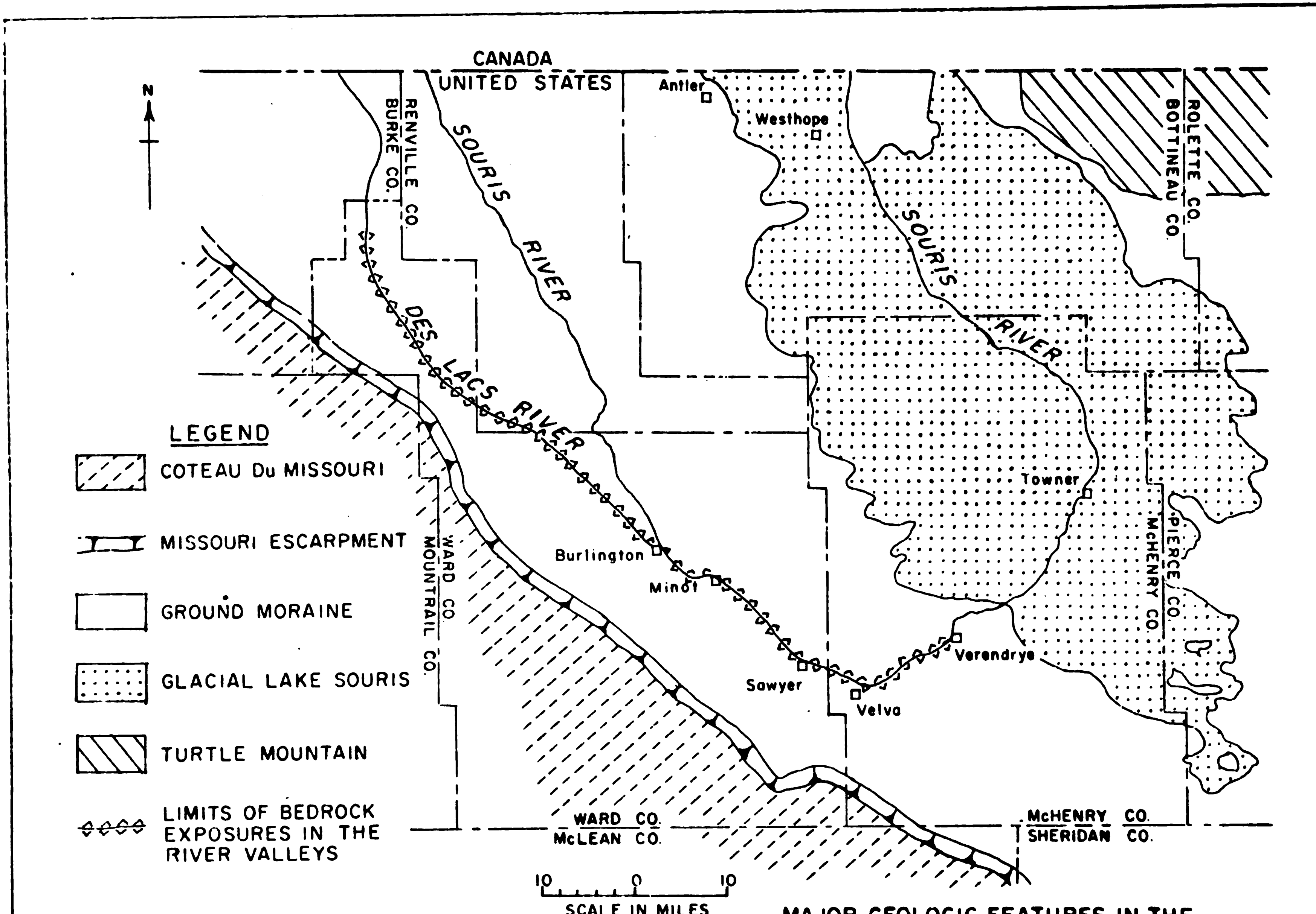
2.02 At Minot the prevailing wind direction is northwest during the winter. During the summer, winds are generally from a southerly direction.

PHYSIOGRAPHY AND GENERAL GEOLOGY

2.03 The United States portion of the Souris River basin lies in the Drift Prairie section of the Central Lowland physiographic province and the Coteau Du Missouri, which forms the eastern border of the Great Plains physiographic province. Four major geologic and topographic features are recognized for purposes of this report, the Missouri Coteau, the ground-moraine plain, the bed of glacial Lake Souris, and the southwest portion of Turtle Mountain (see figure 1).

2.04 The escarpment of the Missouri Coteau is a range of glacial hills and undrained depressions extending across the western portion of the basin. It is roughly 20 miles wide, does not have an integrated drainage system, and stands approximately 400 feet above the level of the ground-moraine plain to the northeast. The Coteau Slope, known also as the Max Moraine, is a gentle slope from the higher level of the Coteau to the ground-moraine plain, and it forms the boundary between the Great Plains and Central Lowlands physiographic provinces.

2.05 The ground-moraine plain which comprises over 50 percent of the total basin area, extends from the Missouri Coteau to the center of the basin, where it meets the lake bed of glacial Lake Souris. The plain has an undulating surface with numerous round, undrained depressions,



MAJOR GEOLOGIC FEATURES IN THE SOURIS RIVER DRAINAGE BASIN

Fig. 1

low mounds, and elongated ridges. The regional slope of the plain is to the northeast at 50 to 80 feet per mile near the Missouri Escarpment, decreases to 40 feet per mile west of the Souris River and is as low as 20 feet per mile east of the river. The surface is marked by shallow glacial outwash channels in the direction of the regional slope. Local relief on the plain, except for the Souris and Des Lacs River valleys, ranges from about 10 to 30 feet.

2.06 The lake bed of glacial Lake Souris is approximately 80 miles long in a northwesterly direction in the United States and 40 to 50 miles wide. It was formed during the last glacial recession when glacial meltwater was dammed from the north by the receding ice masses. The surface is nearly flat and featureless except for occasional sand dunes up to 50 feet in height, and numerous pothole type depressions which often contain water. The lake bed is bordered on the northeast by a thin strip of ground moraine and the Turtle Mountain.

2.07 The Turtle Mountain occupies the extreme northeast corner of the United States portion of the basin. The mountain is an erosional outlier of the Missouri Plateau to the west and forms a moraine-covered tableland approximately 400 feet above the surrounding plain.

2.08 Except for the Missouri Escarpment and the areas bordering stream valleys, much of the drainage pattern within the basin varies from poorly defined to noncontributing. Many of the noncontributing areas include numerous small depressions or potholes where surface water is trapped. These depressions were formed by the uneven melting of glaciers and ground frost, and most of them have clayey soils of high water retention capacity which results in marshy wetlands (see discussion of prairie potholes under the section on vegetation and wildlife).

2.09 Glaciers invaded the Souris River basin several times during the Pleistocene Epoch. The most significant invasion was the Mankato Substage of the Wisconsin glaciation, which laid down thick deposits of drift that obscured nearly all of the preglacial topography. The major drainages in the basin were eroded during the retreat of this ice sheet. The valleys of the Souris and Des Lacs Rivers were eroded to below their present depths by glacial meltwater and were subsequently filled to their present levels as the flows diminished. The present topography is composed essentially of unaltered glacial features and integrated drainage has not yet been established in much of the basin.

2.10 The entire length of the Des Lacs River valley and that portion of the Souris River valley upstream from Verendrye are in the area of the ground-moraine plain. The floor of the Souris River valley averages three-fourths of a mile in width and lies 100 to 200 feet below the ground-moraine plain. The valley walls are fairly steep-sided. The tributary drainages take the form of short, steep-walled coulees with intermittent streamflow which gives the river a slightly dendritic form with little or no outwash terrace development. The Des Lacs River valley is similar in form; however, the valley floor averages one-half mile in width and is incised up to 225 feet below the surrounding plain.

2.11 The Souris River valley downstream from Verendrye is formed in the glacial Lake Souris area. The valley width varies from 1/2 to 3 miles, and it is entrenched less than 100 feet below the surrounding plain and in places shows practically no valley incision.

2.12 Loose surface deposits in the basin are of two types, Recent alluvium and Pleistocene glacial deposits. The Recent alluvium comprises only a small portion of the surface materials and consists mainly of sand, silt, clay, and some gravel in the valleys of the Souris and Des Lacs Rivers where they generally exceed 30 feet in thickness. The glacial materials consist primarily of morainal deposits and sediments of glacial Lake Souris. The morainal deposits are composed of an impervious, stoney clay till with thin seams, lenses, and short channels of sand and gravel. This material is 100 to 200 feet thick on the Missouri Coteau and varies from 50 to 300 feet in thickness throughout the ground-moraine plain and under the sediments of glacial Lake Souris. The thickness of till in the river valleys is probably less, due to erosion by glacial meltwater. A variety of buried preglacial features such as valleys, outwash channels, kames, eskers, overridden ice-contact deposits, diversion channels, and undifferentiated glaciofluvial deposits occur throughout the ground-moraine plain. These contain a higher sand and gravel content than the surrounding glacial till. The sedimentary deposits of glacial Lake Souris range in thickness from a featheredge to more than 70 feet. The material in the Lake Souris area is predominantly silt and moderately to poorly graded sand with sand and gravel beach and other near-shore deposits.

2.13 The depth of erosion into bedrock in the Souris and Des Lacs River valleys varies due to local differences in geologic history. The greatest known channel erosion in bedrock is from Verendrye up the Souris and Des Lacs Rivers to a few miles north of Kenmare. Upstream from a point 6 miles north of the mouth of the Des Lacs River and downstream from Verendrye, the Souris River has made little or no incision in bedrock. Maximum determined depth to bedrock in the river valleys is in the Minot area where it is known to exceed 250 feet.

2.14 The structural geology of the Souris River basin has not been determined in detail. The regional subsurface structure consists of southwesterly dipping Paleozoic beds truncated by Mesozoic beds that dip less steeply to the southwest. The dip of all the beds is gentle and is obscured by local variations in some areas. The Tertiary beds available for study at the surface exhibit local structural irregularities and mineral variations that would make detailed structural analysis questionable. However, the seismic risk map developed by A. T. Algermissen(1) shows the basin to lie in a noncritical area that could expect only minor damage from any probable earthquake.

2.15 Landslides are prominent along portions of the valley walls of the Des Lacs River valley and the tributary drainages that enter the valley from the west, especially where the the Tongue River Formation is exposed. These slides are generally inactive except where the toe of the slide is being eroded or has been excavated by man. The slides are not considered a natural hazard in their present condition, but should be considered a potential problem in planning any development in the area that would change the existing slopes or drainage conditions.

2.16 The bedrock units in the Souris River basin are, in descending order, the Sentinel Butte, Tongue River, and Cannonball Formations of the Fort Union Group of the Tertiary System, and the Hell Creek and Fox Hills

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(1) Presented at the Fourth World Conference on Earthquake Engineering.

Formations of the Cretaceous System. Older Mesozoic and Paleozoic beds which underlie these formations are deeply buried in the basin and, except for their economic importance, are not discussed in this report.

2.17 The Sentinel Butte Formation, the uppermost bedrock unit in the basin, is present only under the Coteau Du Missouri and is lithologically similar to the underlying Tongue River Formation which is present in the western two-thirds of the basin and in Turtle Mountain. The Tongue River Formation varies from a possible thickness greater than 900 feet under the Coteau Du Missouri to a featheredge near the western shoreline at glacial Lake Souris. The formation is exposed intermittently in the Souris River valley and associated drainages from Velva to the confluence of the Souris and Des Lacs Rivers. Tongue River exposures are present in the Des Lacs River valley upstream from the Souris River to a point 7 miles north of Kenmare. The Cannonball Formation underlies surficial deposits in a strip 5 to 15 miles wide which roughly parallels the western shoreline of glacial Lake Souris. Exposures of the Cannonball Formation occur in the Souris River valley from Verendrye upstream to Sawyer. This unit is a marine deposit which consists of thin, alternate beds of sandstone, siltstone, and sandy shale. The total thickness of the uneroded Cannonball Formation is not known, but the thickness of exposed beds in the vicinity of Sawyer is approximately 40 feet. The Cretaceous Hell Creek Formation, with a known thickness of 240 feet, underlies Tertiary rocks in the western part of the area and underlies surficial deposits in a narrow strip about 5 miles wide near the center of the basin.

The formation consists of alternate beds of gray sandstone, siltstone, mudstone, and soft shale. The Cretaceous Fox Hills Formation directly underlies surficial deposits in the eastern one-third of the basin. The formation is chiefly a poorly consolidated, medium-grained, orange-yellow sandstone that contains large oval concretions.

ECONOMIC GEOLOGY

2.18 Natural resources in the Souris River basin that either have economic value, have had economic value, or have economic potential include lignite coal, sand and gravel, glacial till, glacial boulders, brick clay, petroleum, natural gas, and salt. These resources are discussed in the following paragraphs.

a. Lignite coal. -

Lignite is present in the Sentinel Butte and Tongue River Formations, but its development on a commercial basis is restricted by irregular distribution of beds, thinness of beds, and thickness of overlying cover. The only economically feasible method of recovering the material at present is strip mining. The three strippable deposits known in the basin are identified as the Noonan-Kincaid, Niobe, and Velva deposits, which are summarized as follows:

Deposit	Location	Production(1) in fiscal year 1972	Estimated reserve
Noonan-Kincaid	Northwest Burke Co.	486,883 tons	15,000,000 tons
Niobe	8 miles west of Kenmare	Undeveloped	146,000,000 tons
Velva	13 miles southwest of Velva	392,615 tons	5,000,000 tons

(1) Production obtained from North Dakota Annual Coal Mine Report, 1 July 1971 to 30 June 1972.

Lignite beds are exposed along the walls of the Des Lacs River valley and occasionally in the Souris River valley and its tributaries downstream from the mouth of the Des Lacs River. Lignite in the Souris River valley upstream from the mouth of the Des Lacs River is buried under a mantle of glacial till. Numerous caved-in mine openings are visible along the sides of the Des Lacs River valley and some of its tributaries for a distance of 5 miles upstream and 8 miles downstream from Kenmare.

b. Sand and gravel. -

Sand and gravel deposits are abundant throughout the basin. Commercial operations are usually developed in river-terrace or diversion-channel deposits, and the southern part of the Lake Souris area contains scattered piles cleared from farmers' fields, stockpiles of oversized material screened from the numerous gravel operations in the basin, or where they are naturally abundant on the surface of uncultivated areas.

c. Brick clay. -

Clay for brick manufacture has been mined in the past from several localities. The clays were obtained from the Fort Union Group, alluvium and sediments of glacial Lake Souris. No brick is presently manufactured in the basin; however, huge reserves of clay are availale and could be developed if the manufacture of bricks in this area again becomes profitable.

d. Petroleum. -

Oil was discovered in the Souris River basin on 1 January 1953. Since that time 67 fields have been developed. Recent production statistics obtained from the North Dakota State Geological Survey show production in the basin as follows:

County	Production (in barrels) July 1 to December 31, 1971	Total
Bottineau	1,454,033	36,272,919
Burke	691,240	27,883,948
Divide	118,996	4,435,784
McHenry	32,275	367,522
Renville	829,370	21,873,553
Ward	353,692	1,696,538

Production from all but six of the fields is from the Madison Group of the Mississippian System. The other six produce from the Spearfish Formation of the Triassic System to which the oil probably migrated from the Madison Group. Beds of the Devonian, Silurian, and Ordovician Systems are considered to have oil potential but have not been developed in the basin.

e. Gas. -

Gas was first found in the basin in 1907 and was developed for local farm use in the vicinity of Westhope, Mohall, Lansford, Maxbass, and Deering. This gas was obtained from wells ending in the lower portion of the glacial drift or underlying Tongue River Formation. A gas well was developed in glacial drift at Maxbass in 1957, but produced only a total of 665,000 cubic feet of gas. Private and commercial development of this gas source has been discontinued. Production records for the oil fields in the basin show significant estimated yields of gas. The North Dakota State Geological Survey indicates that the only commercial recovery of gas in the basin is by Texaco, Inc., located at Lignite.

f. Salt. -

Thick deposits of salt occur in Mesozoic and Paleozoic beds west of the Souris River basin. Some of the salt beds extend into the basin, but the North Dakota Geological Survey indicates that no salt is produced in the basin.

GROUNDWATER AND WATER SUPPLY

2.19 Groundwater in the basin is obtained from glacial deposits, recent alluvium, and bedrock aquifers. The best sources of good quality water in the basin are wells in the glacial deposits and recent alluvium, but these generally produce no more than 500 gpm (gallons per minute) and in many places sustained yields are no more than a few gallons per minute.

2.20 Cross sections of the Souris River valley between Burlington and the international boundary[1] show the valley fill generally ranges from 70 to 125 feet in thickness and consists mainly of silt and clay with a few small deposits of sand. Only a few domestic and stock wells are developed in this area. Many wells are less than 20 feet deep and developed in sand and gravel. Several wells near the valley walls yield water from the Fort Union Group. Generally, each homestead has shallow and deep wells. The shallow wells produce hard water for culinary purposes. The deep wells, developed in the Fort Union Group, produce soft water for other domestic uses. Either well may be used for stock. Groundwater from the Souris River valley aquifers in this area is believed to be discharging into the stream, but the quantity

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(1) Hutchinson, R.D., and W.A. Pettyjohn, 1971. Groundwater Resources of Renville and Ward Counties: North Dakota Geological Survey. Bulletin 20, Parts II and III.

of water is small and from spring to fall is probably lost to evapotranspiration. Water from the more deeply buried aquifers commonly contains objectionable concentrations of iron, sulfate, and total dissolved solids.

2.21 Recharge to glacial aquifers is slow and consists of local precipitation or infiltration from streamflow and, in some cases, bedrock aquifers. Therefore, large quantities of good quality water are generally not available for industrial or irrigation uses. In general, the gently rolling hill plains of the basin are recharge areas where water can collect and seep to the subsurface. The eastern slope of the Missouri Coteau and the Des Lacs River valley form a regional discharge area referred to as the Des Lacs Artesian Discharge. This area is characterized by numerous springs and flowing wells. The Souris River valley forms a local discharge area; however, the quantity of water discharged into the valley is small due to the low permeability of the surrounding sediments. Also, the Souris River loses water by seepage to some of the major river valley aquifers in the basin and is an important source of recharge for those aquifers.

2.22 Bedrock aquifers in the basin consist of the Cretaceous Dakota Group, Fox Hills and Hell Creek Formations, and Tertiary Fort Union Group. Water from the Dakota Group is generally saline and is used mainly for pressurizing oil fields. Water from the Fox Hills and Hell Creek is a soft sodium bicarbonate type. The water is of poor quality and not recommended for human consumption. The Fort Union Group produces water from sandy phases and lignite beds. Yields from this source are generally small. The water is generally a sodium bicarbonate or sodium chloride type and is not recommended for human consumption. Gas is present with the water in the Fort Union Group and basal drift aquifers in eastern Renville and western Bottineau Counties. When sufficient gas is present, it lifts the water in a well to the ground surface and causes the well to flow. This gas-lift phenomenon was once common in the area but has decreased appreciably with development of the aquifer.

2.23 Waters of the United States portion of the Souris River basin are utilized for the maintenance of habitat for waterfowl and other wildlife in the three large wildlife refuges. The Souris River also serves as a partial source of municipal water supply for the city of Minot, North Dakota, and supplies irrigation water. Recreational uses of the basin waters include fishing, hunting, boating, and swimming, with the most intensive recreational use occurring in the large impoundments such as Lake Darling.

2.24 The distribution and use of Souris River water is controlled by various water rights and several international agreements. Water supply is inadequate to provide for all desired uses, and conflicts exist over priority of water use. Droughts and seasonal fluctuations in the available supply compound these conflicts. Streamflow in the Souris River is regulated somewhat by storage in Lake Darling in the Upper Souris National Wildlife Refuge, which is primarily managed for wildlife production.

2.25 Groundwater sources have been developed throughout the basin to satisfy present municipal and domestic demands, although in some cases the quality of the water in domestic wells probably does not meet standards recommended by the U.S. Public Health Service. The largest user of water in the basin is the city of Minot, which obtains adequate water supplies of 2 mgd (million gallons per day) each from the Souris River, and from buried channel and glaciofluvial aquifers known as the Minot, North Hill, South Hill, Northwest buried channel, Lower Souris, and Sundre aquifers. The combined aquifer system has a large areal extent and storage capacity, but unmanaged withdrawals could easily exceed natural recharge. The Burlington aquifer extends about 3 miles up the Souris River valley from Burlington. The aquifer extends nearly the full width of the valley, has a maximum known thickness of about 88 feet, and would probably provide an adequate municipal supply for Burlington or sustain a small irrigation system. The city has constructed an artificial recharge facility for the Minot aquifer system. The rate of recharge at this station has been estimated at 200 million gallons per year. There has, however, been some difficulty with clogging of the pumping station due to high concentrations of suspended material in the river water. The estimated safe sustained yield of existing water resources is 4.5 mgd. Since this is about equal to current average daily use, new resources will be required to meet projected future requirements. Using the Sundre aquifer, which is currently under development south of Minot and slated to be in use by 1974, should result in an additional sustained yield of 6 mgd. This would meet projected water supply demands for Minot, which also furnishes water to the Minot Air Force Base, to beyond 1980. Phase 2 of Bureau of Reclamation plans for a Garrison diversion (discussed under Existing and Authorized Water Resources Projects) would include supplemental water supplies for the city of Minot. The existing city water intake plant is capable of treating up to 18 mgd.

WATER RIGHTS

2.26 A report on the Souris River dated March 1955 by the International Joint Commission concluded that the natural flow of the Souris River is grossly inadequate to meet the demands for water much of the time at both international boundary crossings. The report indicates further that, even if complete control over the natural runoff were possible, water demands could not be met. Another report, dated 12 August 1955 by an engineering committee of the International Joint Commission relating to filings on water rights above the downstream international boundary crossing, revealed that the water requirements covered by filings made by 31 December 1939 were about 1½ times the average annual flow. Further depletion of Souris River flows can be expected since, under the terms of the 1940 Souris River Reference to the International Joint Commission, Canada has a right to retain up to one-half of all Souris River flows crossing the Saskatchewan-North Dakota border at Sherwood. Also, Canada has rights to 20 cfs (10 cfs during drought periods) at the lower Manitoba boundary crossing at Westhope during June through October. Minot has an existing water rights claim of 6,700 acre-feet annually as approved by the International Joint Commission in 1956. Souris River valley flows are normally inadequate to satisfy these valley water needs as covered by existing water rights. Also mass curve analyses clearly indicate that providing additional reservoir storage beyond that now available in Lake Darling Reservoir would not produce an assured increased yield because of the high evaporation during a long series of drought years.

SURFACE WATERS

2.27 In addition to the Souris River, surface waters in the United States portion of the basin include wetlands and impoundments of Government agencies and private organizations. The projects include a number of reservoirs behind low-head dams on the river and its tributaries, constructed in the interest of irrigation, recreation, stock watering, domestic and industrial water supply, and fish and wildlife production, such as the artificial wetlands and lakes of three Bureau of Sport Fisheries and Wildlife national wildlife refuges. Natural wetlands in the basin are present as prairie potholes in the uplands and oxbow cutoffs in the river valleys. Surface waters other than the rivers are discussed under the sections on wetlands and existing and authorized water resource projects.

2.28 The Souris River is normally a sluggish stream which forms a complex meandering pattern in the oversized glacial valley. As described in the physiography section, the United States portion of the valley is broad and deep, except in the glacial Lake Souris area downstream from Verendrye where the valley floor is less than 100 feet below the surrounding plain. The river itself is a geologically mature stream, with large meanders and isolated oxbows. Bottom types vary from boulders and gravel to sand, silt, and clay. Downstream from where it enters the United States to its confluence with the Des Lacs River, and also from near Bantry and Upham to where it leaves the United States, artificial lakes impounded by earth dams cover much of the Souris River valley floor. Below the confluence of the Des Lacs River, the Souris River winds tortuously in a steep-walled valley. At Minot the south valley wall reaches a height of about 200 feet while the north valley wall is 50 feet lower. Many small tributaries, some of which rise in the Max Moraine, are deeply cut in the south valley wall. Few tributaries enter from the north due to the northeast slope of the adjacent upland.

2.29 Within the United States the primary channel of the Souris River averages about 80 feet in top width and 12 feet in depth. The top width in the Minot area varies between 50 to 90 feet. Due to meanders, the river's length is about twice that of the valley through which it winds. Average slopes in various reaches of the Souris River in North Dakota are as follows:

Western international boundary (mile 512.7) to Minot (Mile 377.7)	0.47 foot per mile
Minot to Towner (mile 254.8)	0.76 foot per mile
Towner to eastern international boundary (mile 154.5)	0.42 foot per mile

The portion of the Des Lacs River extending from Foxholm to its confluence with the Souris River is 20 miles long, with an average width of 30 feet and an average depth of 5 feet.

STREAMFLOW

2.30 Extreme variation in the annual runoff is characteristic of the Souris River basin. On an average, 62 percent of the annual runoff occurs during late spring and early summer. The maximum recorded annual runoff at Minot during a 67-year period occurred in 1904 and amounted to 686,200 acre-feet, of which about 560,000 acre-feet were attributable to the spring flood. The lowest recorded annual runoff at Minot during the same period amounted to 939 acre-feet in 1937. Zero flows on the Souris River have been recorded during many months.

2.31 Records of river stage and streamflow on the Souris River within the United States as obtained by the U.S. Geological Survey are fairly complete. At present, six gaging stations are in operation on the Souris River, including one near each of the two crossings of the international boundary. These stations are located near Sherwood, near Foxholm, above Minot, near Verendrye, near Bantry, and near Westhope. At each of these stations, through 1967, 30 years or more of records are available. The longest combined record is at or above Minot where streamflow data have been obtained since May 1903. Another gaging station was operated on the Souris River near Towner from 1933 to 1941. However, records for this station are incomplete. Tributaries with more than 20 years of streamflow records are Long Creek, Des Lacs River, and Wintering River. Several additional tributary stations which were established in recent years have less than 15 years of records. Monthly stage records are available for Lake Darling since 1936. The maximum streamflow of the year in the vicinity of Minot usually occurs in April or in May, following the spring snowmelt. Occasionally these high flows are augmented by accompanying rains. Runoff in the basin decreases during the summer months. Flow during the fall and winter months is very low and no flow has occurred in many months. Table 1 contains pertinent data for all streamflow stations including periods of record, drainage areas, gage zeros, and maximum and minimum discharges and stages.

TABLE 1

Streamflow records and characteristics (USGS gaging stations) - Souris River basin(1)

Station	River miles below Canadian border	Total drainage area (sq mi)	Gage zero elevation above msl (1929 adj)	Period of record From	Period of record To	Maximum flow data(6) Date of maximum discharge	Maximum flow data(6) Discharge (cfs)	Maximum flow data(6) Gage height (ft)	Minimum flow data Date of minimum discharge	Minimum flow data Discharge (cfs)	Average discharge (cfs)
Long Creek at western crossing of international boundary		2,020	1894.00(2)	1 Mar 59	Date	27 Mar 60	1,330	8.61	Each year	0.0	20.9
Long Creek near Crosby		2,080	1870(3)	1 Apr 44	30 Sep 65	23 Apr 48	6,240	16.10	Each year	0.0	25.8
Long Creek near Noonan		2,500	1840(3)	1 Oct 59	Date	27 Mar 60	3,200	14.40	Each year	0.0	25.6
Short Creek below international boundary near Roche Percee, Sask.		480		1 Mar 60	Date	28 Mar 60	1,360	14.39	Each year	0.0	3.8
Souris River near Sherwood	0.8	9,650	1604.00	1 Mar 30	Date	28 Apr 48	7,400	23.80	In several years	0.0	95.0
Souris River near Foxholm	95.1	10,200	1572.00	22 Jun 04	28 Nov 05						
	98.5	10,200	1561.20	1 Apr 37	25 Mar 38						
	98.3	10,200	1560.73	25 Mar 38	Date	16 May 48	3,040	14.79	In several years	0.0	93.0
Des Lacs River at Foxholm		939	1632.93	23 Jun 04	31 Jul 06						
				1 Oct 45	Date	4 Apr 49	2,000	18.04	In several years	0.0	19.2
Souris River at Minot	135.0	11,300	1533.25	5 May 03	30 Sep 28						
				1 Oct 29	30 Sep 34						
Souris River near Minot	145.8	11,300	1525.55	1 Oct 28	30 Sep 29						
Souris River above Minot	124.1	11,300	1545.75	1 Oct 34	Date	20 Apr 04	12,000	21.90	In several years	0.0	134
Souris River near Verendrye	210.5	12,000	1465.84	1 Apr 37	3 Mar 38						
			1424.87	4 Mar 38	Date	8 Apr 49	4,200	17.70	11 Aug 37(4)	0.3	143
Wintering River near Bergen		176	1587.91(3)	1 Oct 56	Date	23 Jul 65	584	5.44	Each year	0.0	3.88
Wintering River near Karlsruhe		705	1400(3)	1 Mar 37	Date	7 Apr 49	3,000	12.00	Many years	0.0	11.2
Souris River at Towner	258.0	13,100	1444.18	1 Mar 33	28 Oct 34						
Souris River near Towner	248.0	13,100	1443.50	23 Mar 35	31 Jul 41	1 Apr 39	1,150	12.53	In several years	0.0	
Souris River near Bantry	284.8	13,000	1427.55	1 Mar 37	Date	13 Apr 49	4,750	13.76	In several years	0.0	160
Willow Creek at Dunseith		142	1700.00	1 Sep 53	Date	17 Apr 60	410	14.30	Many years	0.0	14.9
Oak Creek near Bottineau		59	2130.00	1 Aug 53	Date	10 Jun 63	95	9.01	Each year	0.0	3.23
Willow Creek near Willow City		1,140	1430(3)	1 Aug 56	Date	9 Apr 60	1,190	14.03	Each year	0.0	19.5
Deep River near Upham		975	1430(3)	1 Sep 57	Date	5 Apr 60	580	10.90	Each year	0.0	1.90
Egg Creek near Granville		289	1470.14	1 Oct 56	Date	28 Mar 60	258	5.44	Each year	0.0	1.83
Cutbank Creek near Granville(5)		534	1477.25	1 Oct 56	Date	13 Apr 60	1	0.52	Each year	0.0	0.002
Boundary Creek near Landa		230	1420.03	1 Sep 57	Date	30 Mar 60	660	10.22	Each year	0.0	7.17
Souris River near Westhope	351.9	17,600	1405.04	26 Jul 29	28 Mar 38						
	350.2	17,600	1402.52	28 Mar 38	Date	18 Apr 49	6,400	16.90	In several years	0.0	163

(1) Data as of 30 September 1967.
(2) International boundary survey, feet above msl, 1912 adjustment.
(3) Gage zero elevation from topographic map.
(4) Minimum recorded, 0.3 cfs, 11-19 August 1937, 10-21 October 1939.
(5) No flow since 23 April 1960.
(6) Maximum flow listed below for some locations was exceeded during April 1969 flood.

NOTE: Drainage areas listed are total drainage areas. A large portion of many of the areas given is probably noncontributing.

2.32 Souris River flows would be modified by the authorized Garrison diversion unit, proposed by the U.S. Bureau of Reclamation. The latest available estimates of irrigation return flows from the Middle Souris and Karlsruhe areas of the Garrison diversion unit are as follows:

Month	Average daily return flow (cfs)
January	76
February	70
March	65
April	60
May	70
June	86
July	102
August	109
September	118
October	101
November	94
December	88

Preliminary data of the U.S. Bureau of Reclamation indicate that the flows may return in the following locations:

Location	Percent of total return flows
Above Towner	8
Towner to Bantry gage	13
Via Deep River	79

WATER QUALITY

2.33 A water quality investigation of the Souris River basin which was conducted in 1969 by the Federal Water Quality Administration, now an integral part of the Environmental Protection Agency, indicated that the Souris River System is naturally eutrophic. The results of this investigation are published in "Water Quality Investigations, Souris River Basin, North Dakota," 1969, by the Environmental Protection Agency. Selected water quality data from the report are given in table 2. Because of unusually high precipitation during the first half of 1969, streamflow was above normal during the field investigations and, therefore, the data may not reflect water quality conditions during low-flow periods. At the time of the water quality investigations, effluent from the Minot, North Dakota, waste stabilization lagoons was discharged to a dry wash and did not reach the Souris River. This effluent has recently been diverted directly to the Souris River. The impact of this new discharge on water quality has not been measured.

TABLE 2

Selected water quality data, average concentrations (mg/1), Souris River, 1969[1]

River mile[2]	Chlorides (Cl)	Sulfates (SO4)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Nitrate-Nitrogen	Soluble-Phosphorous	Conductivity Microhms at 25°C
Canada										
321.5	40	162	.89	.17	63	26	97	.02	.12	947
267.4	7	90	--	--	--	--	--	.02	.12	438
Minot										
232.5	12	149	--	--	--	--	--	.08	.22	638
222.1	16	169	--	--	--	--	--	.20	.28	735
197.6	17	161	--	--	--	--	--	.24	.27	725
161.0	18	183	.89	.27	61	27	111	.27	.31	830
108.0	18	187	--	--	--	--	--	.28	.34	920
73.4	21	182	--	--	--	--	--	.13	.36	921
31.8	23	166	--	--	--	--	--	.01	.34	861
Westhope										
7.9	15	96	.18	.8	52	26	67	.01	.24	861

(1) EPA report, 1971.
(2) River miles measured upstream from Westhope gage.

2.34 Surface water quality is also affected by agricultural runoff, including animal feedlot drainage and irrigation return flows; urban storm drainage; untreated urban wastes (inadequate sanitation facilities exist for summer homes in the Mouse River Park); and possibly the Bureau of Sport Fisheries and Wildlife National Wildlife Refuges. The three large wildlife refuges operated by the Bureau of Sport Fisheries and Wildlife, the Upper Souris National Wildlife Refuge, the Des Lacs National Wildlife Refuge, and the J. Clark Salyer Wildlife Refuge, contain large areas of shallow, marshy impoundments which probably affect water quality conditions in the river system by creating conditions which are favorable to the mineralization of organic matter. However, the refuges also attract large flocks of migrating waterfowl which may contribute quantities of animal waste somewhat in excess of those which were present under natural conditions. Municipal and industrial effluents, including those from the Minot stabilization lagoons, are introduced to the river system. For example, the inadequate sanitation facilities observed for private summer homes in the Mouse River Park area included privies placed directly over the water. Removal of mineral nutrients and organic matter from these effluents would obviously decrease nutrient concentrations in the river system; however, present data are inadequate for determining if high level treatment would result in substantial water quality enhancement in the naturally eutrophic basin.

2.35 Water quality standards applicable to the interstate waters of the Souris River basin, including the Des Lacs and Souris Rivers, have been established by the North Dakota State Department of Health and approved by the Secretary of the Interior in accordance with the Federal Water Pollution Control Act, as amended. These standards apply to various physical, chemical, and bacteriological parameters. During the investigations for the EPA report, water quality conditions on both the Souris and Des Lacs Rivers were found in several instances to not conform with the applicable parameters.

2.36 Dissolved oxygen concentrations were less than those required by standards in Middle Des Lacs Lake near Kenmare, in the Souris River below Towner, and in the J. Clark Salyer National Wildlife Refuge. At Kenmare and Towner this was apparently due to untreated waste discharges which now receive secondary treatment. Degradable organic matter in the shallow refuge impoundments exerts a significant oxygen demand, at times causing locally depressed dissolved oxygen concentrations. Bottom sediments in these same impoundments contain mineral nutrients and organic detritus which could be recycled into the surface waters of the basin during times of either extreme drought or extremely high rates of flow on the rivers. The most significant single source of oxygen demanding materials in the United States portion of the basin is effluent from the Minot sewage stabilization lagoons. The present practice is to release this effluent directly to the river from the secondary lagoon when tests by the North Dakota State Department of Public Health indicate that biochemical oxygen demand (BOD) is 25 milligrams or less per liter of liquid effluent. Fish kills have been noted in the Minot area during such discharges.

2.37 The Environmental Protection Agency report also indicated that nutrient concentrations, especially phosphorus, are adequate to support intense algal blooms under otherwise favorable conditions for algal growth. Intense blooms of blue-green algae have produced nuisance conditions, caused taste and odor problems in domestic water, and caused livestock deaths. During July 1969, soluble phosphorous concentrations ranged from 0.12 to 0.22 mg/l (milligrams per liter) and nitrate-nitrogen concentrations from 0.02 to 0.08 mg/l at three sampling stations on the Souris River between Canada and Minot. The low nitrate concentrations at this particular time were attributed to its uptake by algae in Lake Darling and the smaller refuge impoundments. Nitrate and phosphate levels progressively increased downstream from Minot.

2.38 Excessive concentrations of total coliform bacteria were reported from reaches of the Souris River near Minot, Towner, and Velva. However, fecal coliform concentrations were generally within North Dakota recommended limits for designated water uses at all locations in the basin except near waste discharges.

2.39 Iron and manganese concentrations at several locations were found to be above those recommended by the United States Public Health Service. These high concentrations, which appear to be natural, are at least partially responsible for taste and odor problems which occur in the Minot municipal water supply.

2.40 Dissolved mineral concentrations approach the upper limits of the desirable criteria specified in the Public Health Service Drinking Water Standards and are approaching threshold limits for impairment of irrigation.

Under existing conditions, the concentrations of dissolved solids in the Souris River vary with the quantity of water in the river. During periods of high flow (1,500 cfs or more) the concentration of total dissolved solids (TDS) has been as low as 200 mg/l but during low-flow periods (when flows are less than 10 cfs), this concentration usually rises well above 1,000 mg/l. TDS concentrations as high as 3,650 mg/l (1961) and as low as 160 mg/l (1957) have been recorded near Westhope. The average TDS concentration of Souris River flows from 1952 through 1970 was 796 mg/l (on a time weighted basis). Expected future changes in water use include the importation of Missouri River basin water via the authorized Garrison Diversion Irrigation project. Flows of the Missouri River have been relatively stable in the past. The mean TDS concentration level for the river in 1969 was 425 mg/l in comparison with an historic average of 434 mg/l (1951-1965). Concentrations of total dissolved solids have been as high as 771 mg/l (1952) and as low as 199 mg/l (1959). With anticipated upstream depletions and collection of irrigation return and other waste water, the TDS concentration of Missouri River water is expected to further stabilize at about 500 mg/l.

2.41 Prior to 1970, the city of Minot discharged lime sludge from its water treatment plant directly to the Souris River. This sludge has completely eliminated bottom-dwelling aquatic life in a three-fourth mile-long reach of the river. Since 1970, the city has used a land disposal site for the lime sludge. The lime sludge in the river has never been removed.

2.42 Some surface oil slicks and oil in the bottom sediments were observed in the Minot urban area, and indiscriminate dumping of oil from service stations and other sources was noted.

2.43 Water from the Minot aquifer is of relatively good quality compared to most water supplies within the basin. Total dissolved solids range from 700 to 900 mg/l, as compared to the Souris River with 780 to 1,500 mg/l of TDS. Total dissolved solids from deep wells throughout the Souris River basin range from 1,500 to 3,000 mg/l, and from shallower wells from 500 to 1,500 mg/l. The U.S. Public Health Service recommended maximum TDS for drinking water is 500 mg/l.

2.44 Other than a plan of implementation contained in the water quality standards, no comprehensive plan exists for the basin-wide management of water quality. The need for a water quality sampling network in cooperation with the State Water Pollution Control Agency is apparent in the basin.

EXISTING AND AUTHORIZED WATER RESOURCE PROJECTS

U.S. FISH AND WILDLIFE SERVICE

2.45 During 1935 and 1936 the U.S. Fish and Wildlife Service constructed and placed in operation three migratory waterfowl refuges in the Souris River basin (plate 2). One refuge is located on the Des Lacs River and two on the Souris River. The Des Lacs project consists of a series of eight dams in the vicinity of Kenmare to regulate water levels on artificially created wetlands in the upper reach of that river. The J. Clark Salyer project extends from Upham downstream to the international boundary, and it contains waterfowl habitat which is impounded by a series of five low dams. The Upper Souris project, located along the Souris River northwest of Minot in Ward and Renville Counties, is a series of four dams and reservoirs, but differs from the other projects in that it includes a large storage reservoir known as Lake Darling, created by a dam located at the Ward-Renville County line (mile 429.9). Costs of improvements when constructed by the Service totaled approximately $4,093,000. No local cooperation has been required in connection with these projects.

2.46 The Lake Darling Dam, a compacted, earth-fill structure about 2,500 feet in length and 30 feet in height, includes a 320-foot uncontrolled spillway section adjacent to the left abutment. Top width of the dam is 31 feet. Side slopes are 1V on 2H from the crest (elevation 1606.0) to elevation 1600.0, 1V on 2½H between elevations 1600.0 and 1585.0, and 1V on 3H from elevation 1585.0 to natural ground. The structure includes a 12-foot berm at elevation 1585.0 on both upstream and downstream slopes, riprap protection on the upstream face to elevation 1600.0, and a 3-inch wakefield-piling cutoff wall under the upstream toe.

2.47 Lake Darling Reservoir has a capacity of about 112,000 acre-feet at spillway crest elevation of 1598.0 and at that elevation forms a lake extending up the valley about 27 miles. The primary purpose of the reservoir is to supply water to the small impoundments downstream as required to manage waterfowl habitat. However, the reservoir has been operated so that at least 20,000 acre-feet of the storage capacity, corresponding to a 2-foot range below the spillway crest elevation at 1598.0, have been available each spring for flood control. Depending upon predicted runoff, more flood control storage has been provided in the past. As an example, during the spring of 1949, 70,000 acre-feet of storage were made available for flood control and 60,000 acre-feet of storage remained at the start of the 1969 flood. The structural integrity of dams constructed a long time ago has become a matter of increased public concern, especially in view of the dam failures which have occurred in recent years. On the Souris River, the Lake Darling Dam was built in 1936. Hydrologic and hydraulic analyses indicate that its spillway would not be capable of passing a large flood. For example, it is estimated that the standard project flood in the Upper Souris River basin would lead to overtopping of the dam by 1 foot. Failure of Lake Darling Dam would cause catastrophic damages and loss of life in Minot and elsewhere downstream. The estimated cost of rehabilitating Lake Darling Dam and spillway to meet present day standards would be approximately $11 million. Pertinent data for refuge reservoirs, as well as other reservoirs throughout the basin, are included in table 3.

TABLE 3

Dams and reservoirs in the Souris River basin

Impoundment unit	Miles above mouth	Reservoir capacity (ac-ft)	Purpose
Souris River			
Weyburn Dam, Sask.	703.0	4,000	Water conservation
Dead Lake Dam, Sask.	649.2	2,600	do
Fish and Wildlife Service			
Dam No. 41	471.1	3,224	Migratory waterfowl refuge
Lake Darling	429.9	112,000(1)	Migratory waterfowl refuge, water storage
Dam A	429.0	114	Migratory waterfowl refuge
Dam B	427.7	252	do
Dam C	426.6	258	do
Dam No. 87	425.7	1,320	do
Dam No. 96	416.7	2,884	do
Eaton Dam	269.7	1,650	Irrigation

TABLE 3 (Cont)

Dams and reservoirs in the Souris River basin

Impoundment unit	Miles above mouth	Reservoir capacity (ac-ft)	Purpose
Souris River (cont)			
Fish and Wildlife Service			
Dam No. 1	205.0	1,000	Migratory waterfowl refuge
Dam No. 320	194.0	10,000	do
Dam No. 326	185.7	5,500	do
Dam No. 332	179.9	5,371	do
Dam No. 341	171.2	5,050	do
Dam No. 357	155.4	21,600	do
Dam above Melita, Man.	137.3	350	Domestic and stock watering
Dam near Melita, Man.	124.0	300	do
Napinka Dam, Man.	113.0	350	Domestic and industrial purposes
Hartney Dam, Man.	92.0	400	do
Dam at Souris, Man.	65.4	300	do
Dam at Wawanesa, Man.	12.2	250	do
Long Creek, Sask.			
Boundary Dam		48,800	do
Moose Mountain Creek, Sask.			
Moose Mountain Dam		8,200	do
Roughbark Creek, Sask.			
Roughbark Dam		1,550	do
Des Lacs River			
Fish and Wildlife Service			
Upper Des Lacs Lake Dam		38,000	Migratory waterfowl refuge
Dam No. 2		278	do
Dam No. 3		49	
Dam No. 4		4,900(2)(3)	do
Dam No. 4a		55	do
Dam No. 5		140	do
Dam No. 6		426	do
Dam No. 7		870	do
Dam No. 7a		1,858(2)(4)	do
Dam No. 8		349	do
Judge A.M. Christianson project			
Unit No. 1		370	Irrigation
Unit No. 2		320	Irrigation

(1) Dam No. 41 is inundated by Lake Darling Dam at full pool.
(2) Includes natural lake storage.
(3) Dam No. 4a is inundated by dam No. 4 at full pool.
(4) Dam No. 7 is inundated by dam No. 7a at full pool.

2.48 Private interests and local governmental entities have also constructed low-head dams on the Souris River and its tributaries in the interest of irrigation, recreation, stock watering, and domestic and industrial water supply. The reservoirs, however, are small and are not factors in the flood problems of the basin. The reservoir created by Boundary Dam on Long Creek near its confluence with the Souris River in Saskatchewan, for example, impounds 48,800 acre-feet of water for power production and municipal water supply for Estevan, Sask., but, since it is normally maintained as full as possible, does not provide flood protection.

2.49 Two active irrigation projects are located in the basin: the Eaton Flood Irrigation project on the Souris River near Towner, and the Judge A. M. Christianson project on the Souris and Des Lacs Rivers near Burlington. The Eaton project includes a low-head dam in a reach of the lower Souris River where the banks are only slightly higher than the adjoining level hay lands, facilitating the regulated spring flooding of these hay lands to increase yields. The Judge A. M. Christianson project includes two low-head dams on the Des Lacs River, one low-head dam on the Souris River, and a network of irrigation ditches. This system irrigates small tracts of small grains and vegetables.

CORPS OF ENGINEERS PROJECTS

2.50 Local protection works together with snagging and clearing of the Souris River at Velva for flash floods originating on Bonnes Coulee were approved 25 June 1965 by the Chief of Engineers for construction under the special continuing authority of section 205 of the 1948 Flood

Control Act, as amended. The protective works were completed in 1968 at a total cost of about $308,100. The project includes a levee between the coulee and Velva from the south bluff of the Souris River valley to the Soo Line Railroad embankment near the river, a ramp at the U.S. Highway 52 levee crossing, enlarged waterway openings through the U.S. Highway 52 and Soo Line Railroad embankments, limited channel enlargement on Bonnes Coulee, and snagging and clearing improvement along Bonnes Coulee below the enlarged channel and along the Souris River through and below Velva.

U.S. BUREAU OF RECLAMATION PROJECTS

2.51 The initial phase of the authorized Garrison diversion unit of the Missouri River basin project provides for diversion by the U.S. Bureau of Reclamation of water from the Missouri River above Garrison Dam for the irrigation of about 116,000 acres in the Souris River basin and an additional 134,000 acres in the Sheyenne River and James River basins. When the project is fully developed, water will be supplied to irrigate about 1 million acres of land, including about 400,000 acres in the Souris River basin. In its initial phase the project also provides for restoring historic levels of Devils Lake and Stump Lake, supplementing low flows in the Red River of the North as well as in the above-mentioned streams, and augmenting water supplies of about 14 municipalities and four industrial areas.

2.52 A system of canals and pumping stations would discharge water required for irrigation into Lonetree Reservoir (maximum operating pool, elevation 1640). The Souris River basin would be supplied by the Velva Canal (initial capacity of 2,000 cfs) which would head at the Wintering Dam on Lonetree Reservoir and, in the initial phase, extend northwesterly a distance of about 93 miles through the central part of the Souris River loop. The Deep River and its tributaries would collect irrigation return flows and convey these flows into the Souris River. When the project is completely developed, the return irrigation flow in the Souris River would be lifted by the Westhope pumping plant (capacity of 3,000 cfs) from Westhope Reservoir near the international boundary to the head of the East Souris Canal, which would extend southeasterly a distance of about 117 miles to a tributary of the Sheyenne River. The East Souris Canal works would include the Berwick pumping plant (maximum capacity of 1,200 cfs) to provide for irrigation of additional lands in the Souris River basin and discharge of excess flows to the Sheyenne River basin.

2.53 The region in the Souris River basin being considered for irrigation under the initial phase of the project consists mainly of the area in McHenry County between the Velva Canal and the Souris River, and also includes a 12,200-acre area near Karlsruhe. Siphons would be provided where the canals cross stream valleys, and some of the tributaries joining the Souris River below Verendrye would convey return flows into the Souris River.

2.54 Due to the large scope of the Garrison Diversion Unit, the full operation of the first phase of the project, which includes irrigation of about 250,000 acres, might require more than 20 years after initiation of construction. The estimated construction cost for the first phase of the project is $212,383,000, based on January 1962 price levels.

U.S. SOIL CONSERVATION SERVICE PROJECTS

2.55 In April 1963 the U.S. Soil Conservation Service initiated planning for flood control in the Boundary Creek watershed, tributary to the Souris River in north-central Bottineau County. Improvements authorized for installation within this watershed include two small retarding dams in the upper watershed, with flood storage capacities of 2,250 and 3,720 acre-feet, and extensive channel improvement downstream from these structures. These improvements would have no significant effect on Souris River flood flows.

NORTH DAKOTA STATE WATER COMMISSION PROJECTS

2.56 The Tolley Flats area of Ward and Renville Counties, North Dakota, is part of a 200 square mile upland region between the Des Lacs and Souris Rivers which drains toward Tolley, North Dakota, and has no natural outlet. The water management districts of both Ward and Renville Counties have requested the North Dakota State Water Commission to develop a plan to relieve the farmers in the local districts from flooding in the Tolley Flats area. The current proposal, North Dakota State Water Commission Project No. 626, involves the construction of 11.8 miles of channel and a small dam on Mackobee Coulee to trap sediment and regulate flows into Lake Darling.

VEGETATION AND WILDLIFE

GENERAL

2.57 The United States portion of the Souris River basin is located within the Temperate North American Grasslands Biome[1] in which rolling grasslands are the most prominent and extensive form of strictly vegetation.

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(1) Odum, Eugene P., 1971. Fundamentals of Ecology (3d ed.) W. B. Saunders Company, Philadelphia.

According to Kuchler[1] the following, more specific types of potential natural vegetation are recognizable in the area of study:

a. Wheatgrass-Bluestem-Needlegrass[2] which takes the form of dense, medium to tall grassland.

b. Oak Savannah as taller, denser grassland with scattered deciduous trees and brush (often recognizable also as the uppermost extension of the floodplain forest at the heads of coulees and subvalleys).

c. Aspen parkland which actually represents a transitional zone between the grasslands and the evergreen forests to the north.

d. Northern Floodplains Forest in which the dominant form of vegetation is large, deciduous trees such as willow, cottonwood, and elm and in which the understory varies from open, sparse herbs to dense shrubs and young saplings of the dominant tree species.

2.58 Of the major kinds of terrestrial biological systems considered in this report, the woodlands are the smallest in total area. North Dakota ranks last of the 50 States in total acres of woodlands, with 400,000 total acres of forests (about 2 percent of the State land area as compared to 35 percent, for example, for the State of Minnesota). This is natural because of prairie fires, climate, and soil factors which tend to favor grassland in the area.

2.59 In addition to the terrestrial systems listed above, a number of aquatic and semiaquatic biological systems are generally recognized as follows:

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(1) Kuchler, A. W., 1964. Potential Natural Vegetation of the Conterminous United States. American Geographical Society, New York.

(2) Wheatgrass-Needlegrass generally to the west of the study area, which has a less dense and somewhat shorter form than the above, (consistent with decreasing average annual rainfall along the east to west gradient) is not considered in detail here.

a. The various kinds of wetlands or marshes which occur as natural prairie potholes of glacial origin in the upland drift prairie; natural oxbow cutoffs in the river valleys; impoundments of the United States Fish and Wildlife Service; and "blow-outs" or "dug-outs" which have been created on agricultural lands, mostly under cost-sharing programs with the U.S. Soil Conservation Service.

b. Open, standing waters consisting primarily of the Bureau of Sport Fisheries and Wildlife impoundments as discussed under the section on Existing and Authorized Water Resource Projects, but also including the larger natural oxbow cutoffs along the rivers as well as Buffalo Lodge Lake near Granville.

c. Flowing waters of the Souris and Des Lacs channels and their tributaries in which the most prominent forms of vegetation and animal life are algae and small aquatic invertebrates associated with the stream bed and small fish such as darters.(1)

2.60 The aerial extensions of these systems and their biological characteristics were determined, in part, through a primarily biological study of the Des Lacs and Souris River Floodplains by Minot State College.(2) Other information was obtained through the cooperative efforts of Corps of Engineers Water Resource Planners and Environmental Specialists with other Government agencies as well as concerned private individuals and organizations. Maps showing the various types of biological habitat in the study area are presented in appendix C.

(1) Small (about 3 inches total length as adults), perch-like fishes.

(2) Lunan, James A., Thomas Glorvigen, and Gary Leslie, 1973. Biological and Recreational Impacts of Nine Proposed Flood Control Alternatives in the Des Lacs and Souris River Floodplains, North Dakota.

GRASSLANDS

2.61 The grasslands of the Souris region are dominated in general by western wheatgrass, big bluestem, and needlegrass. The present condition of lands, which are lightly to moderately grazed, and records from the General Land Office Survey indicating presettlement conditions, confirms Kuchler's 1964 analysis of the potential vegetation of the Souris loop. However, at the present time, much of the grassland has been converted to tame and wild hay or small grain crops. Inside refuge boundaries this system is managed for maintenance of wildlife populations. Considering both private and Federal holdings, grasslands presently account for about 15 percent of the land area in the Souris and Des Lacs River floodplains and roughly 20 percent of the United States portion of the basin.

2.62 The species compositions of this community type were determined as a part of the Minot State College study by quadrat sampling according to the methods of Cox[1] and Brown.[2] The results of this sampling, in the form of a list of grassland flora, are presented in appendix A. The latter method, being somewhat faster, was utilized to cover larger areas, predominately on east-facing slopes.

2.63 Untilled grasslands on the floodplain and valley slopes are pastured heavily. When in good condition, pastured grassland is dominated by big and little bluestem and green needlegrass. Drier sites may be dominated by prairie sand reed grass, blue grama grass, and sedges, while the more moist sites are generally characterized by prairie cordgrass,

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(1) Cox, G., 1972. Laboratory Manual of General Ecology, 2d ed. Wm. Brown, Dubuque, Iowa.

(2) Brown, D., 1954. Methods of Surveying and Measuring Vegetation. Bull. 42, Commonwealth Agricultural Bureau, Farnam, Royal Buch, England.

northern reed grass, and sedges. These intergrade on slopes and are associated with varying numbers of asters, sunflowers, and other forbs (herbaceous plants other than grasses). Poor or overgrazed pasture is heavily invaded by green sage, white sage, and fringed sage; and leafy spurge is becoming a dominant nuisance weed. In areas that have been seeded, brome grass and Kentucky bluegrass are common, and some range lands, especially on the floodplain, are being converted to alfalfa.

2.64 Birds, mammals, reptiles, and insects are an important part of this system. Several species of sparrows, the western meadowlark, upland plover, chestnut-collared longspur, and horned lark are common. Larger predatory birds such as the short-eared owl and marsh hawk are frequently encountered.

2.65 Mice, voles, and rabbits consume considerable amounts of grass, herbs, and forbs. Cattle and deer, the largest herbivores of this region, do not appear to compete to a great extent on properly managed rangeland. In the spring and summer, deer browse mainly on the forbs while cattle graze more on the grasses.

2.66 In addition to the small herbivorous mammals and white-tailed deer, weasels, skunks, badgers, foxes, and coyotes are common inhabitants of the grasslands. A number of other animal forms such as muskrat, raccoon, mink, garter snakes and leopard frogs, are somewhat more characteristic of the grassland-water interfaces (ecotones) and are found primarily around the marshlands.

2.67 Insects of the grasshopper, beetle, two-wing flies, moth, and butterfly groups constitute one of the most important groups of grazers. Grasshoppers are especially abundant at times. These invertebrates may, under some conditions, consume more vegetation annually than cattle.

2.68 Provisional lists of grassland fauna are given in appendix A.

2.69 Overgrazing and haying have reduced the diversity of vegetation and animal life over most of the existing grassland community. For example, where plants utilized by mice and voles for cover and food have been eliminated, the populations of these rodents have similarly been reduced. Populations of carnivores depending on these rodents as a food source have also declined. At other times, predator control programs have largely eliminated such carnivores as the foxes and coyotes. This has, in turn, resulted in excessive populations of rodents and other small mammals.

2.70 The primary cultural uses of the grasslands have been for agriculture and recreation. Crop production occurs on the flat valley bottoms. The clay to clay-loam soils of the grassland (North Dakota Agricultural Experiment Station, 1961) have a fairly high water holding capacity and limited porosity. With the limited precipitation of this region, these soil types facilitate holding available water, making the area good for small grain production. These grains are extremely important economically to the people in the Souris and Des Lacs River valleys, where there are approximately 3,950 acres of small grain cropland. In relatively protected areas the river valleys provide grazing.

Pasture land has been overgrazed in the past and the stocking rate for cows is presently limited to enhance the long-range productivity. The Soil Conservation Service at present recommends stocking at the rate of 6 to 12 acres of pasture per cow. Details pertinent to the agricultural setting are presented within the section on economics.

2.71 Hunting is the principal form of recreation associated with the grasslands. Deer are numerous in areas of scattered buck brush, and waterfowl utilize the grasslands for nesting and feeding during migration. Sharp-tail grouse, pheasant, and Hungarian partridge of the grasslands provide for excellent upland game hunting outside wildlife refuge boundaries. A separate section of this report is devoted to recreation.

OAK SAVANNAH AND ASPEN PARKLAND

2.72 In the sand hills southwest of Towner, big bluestem, little bluestem, and bur oak are dominant, with the oak scattered singly or in groves. This sand-hill savannah community type extends from southwest of Towner north to the J. Clark Salyer National Wildlife Refuge. Aspen parkland communities are also found in this area including but not restricted to the Mouse River State Forest near Towner.

FLOODPLAIN FOREST

2.73 Total woodland in the Souris River valley from Burlington to the Canadian border and in the Des Lacs River valley between Burlington and Foxholm is about 2,885 acres. This, alone, is about 0.7 percent of the total State acreage. The total woodlands of the Souris River and Des Lacs River valleys and their coulees constitute over 1 percent of the State's forest resource; about 75 percent of all the State forests are found in Turtle Mountain and the Badlands. On a statewide basis, woodlands have increased in some local areas due to the suppression of prairie fires and due to the planting of field and farmstead shelterbelts but on a statewide basis have decreased due to clearing for agriculture and lumbering.

2.74 Several floodplain forest transects were taken at various points along the Souris River as part of the study by Minot State College in order to ascertain which species were present and to gather quantitative biological data on the major woody vegetation. Since many of the forbs had flowered, set seed, and died before the time of year that this study was initiated, the transect observations were augmented by the work of Weaver,[1] Lautenschlager,[2] and Wanek.[3] Tree and shrub composition has been studied quantitatively by Wanek for the Red River, and Disrud[4] has collected data from the Souris River valley. Disrud utilized the point-center-quarter method of Cox[5] for both tree and shrub composition. The floodplain forest biota are listed in appendix A, and the quantitative data are given in table 4.

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(1) Weaver, L. E., 1968. Prairie Plants and Their Environment. University of Nebraska Press, Lincoln, pages 121-145.

(2) Lautenschlager, L. F., 1964. A Floristic Survey of Ward County, North Dakota. 127 pages.

(3) Wanek, W. F., 1967. The Gallery Forest Vegetation of the Red River of the North, PhD thesis, North Dakota State University, Fargo, North Dakota, 211 pages.

(4) Disrud, D., 1972. Personal communication.

(5) Cox, G., 1972. Laboratory Manual of General Ecology, 2d ed. William Brown, Dubuque, Iowa.

TABLE 4

Relative density, Relative dominance, relative frequency, and importance of selected floodplain forest tree species

	Oak Park				Burlington
Species	Relative Density	Relative Dominance	Relative Frequency	I.V.**	I.V.
Fraxinus pennsylvanicus	45	33	41	119	98
Ulmus americana	32	46	41	110	152
Quercus macrocarpa	5	8	8	21	0
Acer negundo	15	12	16	43	51
Prunus sp.	3	1	2	6	--

2.75 The Northern Floodplain Forest system along the Souris and Des Lacs Rivers consists of a generally thin belt (up to about one-half mile wide in places) connecting intermittent 1- to 25-acre tracts which are generally located within oxbow meanders. It is mature woodland dominated above and below Burlington by elm, green ash, and box elder, and with bur oak entering the floodplain below Burlington. In Oak Park at Minot, aging of oaks and elms indicates a maximum age for oaks of around 120 years; elms of 35 to 40 inches in diameter reach an age of 170 to 180 years when occupying well drained sites. The bur oak seems to be reaching the edge of its range in this area. New tree reproduction consists mostly of willow, cottonwood, box elder, and ash, which are more shade-tolerant species. Where the canopy is open, some shrubs can be found, but where the canopy is dense and the woodland is not grazed, the understory consists of sedges and scattered forbs such as meadow rue, violets, and dogwood, which are capable of flowering and setting seed prior to the closing of the canopy in the spring. On the forest edges a shrub community is present in which the major species are hawthorn, chokecherry, wolfberry, and roses.

2.76 The majority of the river bottom woodland is confined to the primary floodplain. However, a somewhat similar forest community also is developed in the deeper coulees on east-facing slopes. These coulees which tend to be dominated by bur oak are drier than river bottom forests but nonetheless support valuable deer browse.

2.77 Major characteristics which delineate this system from the others considered here are the tree canopy with its shading and insulating effects and the greater fluctuations in soil moisture due to frequent spring flooding. Because of flooding, the bottomland woods function as an aquatic biological system, at times serving the aquatic needs of fish-eating birds, breeding amphibians, fish, and aquatic stages of various invertebrate animals. The forest canopy protects the understory from wind and from extreme daily temperature and moisture fluctuations; therefore the climate in the forest is more uniform, and there are fewer microhabitats. Because of this, the species diversity under the canopy is generally lower than is the case in native, undisturbed, prairie grasslands.

2.78 The stratification of vegetation in the floodplain forest includes the canopy, tall shrub, short shrub, and the grass forb layers. Each of these habitats has a characteristic fauna that is not strictly unique to it, but is either migratory as exemplified by warblers and waterfowl or is disposed to move seasonally between the valley and prairies as do the white-tailed deer.

2.79 A variety of birds is characteristic of the wooded bottoms. Fly catchers, vireos, catbirds, brown thrashers, and kingbirds are migratory nesters. Many of the birds such as warblers utilize this habitat only during migrations. Mammals common to this habitat include several species of mice, fox, squirrel, porcupine, eastern cottontail rabbit, raccoon, beaver, and the white-tailed deer. A complete listing of the fauna is found in appendix A.

2.80 Young cottonwood, willow, and green ash are used as food and shelter by beavers. Aerial censuses taken by the North Dakota State Game and Fish Department from 1952-1957 and 1967-1968 reveal an average of one beaver colony per 3 stream miles. The Upper Souris Refuge, for example, has an estimated average resident population of 124 beavers, and the refuge harvest for 1971 and 1972 has been 65 per year. Since the average litter tends to be slightly greater than four young annually, a good deal of the annual production must emigrate from the refuge area, and stock other areas.

2.81 The floodplain forest is utilized seasonally by many of these animals. For example, bark from trees and shrubs is important to mice and rabbits in winter months, but during the spring and summer the grasses and forbs comprise their diet. Chokecherry, rose, and hawthorn are essential as food for the white-tailed deer that yard up in the floodplain forest during winter, but during spring and summer, various grassland forbs become the staple diet of the deer. It is of importance to note that the forest and its related shrub communities are vital for these seasonal occupants even though they may not utilize this ecosystem year-round. The forest community, especially in sheltered coulees, carries the deer population through the critical winter months. Thus, the density of deer on the upland range is determined during critical winters by the amount of shelter that is available. Based upon the prevailing northerly direction of winter winds and the generally east-west alignment of tributary coulees to the Souris River valley, the steep-walled coulees must provide important shelter during adverse winter weather. The deer probably move intermittently from the coulees to the fringes of brush along the valley floor to browse.

2.82 Estimated populations of wintering deer for portions of the Souris and Des Lacs River valleys, which are based on aerial surveys by the North Dakota State Fish and Game Department, are given below in table 5.

TABLE 5

Estimated wintering deer populations of Souris and Des Lacs valleys

Area	1964-1965	1968-1969	1969-1970
Upper Souris Refuge	412	267	285
Upper Souris Refuge to Canada	153	59	85
Upper Souris Refuge to Minot	16	43	17
Des Lacs Refuge to Burlington	28	1	30

2.83 On the Upper Souris Refuge there are a reported average 2,000 annual activity days of firearm deer hunting with 50 to 75 deer harvested annually. Based on an approximate surface area of 75 square miles of actual river valley along the Souris River between the city of Minot and the Canadian border, considering the census data of North Dakota State Department of Game and Fish, and assuming that about 50 percent of the wintering deer population was counted during the flights, it is reasonable to expect that the wintering population of deer in the

Souris River valley between Minot and the Canadian border is on the order of 1,000 animals. This would indicate for the winter season an average of 1 deer per 48 acres over the entire valley above the city of Minot. Other estimates have placed the total overwintering deer population on the Des Lacs, Upper Souris, and J. Clark Salyer National Wildlife Refuges at 1,246. No estimate of the total deer population of the United States portion of the Souris River basin is presently available; however, about 4,430 deer are harvested annually from the basin.(1) Assuming an average annual harvest equal to one third of the total population, there would be some 13,940 deer in the basin, of which the wintering population in the entire Souris River valley above Minot might comprise about 7 percent.

2.84 Other estimates, to the effect that the deer harvest in the Souris River valley between Minot and the Canadian border has averaged about 500 animals per 1,000 square miles, may be somewhat low because this would indicate an annual harvest, in these 75 square miles of valley, of about 40 deer. The reported annual harvest on the Upper Souris Refuge alone, however, is 50 to 75 deer. Other recreational use of the river bottomland is discussed in the section on recreation.

2.85 One more aspect of the floodplain forest is its importance in cattle production. The ranchers utilize the woods as winter protection for calving cows. Without this protection it would be necessary to provide other shelter. The woods between Burlington and Baker Bridge, as an example, are an integral part of a calf production that in 1970 totaled 1,012 calving cows and 912 calves. More information on agriculture is given in the sections on economics.

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(1) Souris-Red-Rainy Comprehensive Basin Study, Appendix J.

MARSH

2.86 Marsh habitat is defined for purposes of this report as those areas having some standing water until at least mid-July followed by variable periods of wetness, and dominated by emergent semiaquatic vegetation such as cattails and rushes. Wetlands vary in many characteristics, most notably depth and permanence of moisture, qualitative and quantitative aspects of vegetation, and wildlife production potential. For convenience of discussion and to facilitate study, wetlands are generally considered in terms of one of several available classification systems. For purposes of this report, the wetlands of the Souris River basin are considered roughly as follows:

a. A type I wetland is a seasonally flooded basin or flat where the soil is covered with water, or is waterlogged, during variable seasonal periods but usually is well drained during much of the growing season.

b. A type III wetland is an inland shallow fresh marsh. The soil is usually waterlogged during the growing season; often it is covered with as much as 6 inches of water or more.

c. A type IV wetland is an inland deep fresh water marsh. The soil is covered with 6 inches to 3 feet or more of water during the growing season.

d. Types III and IV fresh water wetlands are the most important breeding and feeding habitat in the country. The combination of the two wetland types represents the principal waterfowl production areas in the United States and Canada. These wetlands are also very important to other migratory birds as well.

Attrition of wetlands has been steady as a result of private and Government-sponsored drainage programs, filling for highways, housing and industrial developments, and other causes. Of an estimated 127 million acres of wetlands present in colonial times, more than 45 million have been reclaimed for dry land use.(1) Some 371,000 acres of wetlands of value to waterfowl were drained from 1943 through 1962 in North Dakota. An estimated 6 percent (85,000 acres) of the permanent and semipermanent wetlands which existed in 1964 in North Dakota had been drained by 1972. In the same period, losses in Minnesota were estimated at 20 percent. The Upper Souris National Wildlife Refuge, established in 1935, has 3,400 acres of marsh that are maintained by impounding water from the Souris River behind three low-head dams. The J. Clark Salyer National Wildlife Refuge, near Upham, North Dakota, contains 11,003 acres of marsh created and maintained by five low-structure dams on the Souris River; and the Des Lacs Refuge near Foxholm, North Dakota, includes 500 acres of marshlands.

2.87 Natural marshlands are also present in oxbow cutoffs along the river bottom. Between Burlington and the Canadian border, excluding the Upper Souris National Wildlife Refuge, and between Burlington and Foxholm on the Des Lacs River, oxbows contribute about 300 total acres of marsh.

2.88 Approximately 90 percent of the total wetlands in the basin occur as prairie potholes on the uplands. These are the primary duck-producing habitats in the region when precipitation is adequate. The three national wildlife refuges were established primarily as propagation areas

(1) Linduska, Joseph P., Waterfowl Tomorrow, U.S.D.I. Bureau of Sport Fisheries and Wildlife, 1964.

and sanctuaries for waterfowl, at the end of the drought years of the 1930's when the duck populations in the potholes had declined to precariously low numbers. Large numbers of nesting ducks utilized the marshes with high nesting success rates from 1936 to 1941. The J. Clark Salyer National Wildlife Refuge, for example, produced a crop of ducks in 1936 estimated to have been 15 to 30 percent of the total produced in the entire State of North Dakota. In the following years through 1950, however, there was a gradual increase in precipitation, and during this period the impounded refuge marshes were filled with water. By 1946 the marshes had become more like open-water lakes.(1) This period of high sustained water levels in the marshes was accompanied by a decline in numbers of nesting ducks and nesting success in the refuge, but during these wetter years, the productivity of the potholes on the prairie had again risen. Table 6 presents the production of selected wildlife on the national wildlife refuges and the total production in the Souris River basin for average years.

(1) Hammond, M.C., 1951. Progress report - Marsh Management of Unit 326, Lower Souris Refuge, 14 pages (on file at J. Clark Salyer National Wildlife Refuge).

TABLE 6

Average annual production of selected wildlife for subareas of Souris River basin

Area	Estimated numbers produced annually					
	Ducks	Geese	Muskrat	Beaver	Mink	Deer
National Wildlife Refuges						
Upper Souris	4,000	150	100-500	65	48	50-75
Des Lacs	3,600	200 (1)	250	40	150	60
J. Clark Salyer	24,000	250	4,000-5,000	80-100	200-300	160 (2)
Total Souris River basin (3)	828,570	600 (4)	1,600	400	850	4,430

(1) Based on anticipated production from 129 birds introduced during 1973.
(2) Estimated as 23 percent of wintering herd based on available production and wintering herd information for Upper Souris Refuge.
(3) United States portion, Source: Souris-Red-Rainy River Basins Comprehensive Study, 1972. Appendix J, Fish and Wildlife.
(4) Adjusted to reflect recent introduction of geese at Des Lacs National Wildlife Refuge.

2.89 Cattails are the characteristic vegetation in the most productive types of wetlands. Stands of cattails are often fringed with growths of bulrush and canary reed grass. All of these emergents provide wildlife cover, including nesting and brooding habitat for marsh birds such as red-winged blackbirds, long-billed marsh wrens, grebes, and ducks. Muskrats use the emergent vegetation for both food and lodge-building material. The emergent stands also provide winter cover which is seasonally important to such upland wildlife as deer and pheasants during periods of harsh weather. The drier wetland soils are occupied by sedges. This vegetation also is important nesting and cover habitat for wildlife such as dabbling ducks, short-billed marsh wrens, le Conte sparrows, and mice. The deeper water of the oxbow wetlands and potholes supportssubmerged pondweeds, seeds and tubers of which are an important food item for waterfowl. Aquatic algae are also an important component of the wetland vegetation, serving as the primary food source for such invertebrates as amphiods (scuds), cladocerans (water fleas), fairy shrimp, and midges. These invertebrate organisms in turn constitute a most important source of food for the higher forms of animal life in the marsh, including juvenile waterfowl, yellow perch, northern pike fry, amphibians, and passerine marsh birds.

2.90 Carnivorous mammals common in the wetlands habitats include raccoon, mink, skunk, and red fox. Such associated birds as great blue herons, night herons, American bitterns, and kingfishers prey primarily on fish and amphibians.

2.91 Furbearers of the marsh are a valuable resource for man. A number of fur trapping permits are issued each year on the two refuges. The number of permits allotted is based on the estimated size of the potential crop for the year. The average sustained annual harvest for the J. Clark Salyer Refuge has ranged from 80 to 100 beaver, 4,000 to 5,000 muskrats, and 200 to 300 mink. On the Upper Souris Refuge the average annual fur crop is 65 beaver, 48 mink, and muskrats have ranged from 100 to 500. Fur values fluctuate yearly. The January 1972 prices are \$8-\$9/beaver blanket, \$0.75-\$1/muskrat, and \$17-\$20/male mink and \$5-\$7/female mink. A number of weasels, raccoons, and skunks are also trapped each year. The trapping of furbearers provides a locally important source of income and recreation to many sportsmen. Trapping is also particularly popular with boys of school age in the area.

2.92 Waterfowl production on the marshy wetlands of the Souris River basin is of local, regional, national, and in some ways, of international significance. Fifteen species of ducks commonly nest in the Souris River basin. Puddle ducks such as mallard, pintail, and blue-winged teal are most important. Green-winged teal, shoveler, gadwall, American widgeon, lesser scaup, ruddy duck, and redheads are also common breeders. Canvasback are no longer common but are found in some favorable habitats. Black, wood, goldeneye, bufflehead, and ring-necked ducks nand occasionally hooded mergansers nest in wooded areas, especially the bottomlands. In this regard the interaction of the upland prairie pothole and river bottom oxbows is critical. During years of average or greater precipitation, the upland prairie potholes account for over 95 percent of waterfowl production in the basin (table 6). It is generally believed that the high productivity of these smaller wetlands is related to the periodic drying,[1] which allows the organic material in exposed mud bottoms to be oxidized and nutrients released for future aquatic plant production. In contrast, the marsh units on the refuges have relatively stable water levels with little variation from year to year. The high and stable water levels on the refuge marshes have appeared to lower fertility by burying nutrients in bottom sediments, preventing growth of seedlings, inhibiting decay, accelerating the natural againg of processes, and decreasing potential waterfowl and furbearer production. The best present indication is that the duration of standing water is probably the most important factor determining the long-term biology of a marsh. The permanence of water levels affects the cycling of nutrients, reproduction and composition of flora, and many aspects of all marsh animal life.[1]

2.93 In spite of their apparent lower overall productivity, the marshes of the Upper Souris National Wildlife Refuge and the J. Clark Salyer Refuge have been dependable producers of waterfowl through their existence. Semipermanent potholes on private lands found in the State account for the vast majority of duck production during years of adequate rainfall. During years of little rainfall and drought conditions, when duck production from the potholes drops precipitously, the refuges become considerably more important in the total picture of duck production. These wetland refuges serve as dependable reserves for duck production during dry years.

2.94 Large numbers of waterfowl are attracted to the refuges during spring and fall migration. Peak concentrations of waterfowl exceed 70,000 in September and October on the Upper Souris Refuge. The J. Clark

(1) Bedish, J. W., 1967. Cattail moisture requirements and their significance to marsh management. American Midland Naturalist. Vol. 78, pages 288-300.

Salyer Refuge has had peak concentrations of 240,000 birds during the fall with more than 100,000 being normal. Mallards and pintails are the most prominent waterfowl during these migrations. The J. Clark Salyer Refuge is a major staging area for white-fronted geese, which reach peak numbers of about 20,000 in early October.

2.95 Migrating waterfowl provide the area a major recreation during the fall in the form of hunting. Grain feeding ducks and geese provide pass shooting around the perimeters of the refuges and field shooting in the surrounding areas. The J. Clark Salyer Refuge is especially popular for goose hunting and attracts hunters from all areas of the State as well as out-of-State hunters. Pheasant hunting offered on the J. Clark Salyer Refuge, usually from November 20 to December 10, provides some of the best hunting in the State for this bird.

2.96 The refuge marshes are utilized during spring migration by large numbers and many kinds of shorebirds, sandpipers, and other birds associated with water. Some of the most prominent nongame birds observed are listed below:

White pelican	Loons
Double-crested cormorant	Terns
Lesser sandhill cranes	Gulls
Herons and egrets	Shorebirds
Grebes	

2.97 Observation of the spectacular spring migrations of these many kinds of birds is of great interest to birders (i.e., people that study birds nonprofessionally), and people from all parts of the country visit the Souris River basin potholes and refuges for this reason.

These areas serve such public interests as wildlife photography and observation, educational and scientific research opportunities. Much of the latter is oriented toward the enhancement, utilization, and appreciation of the wetlands.

OPEN WATER

2.98 The open waters of the basin, as discussed in the section on water quality, are naturally fertile and capable of relatively high rates of biological productivity. Therefore, with the adequate sunlight and optimum temperatures (which are frequently available during the growing season) relatively high rates of algal production occur and produce algal blooms. The subsequent die-offs of such blooms create taste and odor problems, toxins, and depressed oxygen levels. The blue-green alga, Aphanozomenon, for example, has been known to create such problems in Lake Darling and the Des Lacs and Souris Rivers. Lake Darling appeared to be experiencing such an algal bloom during August and September 1972.

2.99 Algal phytoplankton were surveyed as part of the study by Minot State College.(1) Samples taken from the Souris River proper indicated a dominance of the green algae Scenedesmus and Ankistrodesmus, the latter of which is listed as a "clean water form".(2) The blue-green alga, Aphanizomenon, which is a common nuisance form, was present in several places, including Lake Darling.

2.100 Part of the algal production is utilized by zoolplankton, mainly cladocerans and copepods, which in turn are an important food source for small fish and fry. The remaining planktonic algae ultimately

(1) Appendix A.

(2) American Public Health Association et al, 1971. Standard Methods, plate D.

reach the bottom and are either consumed by bottom invertebrates such as the microcrustaceans and insects or decomposed by bacteria.

2.101 Aquatic rooted plants (mostly Sago pondweed) cover most of the bottom of standing waters such as Lake Darling. These larger submerged aquatic plants provide cover for fish and a substrate for many of the aquatic invertebrates. Also, they serve as an important source of food for migrant waterfowl which are especially concentrated over the open waters during the fall.

2.102 Decay of the plant and animal material during the winter lowers oxygen levels in the open waters and the Souris River. Dissolved oxygen has reached critical levels that caused partial winter kills. However, even these partial winter kills have been infrequent in Lake Darling.

2.103 The bottom dwelling invertebrates (benthos) were also sampled as part of the Minot State College Study.(1) The more prominent groups of organisms from the samples included mayflies, mainly of the taxonomic families Baetidae and Hexagenidae; amphipods (scuds or sideswimmers); larvae of such dipteran (two-winged) flies as Chaoborus and chironomus (midges); snails, mussels, and tubificid worms. Mayflies of the genera Hexagenia and Heptagenia, which were present in particularly large numbers below Lake Darling, are an important source of food for many species of fish. The invertebrate composition at several sampling stations (for example where tubificid worms were numerous) was indicative of pollution.

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(1) Appendix A.

2.104 One may note that the difference between stations in numbers of pollution sensitive and tolerant forms indicates differences in water quality (appendix A). Stations that exhibit relatively fewer types of sensitive forms and more of the tolerant forms characterize zones of pollution and degraded water quality.

2.105 Fish species found in Lake Darling and the Souris and Des Lacs Rivers are characteristic of warm waters in the midwest. Perch, which successfully spawn in Lake Darling, are especially abundant and serve as prey for walleye and northern pike as well as making up a large percentage of the creel. Northern pike require flooded terrestrial vegetation during March and April for their spawning, but this situation has not existed in Lake Darling for several years. There is no walleye recruitment in the lake due, in part, to the absence of suitable spawning substrates and in part to the lack of sufficient depth.

2.106 The Souris River fishery between Burlington and Logan depends on fishery production in the Lake Darling Reservoir and varies with the amount of water being released from the reservoir. When surplus water is being released, downstream fishing is improved. As water is stored at the refuge to provide natural habitat for waterfowl reproduction, downstream fishing becomes marginal. Northern pike, walleye, yellow perch, and black bullhead make up the bulk of fishermen's harvest. Bluegill, white crappie, and black crappie are also caught. The forage and rough fish consist mainly of darters (subfamily *Etheostominae*), fathead minnow, spottail shiner, plains shiner, and common white sucker. The recreation aspects of the fishery in the Souris River system are discussed under the section on recreation.

RARE AND ENDANGERED SPECIES

2.107 Lands and waters which would be affected by the recommended plan are not known to be critical for any rare, endangered, or otherwise unique species of vegetation or wildlife. The ranges of the black-footed ferret, American peregrine falcon, whooping crane, greater sand-hill crane, northern greater prairie chicken, mountain plover, ferruginous hawk, and American osprey have all, at least during the past, approached or included part of the Souris River basin. At the present time, it is known that the endangered whooping crane and peregrine falcon and the rare greater sandhill crane do migrate across project lands and spend some time in the area. Also, egrets (snowy and common are rare) are known to use the Upper Souris National Wildlife Refuge.

SOCIAL AND ECONOMIC SETTING

SETTLEMENT

2.108 The city of Minot was originally settled as a division point for the Great Northern Railroad in 1887. In 1912, it became North Dakota's main station for the Great Northern line. With additional north-south rail service being provided by the Soo Line, and air service by North Central and Frontier Airlines, Minot has become the regional social, economic, and transportation center for north central North Dakota.

2.109 The early settlers built their homes and businesses in the Souris River valley in order to take advantage of the natural shelter from severe winter cold and summer heat, and to be near to accessible water.

This pattern of development has persisted to the present and even today the banks of the meandering river are regarded as prime homesites. Some 4,000 residences and 300 businesses as well as local utilities, 15 churches, and 7 schools are now situated on the floodplain at Minot and approximately another 800 residences are located on the floodplain in eight new and growing subdivisions between Minot and Burlington , Minot and Logan, Sawyer, Velva, and rural areas below Minot. There are about 30 low-lying residences in the Des Lacs River valley just above Burlington and about 35 residences in the Souris River valley below elevation 1620 between Burlington and the Canadian border. As discussed in the section on land use, most of the valley above Burlington is occupied by relatively large farms or ranches and the Upper Souris National Wildlife Refuge.

ECONOMIC ENVIRONMENT AND EMPLOYMENT

2.110 The Minot economic region comprises 20 counties of north central and northwestern North Dakota and northeastern Montana with an area of 38,000 square miles. The population in 1970 was 209,000. The 20 counties were delineated as an economic region in 1968 by the Office of Business Economics, U.S. Department of Commerce, and designated as OBE Economic Area 06085. Smaller than the block of 20 counties is an area of nine counties in which Minot's economic influence is more intensive, designated as the Minot Retail Trade Area. The nine counties comprise 13,500 square miles and the population in 1970 was 114,000. At the core of both the OBE Economic Area (20 counties) and the retail trade area (nine counties) is the United States portion of the Souris River basin. The basin, including the watersheds of tributary streams, comprises 9,320 square miles and the population in 1970 was 95,000. Essentially all of Renville, Ward, McHenry, Bottineau, and Rolette Counties, North Dakota, are within the basin. Several other counties lie partially within the basin. Recorded and projected population is given in table 7 below for the city of Minot and the Souris River basin.

TABLE 7

Recorded and projected population for Minot and the Souris River basin

Year	Minot	Souris River basin
1940	16,577	86,749
1950	22,032	82,929
1960	30,290	90,213
1970	32,290	94,603
1980	38,750	99,000
2000	56,000	120,000
2020	78,000	141,000
2030	92,500	152,000

2.111 In 1970, 20,000 persons resided in the immediate vicinity of Minot outside the present municipal limits. Thus, the 1970 population of the Minot urbanized area was more than 52,000. In Ward County, which includes the Minot urban area, the 1970 population was 58,560.

2.112 The labor force in Minot in 1970 consisted of 12,113 workers. Business, agricultural, professional, health, and other services accounted for 37 percent of all employment in Minot in 1970. Wholesale and retail trade was second most important in 1970, followed by transportation and communications in order of importance. Government and manufacturing followed and were of equal importance as sources of employment. The relatively low order of importance of manufacturing is attributable to the distance between Minot and major markets for manufactured products marketed mainly within the region, such as food products. Table 8 shows employment by industry in Minot from 1940 to 1970.

2.113 Total employment in Ward County increased from 10,317 in 1940 to 17,407 in 1970, an increase of about 70 percent as shown in table 9. From 1940 to 1970, agricultural employment in Ward County declined from 3,269 to 1,525, a reduction of over 50 percent. This decline reduced the rate of growth in total employment for Ward County, and reflects a nationwide trend to larger, more efficient, highly mechanized farms. The large percentage increase in employment in the construction category was due to the construction of a large air base north of the city, and several missile sites. Table 9 shows employment by industry for Ward County from 1940 to 1970.

TABLE 8

- Employment by industry, Minot, North Dakota, 1940-1970

Industry	1940		1950		1960		1970	
	Number	Percentage of total	Number	Percentage of total	Number	Percentage of total	Number	Percentage of total
Agriculture, forestry, and fisheries	52	1.0	236	2.7	181	1.6	132	1.1
Mining	41	0.7	31	0.4	39	0.3	34	0.3
Construction	220	4.0	613	7.1	937	8.4	681	5.6
Manufacturing	363	6.6	502	5.9	655	5.9	693	5.7
Transportation, communications, and utilities	916	16.5	1,489	17.4	1,512	13.6	1,314	10.8
Wholesale, retail	1,754	31.7	2,808	32.7	3,260	29.2	3,548	29.3
Finance, insurance, and real estate	212	3.8	283	3.3	592	5.3	533	4.4
Services	1,669	30.1	2,179	25.4	3,199	28.7	4,485	37.1
Government	223	4.0	323	3.8	622	5.6	693	5.7
Industry not reported	87	1.6	115	1.3	157	1.4	—	—
Total	5,537	100.0	8,579	100.0	11,154	100.0	12,113	100.0

TABLE 9

Employment by industry, Ward County, North Dakota, 1940-1970

Industry Sector	1940 Number	1940 Percentage of Subtotal	1950 Number	1950 Percentage of Subtotal	1960 Number	1960 Percentage of Subtotal	1970 Number	1970 Percentage of Subtotal
Agriculture, forestry, and fisheries	3,269	31.7	2,823	21.8	1,977	12.7	1,525	9.7
Mining	218	2.1	100	0.8	109	0.7	61	.3
Construction	274	2.7	785	6.1	1,241	8.0	1,040	6.6
Manufacturing	412	4.0	558	4.3	749	4.8	847	5.3
Transportation, communications, and utilities	1,098	10.6	1,809	14.0	1,810	11.6	2,753	17.6
Wholesale and retail	2,134	20.7	3,314	25.7	4,055	26.1	3,683	23.6
Finance, insurance, and real estate	239	2.3	299	2.3	612	3.9	667	4.2
Services	2,239	21.7	2,605	20.2	3,932	25.3	3,867	24.6
Government	293	2.8	409	3.2	840	5.4	964	6.2
Industry not reported	141	1.4	201	1.6	234	1.5	256	1.6
Subtotal	10,317	100.0	12,903	100.0	15,559	100.0	15,663	100.0
Armed Forces	0		13		1,907		1,744	
TOTAL	10,317		12,916		17,466		17,407	

SOURCE: Bureau of the Census

2.114 Approximately 97 percent of Ward County lands are committed to agriculture. Between 1959 and 1964 the number of farms decreased from 1,719 to 1,503, while the average size of farms increased from 741 to 839 acres. However, between 1964 and 1969 the number of farms increased to 1,555 and the average size decreased to 815 acres. Major crops for Ward County are tabulated in table 10.

TABLE 10

Major crops for Ward County for 1964 and 1969

Crops	Acres (1964)	Acres (1969)
Wheat	225,265	293,876
Other small grains	220,868	170,495
Hay	82,705	63,331
Summer fallow	346,567	297,871
Pasture	17,888	40,127

(Reference source, 1969 Census of Agriculture, Ward County Data.

2.115 Agriculture is the Minot region's basic export[(1)] industry and the foundation for the regional economy. Earnings from sales of farm products make possible most of the region's purchases of goods and services from other regions. Likewise, agriculture is of primary importance in the Minot retail trade area and in the Souris River basin. In the five counties which closely correspond to the basin, there were 5,265 farms in 1969 with an average size of 854 acres. The gross income in 1969 of the basin's farmers and ranchers was $76.9 million, as measured by the market value in 1972 prices of all farm products. The value of farm products net of production costs amounted to approximately $25.9 million. About 27 percent of farm income in the basin was derived

(1) In regional economics, an "export industry" signifies an industry which ships its output to other regions of the United States and/or to foreign countries.

from sales of livestock, mainly beef cattle. Wheat, hay, oats, and flaxseed are the basin's principal crops. In accordance with agricultural practices suitable for northern North Dakota, 40 percent of all cropland is left fallow each year. The efficiency and productivity of agriculture in the Minot area are rising rapidly. The total value and value per acre of all farm products, adjusted to 1972 prices, increased by 75 percent between 1954 and 1969, according to data in the U.S. Census of Agriculture. An irrigation project now under construction will further improve agricultural productivity. Designated as the first phase of Garrison diversion, this Bureau of Reclamation project will divert Missouri River water into the Souris River basin for sprinkler irrigation of approximately 190,000 acres. Timely application of supplemental water to hay and some other crops will substantially increase yields in all years and diminish the possibility of crop failure in dry years. Average yields of alfalfa are expected to reach 5.1 tons per acre on irrigated land by 1980, compared with the 1969 basin average of 1.16 tons of hay per acre; and corn for silage should yield 17 tons per acre by 1980 on irrigated land, in comparison with a basin average of 5.7 tons in 1969. Irrigation will make possible a shift toward more profitable crops which require more water than is presently available, and likewise permit more intensive use of cropland by altering the present practices with regard to leaving land fallow for moisture accumulation. Even on nonirrigated land, the U.S. Department of Agriculture anticipates that crop yields in the Souris River basin will continue to advance.

2.116 In addition to agriculture, petroleum production and Federal expenditures on national defense also bring money from outside into the Minot region. Production of petroleum in the vicinity of Minot commenced 20 years ago. The Minot Air Base also has beneficial effects on the regional economy. However, petroleum and defense are of less importance than agriculture.

2.117 The favorable prospects for agriculture in the Minot region in general and the Souris River basin in particular redound to the benefit of the city of Minot. The region's wholesale and retail trade, agricultural and business services, medical and other professional services are highly concentrated in Minot. The population of Minot in 1970 was 32,290, which was double the population of 30 years earlier in 1940. It is anticipated that Minot will continue to grow in population and reach 92,500 by 2030.

LAND USE

2.118 Concurrently with growth of population, the number of acres of developed land in Minot has also been growing in recent years. In fact, the city's size in developed acres is growing at a faster rate than its size in number of inhabitants. A land-use survey in 1957 indicated that there were 3,520 developed acres. Another survey in 1966 indicated that there were 5,070 developed acres. Although no land-use study has been made since 1966, the acreage of developed land has presumably continued to expand. Table 11 gives data pertaining to land use in Minot in 1957 and 1966, and table 12 provides land-use data for the Souris and Des Lacs River valleys above Burlington.

TABLE 11

Land Use in Minot, North Dakota, (1957-1966)

Urban land use	Area in acres 1957	Area in acres 1966	Percentage of total developed area 1957	Percentage of total developed area 1966	Percentage of change 1957-66
Residential	995	1,590	28.3	31.4	+59.8
Commercial	100	300	2.8	5.9	+200.0
Light industrial	80	240	2.3	4.7	+200.0
Heavy industrial	55	45	1.6	0.9	-18.2
Public and semi-public	1,115	1,155	31.7	22.8	+3.6
Parks and recreation	220	310	6.2	6.1	+40.9
Streets and railroads	995	1,430	27.1	28.2	+49.7
Total developed land	3,520	5,070	100.0	100.0	+44.0

TABLE 12

Land Use for Souris and Des Lacs River Valleys above Burlington, below Elevation 1620[4]

Land classification category	Souris River valley: Burlington to Baker Bridge[1] Acres	Per-cent	Upper Souris National Wildlife Refuge: Baker Bridge to Lake Darling Dam Acres	Per-cent	Lake Darling Dam to north refuge boundary Acres	Per-cent	North refuge boundary to elevation 1620 of valley floor[2] Acres	Per-cent	Souris valley subtotal Acres	Per-cent	Des Lacs valley subtotal: Burlington to intersection of U.S. Highways 52 and 2[3] Acres	Per-cent	Total Acres	Per-cent
Marsh	70	2	1,355	37	873	6	60	2	2,358	9	100	8	2,458	9
Open water	190	5	901	24	11,300	80	358	9	12,749	50	180	14	12,929	49
Grassland-pasture	1,522	40	753	20	1,196	8	95	3	3,566	14	260	21	3,826	14
Cropland-hayland	1,300	35	310	8	70	Trace	2,291	61	3,971	16	479	39	4,450	17
Woodland	524	14	286	8	573	4	824	22	2,207	9	190	15	2,397	9
Roads, farmsteads	140	4	95	3	250	2	110	3	595	2	36	3	631	2
Total	3,746		3,700		14,262		3,738		25,446		1,245		26,691	

(1) South boundary of Upper Souris National Wildlife Refuge.
(2) Elevation 1620 is design pool elevation for Confluence and Burlington Reservoirs.
(3) Approximate elevation 1620 of Des Lacs valley floor.
(4) Land-use data to elevation 1650 are available from Lunan, James S., Thomas Glorvigan, and Gary Leslie. 1973. Biological and recreational impacts of nine proposed flood control alternatives in the Des Lacs and Souris River floodplain, North Dakota. Contract No. DACW 37-73-C-0001, U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota 55101.

PUBLIC HEALTH AND SAFETY

2.119 The project area has not suffered significantly from public health problems associated with flooding, because local health authorities have taken several precautions. Disposal of debris and garbage is well planned and consequently there are few bank dwelling rats to be forced to higher ground during flood conditions. A mild mosquito nuisance was experienced during the 1969 flood, and some cases of mosquito-borne equine encephalitis were identified in the area at that time. Private wells with faulty casings have been found to be contaminated with coliform bacteria; however, very few problems concerning sewage or municipal water supply have occurred. In the 1969 Souris River flood, a rancher was drowned while attempting to save his cattle by moving them to high ground, and a death from drowning was also reported in connection with high Des Lacs River flows in 1970.

SEWAGE DISPOSAL

2.120 Minot waste water is presently transferred by a series of pump stations with mechanical gates to a pair of open lagoons, one 135 acres, the other 145 acres, each containing approximately 6 feet of effluent when full. A third lagoon of 145 acres with a depth of 9 to 10 feet is scheduled to be operational by spring of 1973. The waste water is allowed to stand for periods of approximately 60 days, or when 5-day BOD (Biological Oxygen Demand) tests by the North Dakota State Department of Health indicate a residual of 25 mg/l or less of oxygen demand. The effluent is then discharged to the Souris River. Raw sewage from several minor sources has been dumped into the Souris River between Burlington and Logan. The Minot health authorities have been active recently in discouraging the release of raw sewage. Problems with septic tanks are frequent in the floodplain developments, due in part to high-water table levels and inadequate drainage field areas.

AIR QUALITY AND SOLID WASTE

2.121 Air quality degradation is negligible in Minot because of the lack of industry. Air quality data for the first 7 months of 1973 are given in table 13. At one time there was considerable disposal of solid waste in the river; however, a land fill has been established and this is no longer a problem.

TABLE 13

City of Minot. Air Quality Data

SAMPLE DATE	PH	TOTAL PARTICULATES	SUSPENDED SULPHATES	SUSPENDED NITRATES	SUSPENDED FLUORIDES	BETA RADIATION
		11101 91 01	12403 92 01	12306 93 01	12202 91 01	11302 91 30
		MICRO GRAMS / CU. M.	MICRO GRAMS / CU. M.	MICRO GRAMS / CU. M.	MICRO GRAMS / CU. M.	PCI / CU. M.
1- 4-73	9.7	37.	4.95	0.42	0.00	0.04
1-16-73	7.8	14.	2.91	0.43	0.10	0.03
1-28-73	7.7	62.	2.49	0.82	0.00	0.02
2- 9-73	8.4	89.	3.33	0.82	0.00	0.03
2-21-73	9.0	37.	2.72	0.53	0.00	0.04
3- 5-73	7.5	87.	5.10	3.51	0.00	0.03
3-17-73	8.6	103.	3.71	1.03	0.00	0.02
3-29-73	8.4	126.	3.72	1.12	0.00	0.04
4-10-73	9.0	86.	2.39	0.49	0.02	0.05
4-22-73	8.0	25.	3.42	0.39	0.00	0.02
5-10-73	8.0	184.	1.58	1.58	0.00	0.04
5-15-73	8.1	119.	2.21	1.86	0.00	0.03
5-28-73	8.7	40.	2.51	0.93	0.00	0.03

TRANSPORTATION

2.122 Rail service was instrumental in Minot's development as a major trade and transportation center in North Dakota. Ward County is presently served by two major railroads, Burlington Northern and Soo Line. Burlington Northern maintains its division headquarters at Minot, while the Soo Line parallels the Souris River throughout the project area. Passenger service is provided by Amtrak. This pattern is slowly changing as airlines and trucking companies become increasingly competitive in the freight industry. Also, most forms of shipping are becoming increasingly automated, reducing some types of jobs in the field. Despite this moderate decrease in numbers of jobs, continued income growth is expected.

2.123 The highway network throughout Ward County consists of three Federal highways, U.S. 2, 52, and 83; and two State highways, 23 and 53. U.S. 2 runs east and west, U.S. 52 crosses the county diagionally from northwest to southeast, and U.S. 83 runs north and south. These highways intersect at Minot and are supplemented by numerous local roads to provide adequate circulation through and within the county. Daily bus service is available to Minot from Grand Forks, Jamestown, and Bismarck.

2.124 Minot International Airport is served by two major airlines, North Central and Frontier, which offer a total of five flights daily.

WATER RESOURCE PROBLEMS AND NEEDS

2.125 The principal water resource needs of the Souris River basin have not changed since project authorization. The foremost needs are for reduction of urban flood damages at Minot, Velva, and Sawyer and the developing residential areas upstream and downstream from Minot; and an adequate water supply for future needs at Minot. There is also a need for reduction of flood damage to highways, bridges, utilities, and agricultural lands in the Souris River floodplain. A need for improvement of water quality is also recognized in the Souris River, especially at Minot.

a. Floods and flood damage. - The Souris River can be expected to flow out of its banks in the Minot area about once every 5 years. The history of flooding on the Souris River dates back to about 1882. Since then, floods have been reported in 1897, 1899, 1901, 1904, 1916, 1923, 1925, 1927, and 1928. In 1936, Lake Darling Dam was constructed and this has served to reduce flooding in the Minot area since. Spring floods have occurred since in 1943, 1948, 1949, 1951, 1955, and 1969. In 1970, a flood of record was recorded on the Des Lacs River. The 1904 flood is the largest flood of record on the Souris River. However, historical data indicate that a flood 3 feet higher in stage at Minot occurred in 1882. In terms of volume of flow, the 1969 flood was the second largest flood of record on the Souris River. However, in terms of stage at Minot, the 1969 flood was only one-half foot lower than the record 1904 flood. The 1969 flood had a flow of about 12,000 cfs at Sherwood near the international boundary and 6,000 cfs at Minot after attenuation by Lake Darling. This flood produced economic losses estimated to be $12 million (1969 prices) in the Souris River valley, of which about $10.9 million were in Minot. During this flood, over 11,800 people were evacuated from the valley and about 3,000 homes, 250 businesses, seven schools, and six churches were flooded with varying degrees of damage. Without evacuation of furniture, supplies, and equipment from the floodplain and construction of temporary levees, flood losses in Minot in 1969 have been estimated to exceed $19 million. Under 1973 conditions and prices the economic damages would be much higher. During the 1969 flood the Corps of Engineers expended approximately $1 million under the authority of Public Law 99 to defray the costs of evacuating floodplain residents, to raise streets for access, to construct levees and other emergency works around public buildings at Minot, and to construct emergency levees at the downstream communities of Sawyer and Velva. During the spring of 1970 the Corps of Engineers implemented an emergency levee plan at Minot which was credited with protecting some 1,600 residences and 58 businesses and other private and public properties from damages estimated at $4.3 million from the record Des Lacs River flood. Although flooding at Minot has never occurred from Gassman Coulee, this coulee poses a serious threat to life and property at Minot because of its location with respect to the city and its steep gradient. With a severe thunderstorm centered over Gassman Coulee, it is estimated that flooding at Minot could occur within a period of 12 hours. The economic damages of flooding do not express all of the adverse social consequences of the existing setting at Minot and in adjacent areas because there is a significant but intangible element of human misery and anxiety which is not subject to monetary quantification. In the particular case of Minot and adjacent areas, the anxiety suffered by floodplain residents during every flood season is evident even though flooding occurs infrequently.

b. Water supply and water quality problems. - As discussed in the section of this report concerning water supply, the development of additional water supplies will be necessary in order to meet future needs at Minot. The additional needs to beyond 1980 should be obtainable from the Sundre aquifer. However, if difficult problems should arise with the development of this aquifer or if the available supply of water does not meet future demands, the Garrison diversion may become a source of urban water supply. Water quality problems in the Souris River basin and in the Minot vicinity are somewhat more constraining than water supply problems because standard and economically feasible technology is not readily available for the removal or reduction of high concentrations of such dissolved substances as nitrate, phosphate, and manganese. If, as indicated in the Environmental Protection Agency report, the importation of water through the proposed Garrison diversion irrigation project results in higher concentrations of dissolved solids, additional alternatives to the water supply problem may need to be considered.

RECREATION

2.126 The study area is located within Recreation Region 2 as recognized by the North Dakota State Outdoor Recreation Agency.(1) The population in this defined area, which includes the counties of Burke, Bottineau, Mountrail, McHenry, Pierce, Renville, and Ward increased from 89,250 to 100,360 during the period 1950 to 1970. The population is expected to increase to 117,200 by 1985. Over 50 percent of the present population is located within Ward County, including the city of Minot (population 32,290), which is recognized as the regional center of Recreation Region 2. Grants which had been made to local jurisdictions and State

(1)North Dakota State Outdoor Recreation Agency, 1970. North Dakota Outdoor Recreation Plan.

government entities of Land and Water Conservation Funds as of 1 March 1970 totaled $477,984. The North Dakota Outdoor Recreation Plan includes findings relevant to the present and future needs for outdoor recreation facilities and areas. The demand, supply, and current as well as projected needs, are given in table 14 for selected activities.

a. Hunting. - The Souris River valley, especially the Souris loop National Wildlife Refuges provide for considerable hunting in the project area. The Upper Souris National Wildlife Refuge for example supports 2,000 recreation days of firearm deer hunting with 50 to 75 deer harvested annually. The refuge is also opened to the hunting of pheasant and to trapping. Although hunting for waterfowl is not permitted, waterfowl from the refuge have been taken in almost every other State at one time or another. The immediate implementation of acquisition programs by Federal and State Government is recognized as necessary before existing and potential hunting areas become unavailable due to increasing costs of land and competition from more intense land uses. The Missouri River Bottomlands, Custer National Forest, and North Dakota Badlands are recognized as the prime big game hunting areas of the State. Areas for the hunting of crows, red fox, and waterfowl are much more widespread.

TABLE 14

Recreation demand, supply and needs, North Dakota Recreation Region 2

Activity	Demand[1] 1969	Demand[1] 1980	Demand[1] 1985	Supply[2] 1969	Needs 1969	Needs 1980	Needs 1985
Hunting	335,980	421.480	440,170	246,390	5,540[2]	13,080	14,290
Fishing	588,130	746,500	808,670	242,030	4,610[2]	6,730	7,560
Boating and water-skiing	474,870	578,060	627,020	348,500	1,220[2]	2,210	2,680
Swimming							
Pools	463,700	591,900	667,130	337,780	20,310[3]	40,990	53,120
Beaches	226,870	696,210	746,240	2,224,110	None[4]	None	None
Camping	307,970	403,580	454,990	269,000	78[5]	269	372
Picnicking	412,470	475,280	519,030	513,000	None	None	10[6]
Hiking, walking for pleasure, and nature study	523,880	618,930	665,220	194,880	24[7]	31	34
Snow skiing	52,560	88,840	110,180	102,960	None	None	23[8]
Sledding and tobogganing	209,390	244,850	262,000	12,960	68[2]	81	87
Snowmobiling	651,680	809,910	892,010	19,200	329[7]	412	455
Horseback riding	100,020	109,990	117,130	124,800	None	None	None
Driving for pleasure and sight-seeing	1,271,250	1,421,290	1,489,490	1,061,400	11[9]	20	23
Urban park land[2]	1,340[2]			638[2]	702[2]		

(1) Total annual activity days except urban park land.
(2) Acres.
(3) Square feet.
(4) No needs for additional beaches recognized; however, improvement of existing potential beaches will be required in lieu of new sites.
(5) Units.
(6) Tables.
(7) Miles of trails.
(8) Tow lift capacity.
(9) Miles of scenic roads.

SOURCE: North Dakota State Outdoor Recreation Agency, 1970. North Dakota Outdoor Recreation Planner.

b. Fishing. - The Souris River System supports considerable fishing pressure in the study area. Of approximately 100,000 annual activity days of fishing which occur on the Upper Souris National Wildlife Refuge, some 50,000 occur on Lake Darling. Downstream areas, which depend upon Lake Darling for their fish stock, support lesser amounts of fishing use. Important recreation sites of the refuge and the total percentage of refuge use supported (which consists mostly of fishing) are given in table 15. Action at all levels of government and by private interests is recognized as necessary in order to provide for the recognized present and projected future needs in fishing. Since the present supply of natural fishing areas that can be effectively managed is not sufficient to meet the needs, the construction of reservoirs is recognized as necessary. The construction of any reservoirs for recreation, fish, or wildlife enhancement should also include consideration of such boating and water-skiing facilities as marinas, boat-launching ramps, access roads, and boat/trailer parking.

TABLE 15

Recreation use of existing public-use sites on the Upper Souris National Wildlife Refuge during 1972(1)

	Percent of Refuge Use	Activity days		
		May	June	July
Baker Bridge	30	2,281	2,664	1,975
Lake Darling Picnic site	20	1,521	1,776	1,317
St. Mary's Bridge	10	760	888	658
Grano Crossing	15	1,140	1,332	987
Landings 2 & 3	10	760	888	658
Landing 1	10	760	888	658
Green Crossing	5	380	444	329
TOTAL	100	7,602	8,880	6,582

(1) Data from Refuge Manager.

c. Swimming. - Because of marginal quality, primarily due to poor water quality and seasonal growth of objectionable algae, many of the State's existing natural and man-made swimming beaches are not usable. Supplies of fresh, high quality water supplied via the Garrison Diversion project are expected to greatly increase statewide participation in natural areas. It is considered that lack of suitable opportunity has caused many people to participate in other activities instead of swimming. Thus, past estimates of the demand for this activity have been low. On this basis it is recognized that the data from table 14 do not present an entirely accurate picture of the need for swimming beaches.

d. Camping. - The provision of camping facilities is recognized as primarily the responsibility of the State. This includes the management by the State of federally administered lands, as well as increased acquisition and development by the North Dakota Park Service. A camping unit is generally considered to consist of a trailer pad, vehicle parking area, table, trash receptacle, and electrical supply. Other necessary facilities for camping areas are comfort stations and water supplies.

e. Picnicking. - The supply of picnic tables in Recreation Region 2 is generally adequate to meet demands through 1985. However, many of the picnic facilities associated with rural areas lack such supporting facilities as grills, fireplaces, comfort stations, picnic shelters, water supplies, or sanitary equipment. Development of such areas would be desirable and it will also be necessary to provide picnicking facilities at lakes and reservoirs where a significant amount of picnicking occurs in conjunction with water-based activities.

f. Trails. - Trails will be needed in scenic areas such as lake shores, river bottoms, woodlands, and picturesque sections of scenic towns. In order to satisfy the present and developing needs for hiking, pleasure walking, and nature study, trails should include interpretive measures oriented toward natural vegetation, fish and wildlife study, geology, history, and aesthetic and other interesting features.

g. Snow-skiing, tobogganing, and snowmobiling. - Region 2 normally has marginal snow for snow-skiing; therefore, the more eastern regions may have to satisfy the demand for this activity. This would also apply to the substantial needs for sledding and tobogganing and snowmobiling in Region 2.

h. Driving for pleasure. - Driving for pleasure and sight-seeing was the most popular recreational activity among North Dakotans during 1969. Since the opportunity to provide scenic roads depends almost entirely upon the resources and terrain of an area, many areas are limited in the amount of such roads they can supply. Therefore, any opportunity to develop scenic roads, especially in conjunction with relocations required as a result of other public works projects should be taken.

i. Urban parkland. - Future needs for urban park lands have not been determined by the State of North Dakota due to a lack of adequate background information, and studies will be initiated in the future to determine more specifically the needs for urban parks and other open-space lands. However, almost every community in the

State, including the city of Minot, lacks adequate open spaces. The State Outdoor Recreation Plan recognizes every opportunity for acquisition of such areas as greenbelts, outstanding scenic features, and floodplains because the supply of these areas is low and opportunities to acquire them are limited.

j. Recreation land inventory. - The 1970 North Dakota Outdoor Recreation Plan includes an inventory of recreation lands administered by Federal and State agencies. These are given in table 16 which follows. Neither Ward County nor the city of Minot has an outdoor recreation plan; however, an inventory of existing recreational resources for Ward County, which includes the city of Minot, was provided by the North Dakota State Outdoor Recreation Agency (see table 17). This inventory indicated that approximately 20,150 acres of land and water in Ward County are presently designated for recreational uses. The majority of this land is open to the public, and is committed to wildlife propagation, game management, and hunting. Land devoted to conventional land-based or water-oriented recreational activities in Ward County totals 1,200 acres. Major recreational areas in the study area include: two city parks in Minot (Oak and Roosevelt Parks), a county park near Burlington (Old Settlers Park), Renville County Memorial Park just upstream from State Highway 5 on the Souris River, Upper Souris Refuge, Des Lacs Refuge, and the Kenmare Recreation area. Lake Sakakawea, a major water-oriented, recreational facility of regional importance, is located approximately 50 miles south of Minot. The area contains several State parks and offers considerable opportunity for boating and fishing. Lake Metigoshe State Park, in Bottineau County, receives heavy use from Ward County residents. Appendix B is an annotated list of the recognized public-use areas along the Souris River between Burlington and the Canadian border.

TABLE 16

Recreation lands administered by Federal and State agencies[1]

Level of Government administration	Number of areas	Acres	Annotations
Bureau of Land Management	117	5,132	Public domain lands open to hunting and other pursuits.
Bureau of Sport Fisheries and Wildlife			
Waterfowl production areas	59	8,898	Leased by Bureau of Sport Fisheries and Wildlife, and unstaffed.
National Wildlife Refuges	10	144,080	Owned by Bureau of Sport Fisheries and Wildlife, and staffed.
National Forest Service	1	520	
U.S. Army Corps of Engineers	9[3]	677	All managed by local governmental agencies.
North Dakota State Agencies			
Fish and Game Department		5,842	
State Park Service	3	799	
Historical Society	1		David Thompson site.
State Forest Service	3	7,640[2]	Turtle Mountain, Homen, and Souris River State Forests.

(1) 1970 North Dakota Outdoor Recreation Plan.
(2) Includes 640 acres of North Dakota State school land which is managed by the State Forest Service.
(3) Four areas not yet developed.

TABLE 17

RECREATION INVENTORY
WARD COUNTY, NORTH DAKOTA

NAME OF AREA	LOCATION	OWNERSHIP*	TOTAL ACRES	TOTAL WATER ACRES	BOATING	CAMPING	FISHING	HIKING	HUNTING	OUTDOOR GAMES & SPORTS	PICNICKING	PLEASURE DRIVING	SWIMMING	SLEDDING & TOBOGGANING	ICE SKATING	OTHER
					EFFECTIVE ACRES											
Federal																
Kenmare Recreation Area	City	F/M	2,880	40	40	2	--	--	--	10	2	--	--	--	--	--
Waterfowl Production Areas	County	F	2,196	--	--	--	--	--	2,196	--	--	--	--	--	--	--
B.L.M. Land	County	F	265	--	--	--	--	--	265	--	--	--	--	--	--	--
Upper Souris Refuge**	County	F	6,400	NA	--	--	--	--	6,400	--	--	--	--	--	--	--
Des Lacs Refuge**	County	F	6,300	NA	--	--	--	--	6,300	--	--	--	--	--	--	--
Hiddenwood Lake	County	F	200	NA	--	--	--	--	200	--	--	--	--	--	--	--
State																
Highway Rest Area	County	S	3	--	--	--	--	--	--	--	2.5	--	--	--	--	--
Foxholm Game Mgt. Area	County	S	40	--	--	--	--	--	40	--	--	--	--	--	--	--
County																
Old Settlers Park	County	C	22	--	--	5	--	--	--	3	10	--	1	--	--	--
Rice Lake	County	C/P	400	300	300	--	--	--	--	--	1	--	2	--	--	--
Velva Fish Dam	Velva	C/P	130	20	20	3	20	--	--	--	2	--	--	--	--	--
Nelson-Carlson Lake	County	C	20	8	8	5	8	--	20	--	4	--	4	--	--	--
Municipal																
Berthold Park	City	M	3	--	--	--	--	--	--	2	1	--	--	--	--	--
Carpio Park	City	M	6	--	--	--	--	--	--	2	1	--	--	--	--	--
Des Lacs Dam	County	M	55	50	--	--	50	--	--	--	1	--	1	--	3	--
Bonnybrook Park	City	M	10	--	--	--	--	--	--	--	1	--	--	--	--	--
Tasker Coulee	Kenmare	M	30	--	--	2	--	--	--	4	5	--	--	--	--	--
Kenmare Park	City	M	10	--	--	--	--	--	--	2	8	--	1	--	.5	--
Makoti Park	City	M	4	--	--	1	--	--	--	2	1	--	--	--	--	--
Minot Recreation Area	City	M	407	--	--	--	--	--	--	50	--	--	--	--	15	--
Minot Parks	City	M	336	35	--	20	--	--	--	30	120	--	1	--	--	--
Ryder Park	City	M	3	--	--	--	--	--	--	2	--	--	--	--	.25	--
Danish Mill	Kenmare	M	.01		Historical Site											
Minot Baseball Field	City	M	6	--	--	--	--	--	--	4	--	--	--	--	--	--
Souris River Golf Course	City	M	120	--	--	--	--	--	--	--	--	--	--	--	--	120
Kenmare Golf Course	Kenmare	M	50	--	--	--	--	--	--	--	--	--	--	--	--	50
Des Lacs Ballfield	DesLacs	M	2	--	--	--	--	--	--	2	--	--	--	--	--	--
Sawyer Ballfield	City	M	2	--	--	--	--	--	--	2	--	--	--	--	--	--
Surrey Ballfield	City	M	2	--	--	--	--	--	--	2	--	--	--	--	--	--
Private																
KOA Campgrounds	County	P	13	--	--	7	--	--	--	2	4	--	--	--	--	--
Boy Scout Camp	County	P	15	--	--	15	--	--	--	--	--	--	--	--	--	--
Minot Country Club	County	P	160	--	--	--	--	--	--	--	--	--	1	--	--	160
Ryan Football Field	Minot	P	5	--	--	--	--	--	--	5	--	--	--	--	--	--
L. Opland Dam	County	P	2	1	--	--	1	--	--	--	1	--	--	--	--	--
Hanson Pond	County	P	1	1	--	--	1	--	--	--	--	--	--	--	--	--
Norgard Pond	County	P	2	1	--	--	--	--	--	--	1	--	--	--	--	--
Sharon Pond	County	P	2	1	--	--	1	--	--	--	1	--	--	--	--	--
Minot Gun Club	Minot	P	10	--	--	--	--	--	--	--	--	--	--	--	--	10
Minot Archery Club	Minot	P	20	--	--	--	--	--	--	--	--	--	--	--	--	20
CASA Camp	County	P	10	--	--	8	--	--	--	--	1	--	--	--	--	--
TOTALS			20,142	457	368	68	81	0	15,421	124	167	0	11	0	19	360

Source: North Dakota State Outdoor Recreation Agency

* F - Federal; S - State; C - County; M - Municipal; P - Private

**Acreage Estimated

HISTORICAL AND ARCHEOLOGICAL SITES

2.127 The North Dakota Historical Society has indicated that no areas of historical significance are located within the project area. The historical society is not aware of any major archeological sites in the design flood pool area. The director of the North Dakota Historical Society recommends that funds be made available to the society for an archeological field investigation of the project area. No sites within Ward County are listed in the March 1972 issue of National Register of Historic Places. The National Park Service has been contacted and is aware of the proposed project.

3. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

INTRODUCTION

3.01 In this section, the impacts of the proposed action are discussed in terms of the recognized planning objectives of environmental quality and economic feasibility. The benefits of the recommended action would accrue as reduced flood damages and improvement of the urban setting, including public health and safety, in the floodplain of the Souris River, particularly at Minot, N. Dak. The adverse environmental effects of the plan will depend in part on the timing of any given flood (whether an early spring or late spring flood), its volume and the operation plan, including the release rate from the reservoir. The major effects to be considered are those of intermittent inundation on lands and present natural resources within the design flood pool and certain downstream effects upon other areas. For the Burlington Dam, all areas at elevation 1620 and below are potentially subject to varying periods of inundation. Statistical analyses of available hydraulic data indicate that the reservoir would store water once in about 30 years or the 3-percent or less frequent flood in any one year. Storage of the 1-percent chance flood or 100-year flood for example would inundate valley lands above the recommended Burlington Dam to elevation 1602 (the spillway crest of Lake Darling Dam is at elevation 1598) until 1 July and elevation 1600 until 1 September, while the low-head dam at the diversion tunnel entrance on the Des Lacs River would result in stage increases of

5 feet for the standard project flood and about 1 foot for the 100-year flood.

3.02 The following discussion of the beneficial and adverse impacts of the recommended plan is arranged under subheadings similar to those used in section 2, Environmental Setting Without the Project. This will enable the reader to cross-reference these two sections and will provide an efficient means of relating the various required trade-offs to the United States portion of the Souris River basin and to other regional entities.

3.03 Existing conditions in the basin would be most closely approximated by using the greatest possible rate of discharge from the recommended reservoir, thereby minimizing the storage of floodwaters. The recommended plan of reservoir operation, as described in section 1, Description of Proposed Action, attempts to protect a majority of flood-plain residents from flooding, while causing the least possible impact in the reservoir area.

IMPACT ON GEOLOGY AND TOPOGRAPHY

3.04 Construction of the recommended reservoir embankments, levees, channels, and tunnel would require that the topography in localized areas of the valleys be altered on approximately 200 acres of project lands. Deposits of sand, gravel, boulders, and clay would be used during construction; and similar mineral deposits within the reservoir design pool would be inaccessible during times of floodwater retention. These effects are essentially neutral as regards their environmental impacts, and the project would have no effect upon the production and development of lignite coal, oil, or the regional supply of construction materials.

3.05 Streambank erosion and sedimentation would be affected in both the flood storage pool and in downstream areas during years requiring floodwater storage. Suspended materials would settle within the reservoir and the discharge from Burlington Dam would have a decreased sediment load; therefore, greater erosive capacity. However, the high rates of erosion and sedimentation which accompany the approximate 30-year and less frequent peak discharge would be substantially reduced in accordance with the reduction of maximum peak flows to 5,000 cfs. The net effect as regards streambank erosion would be toward stabilization of the immediate downstream area because the channel and levee work between Burlington and Minot would be designed to accommodate the planned maximum release rate of 5,000 cfs. However, some channel scouring and bank erosion are recognized as possible local problems following storage of a major flood. The greatest potential problem area in this regard is that portion of the river downstream from Verendrye where the channel has limited capacity. Although channel erosion and stability are recognized as potential problems, they are not considered critical because of the low frequency of floodwater storage. Nevertheless, the proposed plan provides a monetary allowance for annual channel maintenance chargeable to the Federal Government.

3.06 In the reservoir area the frequency and duration of floodwater storage would not result in the saturation of a sufficient mass of soil to cause significant shoreline erosion as is often conspicuous with permanent reservoirs.

IMPACT ON GROUNDWATER

3.07 Any changes induced in groundwater levels near the valley by the infrequent storage in the reservoir would not be significant due to the very low permeability of the sediment surrounding the valley. The length of time required for the water table to adjust to the temporary increase in base level would be greater than the duration of floodwater storage.

3.08 During years of floodwater storage, flows in excess of those which occur under existing conditions would be maintained during the summer, fall, and winter months to permit evacuation of the reservoir pool (see explanation of recommended operating plan under section 1, Description of Proposed Action). During these times, the groundwater level under the floodplain would tend to rise to about the same level as the water surface in the river. Since the floodplain sediments upstream from Verendrye are generally silts, clays, and fine sands with low permeability and the channel has sufficient capacity to accommodate the reservoir evacuation rate, no significant rise in the groundwater level would be expected in this area. Downstream from Verendrye in the hay meadow area near Towner, the channel capacity is lower and the floodplain sediments are more pervious. Therefore, slightly higher water tables would be expected in that area during the fall and winter following storage of a major flood where the plan of reservoir operation provides for releasing at or near bank-full capacity. However, this should cause little or no effect on agricultural production because of the infrequency of flood events and since ranchers will have already completed harvesting operations.

3.09 In the area of Minot, where the Souris River contributes some recharge to deep valley aquifers, the oxbow cutoffs are being constructed so as to maintain low flow through the existing meanders. The channel area available for aquifer recharge is, therefore, being increased slightly.

IMPACT ON SURFACE WATER AND STREAMFLOW

3.10 During years of floodwater storage, existing water-surface areas within the upper Souris River basin above Burlington would be inundated, and natural flood peaks would be reduced on the Des Lacs River below the tunnel diversion and on the Souris River below Burlington. Elevation, duration, surface area, and frequency curves are given on figure 2 for the 50-, 100-, 200-, and 500-year floods. Since the reduction in peak flow is made possible by the retention of floodwater behind a normally dry dam, which would be required on an average of about once in 30 years, higher than normal flows on the Souris River below Burlington (as indicated in the Description of the Proposed Action) would be maintained as necessary to evacuate the reservoir without causing unacceptable downstream losses of agricultural production and unnecessary disruption of wildlife. The Des Lacs River valley downstream from the recommended Des Lacs diversion tunnel would be subject to decreased frequency, stages, and duration of flooding for the 25-year and less frequent floods.

IMPACT ON WATER QUALITY

3.11 During periods of floodwater retention behind the recommended Burlington Dam, suspended sediments and organic matter and dissolved nutrients such as nitrogen and phosphorus would be deposited on the bottom. As a result of the removal of these materials from the standing, intermittent pool, the reservoir discharge would be lower in suspended solids, dissolved nitrogen and phosphorus, total dissolved solids, and perhaps other constituents than the floodwaters entering the reservoir. As the reservoir is evacuated, exposing the settled material, the previously suspended and dissolved substances would be transferred to a terrestrial phase of biological activity as discussed in the subdivision, Impact on Vegetation and Wildlife.

IMPACT ON VEGETATION AND WILDLIFE

GENERAL

3.12 The biological effects of the recommended plan are more dependent upon the timing of any given flood (whether an early spring or late spring flood) than are the other kinds of impacts, because the vegetation is much less sensitive to inundation prior to the onset of the growing season than after, and because wildlife is generally most susceptible to environmental changes during the critical reproductive phases of life history.

3.13 For the Burlington Reservoir area, flood storage as required respectively for the 50-, 100-, 200-, and 500-year floods would inundate the surface areas and elevations as given in figure 2. Based on the respective peak stage for each of the above floods, it is convenient to consider the reaches between the Burlington Dam and the Lake Darling Dam; Lake Darling Dam and the upstream or northernmost boundary of the Upper Souris National Wildlife Refuge; and the north refuge boundary to the upstream limit of the design flood pool (elevation 1620). The land classification categories for each of these reaches are given in table 12. The vegetational components of the different biological systems would be subject to replacement by other vegetation or to a reversal of ecological succession due to the elimination of forms which cannot tolerate the increased flooding.

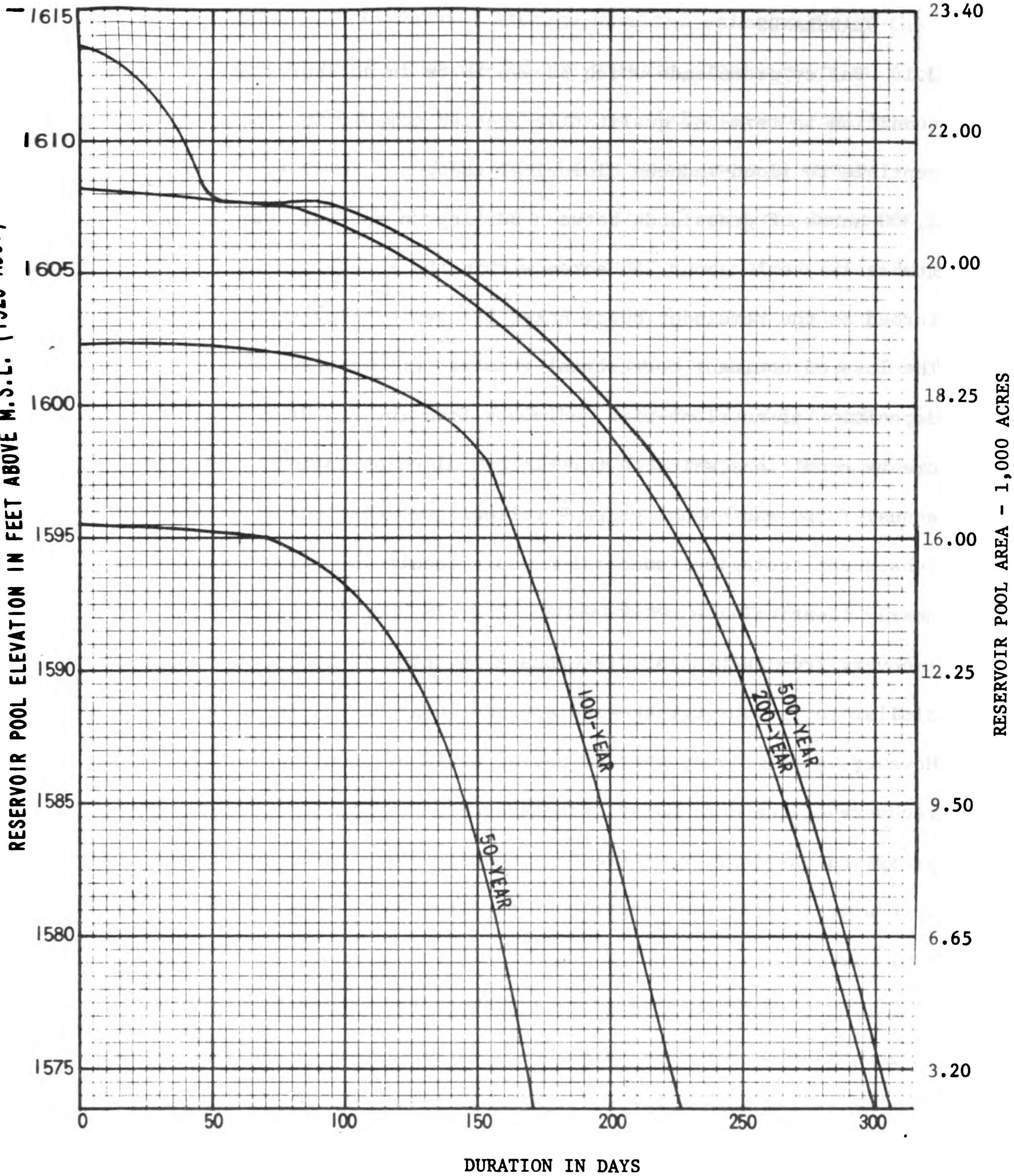

FIG. 2 - Elevation-Duration-Frequency-Area Curves
Burlington Reservoir

GRASSLANDS

3.14 Valley grasslands which happen to be in an approximately natural condition in terms of qualitative species composition would be most susceptible to flood-induced biological changes. However, of the approximate 2,300 acres of grasslands between Burlington and Lake Darling Dam (table 12), only about 750 acres within the refuge are relatively undisturbed as the remainder below Baker Bridge is being extensively grazed. The loss of dominant terrestrial grasses (grazed and ungrazed) and the deposition of nutrient-rich sediments from the standing floodwaters would create conditions suitable for biological colonization by a series of annual forbs and annual grasses following evacuation of stored floodwaters. Subsequent ecological succession would result in a grassland system nearly identical to that existing. The time period required for ecological recovery from such major disturbance is about 40 to 50 years in association similar to the wheatgrass-needlegrass-bluegrass of the upland prairies. However, a relatively shorter period would be required for ecological recovery of the more moist grasslands of the valley. The acreages of grassland upstream from Lake Darling Dam, which could be subject to inundation during the larger but less frequent floods, are given in table 12.

3.15 The conversion of grassland pasture to cultivated hay, some of which has been occurring in the valley for several years, would probably be accelerated subsequent to flooding. This kind of practice might be expected to result in the conversion of some 25 to 50 percent of inundated grassland to hay or cropland.

3.16 The impacts of floodwater storage upon the animal life of the grasslands would include the upward and outward displacement of forms which are sufficiently mobile to escape the rising waters, and the direct drowning of those forms, especially young and egg stages which were unable to escape. The overloading of adjacent habitats would result in a period of ecological stress during which an undetermined percentage of the fleeing animals would die of starvation or would be taken by predators. These losses, coupled with the drowning of the less mobile forms, would result in temporarily decreased populations of grassland animals. The ecological recovery of the animal life would generally parallel the redevelopment of vegetation.

WOODLANDS

3.17 Of approximately 800 acres of wooded land, located in the area between the recommended Burlington Dam and existing Lake Darling Dam, some 700 acres of primarily bottomland hardwoods association are at an elevation sufficiently low to be inundated throughout most of an entire growing season with an approximate 50- to 75-year flood. Most of the dominant overstory trees would be killed under such circumstances and the herb and shrub layers, excepting the annuals and the especially moisture-tolerant forms such as willows, would be eliminated. The major biological implications of such an event are twofold; first, the loss of a shading overstory would permit the onset of an ecological series somewhat similar to that described for grasslands but resulting in shrubs and saplings of the typical bottomland tree species second, the recovery or ecological succession to a natural bottomland hardwoods situation, which apparently requires about 100 years, would probably never occur because the frequency of floodwater storage is greater than once in 100 years. Based on 30 to 50 years of natural succession after a 50- to 75-year flood, the regenerated woodland would consist of typical bottomland tree species of possibly 6 to 12 inches in diameter at breast height and with about 100 to 500 trees per acre. There would, throughout the ecological succession, be relatively more brushy edge than is present with the existing situation.

3.18 Wooded valley lands above the elevation of Lake Darling Dam would be subject to shorter and less frequent (greater than 75-year) periods of inundation. This would tend to favor the more water-tolerant (hydric) tree species such as willow, box elder, and green ash. The elm and certain of the shrubs would tend to decrease following prolonged inundation of their root systems.

3.19 Impacts upon animal life of the bottomland hardwoods would be similar to those described for valley grasslands. White-tailed deer, because of their importance to recreation as an intensively managed game-farm species, are of special concern in this regard. Immediate effects of an approximate 50- to 75-year flood would include severe stress upon the deer herd due to loss of browse and cover. With most floods of this magnitude, the deer would be forced to leave the shelter of the valley somewhat prematurely, before the last of the winter weather had broken. Fawn and pregnant doe would be especially subject to environmental stress. However, since this game animal is characteristic of subclimax biological situations resulting from disturbance by fire, logging, or even flooding, and since an abundance of browse shrubs would be present during recovery of the bottomland hardwoods association from flooding, the most adverse long-term impact upon deer would probably be the reduction in winter cover. It is for this reason that the continuing postauthorization studies will include further analysis of deer movements between the valley and the upland prairie in order to provide basic data for a plan of tree plantings to mitigate this particular impact.

WETLANDS

3.20 The natural oxbow wetlands and impounded marshes of the Upper Souris National Wildlife Refuge are subject to a flood-induced biological change significantly less than are the grasslands and woodlands. This is essentially due to the semiaquatic nature of the marsh vegetation. Wetland systems can and do recover from such long periods of inundation as an entire growing season in 2 to 5 years. With repeated flooding, however, during consecutive growing seasons, the dominant species of marsh vegetation are killed and several growing seasons are required for restoration of true wetland conditions. Approximately 1,425 acres of marshland between the recommended Burlington Dam and existing Lake Darling Dam would be inundated for nearly an entire growing season with an approximate 50- to 75-year flood. About 1,350 acres of marsh lands are located on the Upper Souris National Wildlife Refuge.

3.21 During the year of any given flood and for a period of 2 to 5 years thereafter, the production of wildlife would be reduced on the affected marsh units. For waterfowl, any significant fluctuation in water level during the periods of egg incubation and brood care (generally early April through August in this area) tends to flood nests during the egg stage and to either reduce the food base or render portions of it inaccessible. The effects of a drop in water level are normally regarded as less constraining than an increase in this regard. However, in the case of the recommended action, most of the affected marsh area would be inundated for approximately the entire growing season with the 50- to 75-year floods, and the probability of success during second nesting attempts would be low.

3.22 Based on the 50- to 75-year flood and the inundation of 1,425 acres of marsh, the loss in waterfowl at roughly two birds per acre would be on the order of 50 birds for the particular year of the flood. However, the loss of wildlife on an average annual basis may be greater, recognizing the fact that the offspring, minus natural mortality and hunter's success, would not be available for production. It is because of these losses that the recommended mitigating features of the total plan (see section on mitigation) include the impoundment of additional wetlands, similar to those now existing on the Souris Loop National Wildlife Refuges.

3.23 Other prominent wildlife which would be affected by flooding of wetlands include the muskrat, beaver, and mink. The flooding of marshes would cause these animals to be displaced from their natural cover or dens and to be separated from their natural food sources. Mortality of both adults and young would increase during such circumstances.

3.24 Based on the natural cycles of dry and wet years for the upland prairies and the corresponding increases and decreases in the percentage of duck production occurring in the basin, the refuge marsh units would only be inundated during the relatively wet years when production of waterfowl on the upland prairie potholes is high. During normal as well as extended periods of dry years, when the pothole production is low and the river valley wetlands become critical in supporting waterfowl populations, the Burlington Dam would not need to be operated and the proposed 850+ acres of wetland (see section on mitigation) would be providing about 1,700 additional birds over those produced under the existing situation. In general, a similar relationship would apply to the other characteristic wildlife of the wetland habitats. However, over the long term, net wildlife production on an average annual basis probably would approximate existing wildlife production since the production gained during dry years would probably be offset by production lost during those years when reservoir storage is required and for the 2- to 5-year period it would take for the marsh system to recover following a period of inundation.

3.25 Certain of the more terrestrial wildlife which utilize marshes for winter cover, including pheasants, wintering songbirds, fox, and deer, would also be adversely affected for the 2- to 5-year period that it would take for the marshes to recover from a sustained period of inundation.

OPEN WATERS

3.26 Aquatic biological systems subject to impacts of floodwater storage would include about 34 miles of the Souris River between the Burlington and Lake Darling Dams for the 50- to 75-year flood, and all of Lake Darling in addition to the above for the 100-year flood or greater (less frequent) floods. Since the plants and animals of the river bed require flowing water habitats, these would generally be eliminated during the period of standing water. The previously described impacts of flooding upon the river bottom woodlands would also affect the biology of the stream because subsequent to the evacuation of the reservoir there would be substantially less shading vegetation along the stream and therefore less introduction of allochth-ancus (produced on surrounding lands) material such as terrestrial insects and organic detritus. Since the invertebrate animals and fish of the stream reaches depend heavily upon this material as a food source, the biological productivity of the stream would be correspondingly reduced.

3.27 The inundation of Lake Darling which would occur with the 60-year and less frequent floods would result in an upward and outward shifting of the littoral zone followed by a return to normal conditions as the floodwaters were evacuated. Since the existing biological system is already characteristic of standing waters, the lake would be subject to less change as a result of floodwater storage. However, the zone of rooted aquatic vegetation would tend to be shifted upward and outward and the existing rooted aquatics would be adversely affected due to the decreased sunlight. The open water zone (limnetic zone) of the lake where most of phytoplankton production occurs would be increased during the storage of floodwaters; however, lake productivity depends more upon the littoral zone than upon the limnetic. For floods of about the 50- to 75-year magnitude, where peak stage within the recommended reservoir would not exceed elevation 1600, the water surface elevation of Lake Darling could be raised to approximately 2 feet above present spillway crest elevation for approximately one growing season. For the larger, less frequent floods (say 100-year), the water surface could exceed spillway crest elevation by as much as 5 feet for most of one growing season. With these higher stages and longer durations, some of the littoral zone vegetation would die, decompose, and begin to extract dissolved oxygen from the lower areas of the flood storage pool. Since the physical situation is not conducive to stratification, no significant oxygen depletion of the flood pool is expected.

3.28 The impacts upon the fishery storage forage base would depend largely upon the aquatic invertebrate situation in the flood pools. Based on past experience with newly impounded reservoirs, the production of aquatic invertebrates, suitable for fish food, tends to be high and the newly inundated tree branches and other vegetation tend to provide some of the best known fish cover on approximately a 5- to 10-year basis.

3.29 The water level fluctuations during years of floodwater storage could either jeopardize or benefit fish spawning. The temporary inundation of marshy fringes and terrestrial vegetation could result in good to excellent spawning conditions for at least northern pike and perch if the water surface elevation were fairly stable during critical life history stages and if the timing were correct.

3.30 At times when the Lake Darling spillway was inundated, fish would tend to move from Lake Darling into the downstream area at a greater rate than occurs with the existing situation. With this greater dispersion of the fish, the fisherman success rate could be reduced; also during floodwater storage, the existing fishing accesses would be inoperable and fishermen would be forced to use other areas. During and subsequent to floodwater evacuation, the fish would again become concentrated, especially in the reach between Lake Darling Dam and the recommended Burlington Dam.

DOWNSTREAM AREAS

3.31 The total recommended plan of flood control would have considerably less impact upon biological systems in downstream areas than within the Burlington reservoir area. This is because in general the flood flows which occur with sufficient frequency to determine the kind of biological system in any given area (say 25 to 30 years) are not affected by the plan except for urban developments such as Minot, Sawyer, and Velva. The reduction of the larger peaks for the 30-year and greater (less frequent) floods would be consistent for purposes of waterfowl management with the predominant objectives of the J. Clark Salyer National Wildlife Refuge provided that discharge rates remained fairly stable throughout the nesting and brooding stages.

IMPACT ON RARE AND ENDANGERED SPECIES

3.32 The proposed action is not expected to impact upon any rare or endangered or otherwise unique species of vegetation or wildlife.

ECONOMIC IMPACTS

FLOOD CONTROL

3.33 The benefits of the Burlington Reservoir and related diversion and downstream channel works accrue from reduced flood damages on the Souris River floodplain between the damsite and the J. Clark Salyer Wildlife Refuge, particularly in the city of Minot. The floodplain of the Souris River has been highly developed for residential, commercial, industrial, transportation, and agricultural purposes; and many millions of dollars of urban and rural property are susceptible to flood damage. Within the city of Minot, the area which would be inundated by a flood of 100-year frequency contains approximately 3,800 residential dwellings, more than 300 business firms, seven schools, 15 churches, many miles of streets and rail lines, and all of the utilities characteristic of an intensively urbanized area. More than one-third of the 32,000 inhabitants who reside within the present city limits of Minot reside on the floodplain. Practically all of the 52,000 inhabitants of the Minot urban area have several of the following in common:

a. Their place of residence is on the floodplain.

b. Their place of employment is on the floodplain.

c. They attend schools or churches located on the floodplain.

d. They regularly buy goods and services from stores and other business firms on the floodplain.

e. They regularly sell goods or services to residents or business firms on the floodplain.

f. They are physically present on the floodplain for all or some part of each day.

Both upstream and downstream from the area within the present limits of Minot are additional urbanized areas on the floodplain; and throughout the basin there are small towns, farms, and ranches on the floodplain.

3.34 Under the 1973 floodplain development conditions, estimated average annual flood damages without any protection, except for that which is provided by Lake Darling, amount to $2,284,000. The channel improvement now under construction will reduce these damages by about $1,096,000. Channel improvement through Minot is an integral feature of the selected protection plan for Minot in that it will facilitate operation of the reservoir and provide protection against floods emanating from the local uncontrolled drainage area. The present channel design discharge has been determined to be 5,000 cfs. Flood control benefits for this size channel have been computed as the first in place element of protection. The Burlington Reservoir and Des Lacs River diversion tunnel will further reduce damages by about $1,017,000 and $83,000, respectively, under existing 1973 conditions.

3.35 Because of more abundant trees and vegetation on the floodplain than the adjacent uplands and more agreeable winter weather conditions, there has been a traditional preference for floodplain land for residential and other uses. Further development of the floodplain has been temporarily halted by the 1969 and 1970 floods and controls on new construction which were adopted pursuant to recommendations in the Souris River Review Survey Report of 1969. With the protection to be provided by the Burlington Reservoir, floodplain development will be resumed. Taking into account anticipated increases in population and personal income and the availability of floodplain land, it is anticipated that the floodplain growth and development will cause reservoir average annual benefits to increase to $1,117,000 by 1980, and that the average annual equivalent of all flood damage prevention benefits will amount to $4,765,000 over the economic life of the project, including the Minot channel improvement feature recommended under the separate authorization.

3.36 In addition to flood control benefits, the construction of the Burlington Reservoir will eliminate the need, in the interest of public safety, to modernize the Federal dam at Lake Darling and upgrade it to contemporary engineering standards. Also, as discussed in a subsequent paragraph, recruitment of construction workers from the pool of available but unemployed manpower to construct project structures would alleviate an unemployment problem. It is estimated that these two supplementary project benefits amount, on an average annual basis, to $621,000 and $773,000, respectively. Table 18 summarizes the benefits of the proposed flood control project.

TABLE 18

Average Annual Benefits

Item	Flood control	Foregone costs Lake Darling rehabilitation	Total without local employment	Local employment	Total with local employment
Minot channel improvement and Burlington Reservoir					
A. Flood control					
Existing development (1980)					
Burlington to Minot	$43,000				
Minot to Bison power plant	2,131,000				
Bison power plant to Logan	1,000				
Sawyer and Velva	81,000				
Logan to J. Clark Salyer Refuge (exclusive of Sawyer and Velva)	11,000				
Future growth (1980-2080)					
Burlington to Minot	369,000				
Minot to Bison power plant	1,880,000				
Bison power plant to Logan	35,000				
Sawyer and Velva	12,000				
Logan to J. Clark Salyer Refuge (exclusive of Sawyer and Velva)	2,000				
B. Foregone cost Lake Darling rehabilitation		$621,000			
Total without local employment	4,565,000	621,000	$5,186,000		
C. Local employment				$618,000	
Total with local employment	4,565,000	621,000	5,186,000	618,000	$5,804,000

TABLE 18 (Cont)

Average Annual Benefits

Item	Flood control	Foregone costs Lake Darling rehabilitation	Total without local employment	Local employment	Total with local employment
Des Lacs River diversion					
A. Flood control					
Existing condition (1980)					
Burlington to Minot	$5,000				
Minot to Bison power plant	86,000				
Bison power plant to Logan	0				
Future growth (1980-2080)					
Burlington to Minot	46,000				
Minot to Bison power plant	63,000				
Bison power plant to Logan	0				
Total without local employment	200,000		$200,000		
B. Local employment				$155,000	
Total with local employment	200,000		200,000	155,000	$355,000
Total Minot channel reservoir and diversion without local employment	4,765,000	$621,000	5,386,000		
Total Minot channel reservoir and diversion with local employment	4,765,000	621,000	5,386,000	773,000	6,159,000

LAND USE

3.37 Negative economic impacts of the reservoir are reduced by the fact that approximately 17,000 acres of the 25,000 acres to be inundated by maximum reservoir storage have already been purchased by the Federal Government and withdrawn from productive agriculture use. These 17,000 acres are part of the Upper Souris National Wildlife Refuge, which covers a total of approximately 33,000 acres and was established by the Federal Government during the decade 1930-1940. Furthermore, about 14,000 acres of land within the wildlife refuge to be affected by operation of Burlington Reservoir have already been permanently inundated in the interests of fish and wildlife propagation. However, the Federal Government will have to purchase 1,500 acres in Ward County between the damsite and Baker Bridge for project structures and for fish and wildlife mitigation. Upstream from the dam, flowage easements will be required on the remaining 5,700 acres of private lands in Ward and Renville Counties, needed for floodwater storage.

3.38 Local interests have presented an estimate for the Burlington pool area indicating gross annual earnings on 5,900 acres in 18 ranch units in Ward County and on about 5,000 acres involving 18 ranch units in Renville County of about $303,000 and $221,000, respectively. Agricultural production records for Renville and Ward Counties show that farm production expenses constitute about 65 percent of the market value of all agricultural products sold, including livestock. On this basis, average annual net income would total about $184,000 on the 10,900 acres or $16.90 per acre. Frequency-area flooded data for the reservoir are available indicating that the average area of private lands flooded annually, exclusive of the 1,500 acres of lands required in fee, would approximate 450 acres. Thus, on an average annual basis the total lands withdrawn from agricultural production is about 1,950 acres. Applying the average annual net income of $16.90 per acre on this acreage results in an average annual net loss of production of about $33,000. This amount combined with the costs of moving buildings and any increased operating costs would be fully compensated for in accordance with the terms of the 1970 Uniform Relocation Assistance and Real Property Acquisition Policies Act. The net annual loss of production on the approximate 450 acres of ranchlands would represent a basis for flowage easement payments.

3.39 The lands required for the storage above the Burlington site at pool elevation 1620 and the cottages in Renville County Park had a total assessed value of about $166,000, and in 1971 produced approximately $12,000 in taxes to Ward and Renville Counties. Of this amount, about $5,700 was allocated to seven school districts. A comparison of the taxable value of the property taken off the roles to the total taxable property value in the seven districts indicates that, if no compensations were provided, the loss of funds to the school districts would vary from 1.2 to less than 0.5 percent. The loss of students is of some concern to representatives of the school districts insofar as such loss might jeopardize the State aid received. However, assuming a total loss of approximately 33 families, no school district would lose a large number of students. Thus, the loss of taxes and the effect on schools does not appear to be significant, particularly since the project plan provides for acquiring flowage easements in lieu of fee title on most of the private lands needed for the reservoir, and provides for relocation of area residents to adjacent high ground rather than out of the county or school district entirely, to the maximum extent feasible as determined by later, more detailed real estate studies.

3.40 A positive economic impact of the project is the reduction in property losses in Minot and vicinity during flood events. Also, there is a reduction in cost spent in detouring around flooded areas. Usually land on floodplains appreciate in value with flood control. Benefits due to higher utilization of land represent an entirely different category than benefits on account of flood damage prevention. Care is taken to avoid double counting by excluding increased net earnings from land on which reduction of flood damages is taken as a benefit. Many acres of floodplain land between Burlington and the J. Clark Salyer Refuge on which flood damage reduction benefits are not calculated, will be benefited by the project. However, no estimate has been made of this land enhancement.

EMPLOYMENT

3.41 Ward and Renville Counties, the two counties that would be most affected by the flood control project, became qualified in 1972 under Title IV of the Public Works and Economic Development Act, according to the regional office in Denver, Colorado, of the Economic Development Administration, U.S. Department of Commerce. The North Dakota State Employment office in Minot reported in April 1973 that 2,500 persons were registered and actively seeking employment. It is expected that many would seek employment connected with construction of the project. Likewise, persons already employed who decide to change jobs and work on construction of the project will leave jobs vacant which could be filled from the considerable pool of unemployed manpower. On the basis of computations explained in the Design Memorandum No. 2, Appendix B, Economics, it is estimated that over the economic life of the project, average annual benefits resulting from increased employment will amount to about $148,000 for the channel improvement project, $470,000 for the Burlington Dam, and $155,000 for the Des Lacs River diversion tunnel. A positive secondary benefit of the project relating to employment, but not included in the above estimates, is the increased income to those trading with newly employed workers.

IMPACT ON THE SOCIAL SETTING

3.42 Several intangible, nonmonetary benefits of the project are its principal favorable social impacts. These include an end to the interruption and disruption of regular family life, civic activities, and community affairs caused by major floods. In 1969, approximately 12,000 residents of the floodplain in Minot had to be evacuated to temporary quarters, including tents, and many of their household furnishings and personal property were likewise taken to dry locations for temporary storage. A most difficult problem for the city was to keep utility systems functioning. During the flood, faulty gas mains caused the explosion of two houses. Personnel and vehicles from the Minot Air Force Base made a very important contribution to the evacuation effort, but it cannot be assumed that in the future the same resources of manpower and equipment would be so readily available, nor will there always be as much advance warning as there was in 1969, particularly if the flood originates from the Des Lacs River or Gassman Coulee. Therefore, a recurrence of a flood of the same magnitude could cause much more hardship and possible loss of life. Permanent protective works will eliminate such hardship and reduce the hazard to life. In the 1969 Souris River flood, a rancher was drowned while attempting to save his cattle by moving them to high ground; and a death from drowning was also reported in connection with the record high Des Lacs River flows in 1970. In addition to greater safety for life and property, flood control should also solve the sanitation and health problems associated with flooding, and eliminate the unsightly conditions which prevailed in Minot and other flooded communities in 1969 when receding floodwaters deposited mud and debris.

3.43 The project will have adverse social impacts in the portion of the reservoir area which is still in private ownership. Approximately 33 ranchers and rural residents will have to be relocated to adjacent high ground above the reservoir including about 15 in Ward County between the dam and Baker Bridge, and 18 in Renville County between the north boundary of the Upper Souris National Wildlife Refuge and the international boundary. Those residents not wishing to relocate adjacent to the reservoir area or where relocation of residences and ranch buildings is not feasible because of access problems will have to be relocated to suitable replacement housing away from the reservoir. As owners will be paid the full value of their houses plus reimbursement of relocation costs, the obligation to move will not be an economic hardship. It will, however, be a social hardship, particularly upon those lifelong residents who must be moved from their present location. The unfavorable social impacts of the project would be greater if all the land in the reservoir area were in private ownership and private use. As most of the land, however, is already in public ownership and public use, many of the adverse social impacts which this project would cause were already caused in the 1930's as adverse social impacts of the Upper Souris River National Wildlife Refuge.

3.44 The purchase of some 80 cottages and other recreation buildings in Renville County Memorial Park is also recognized as an adverse social impact of the project, particularly since the park has been used for years by area residents as a social gathering place. However, owners would be given fair compensation for their properties in accordance with Public Law 91-646, and flowage easements in lieu of fee title would be acquired on vacated parklands.

3.45 Since most of the reservoir lands are federally owned and since flowage easement in lieu of fee title would be purchased on all private lands required for the reservoir, except for those lands needed for project structures and mitigation, the social hardship associated with land acquisition would be materially lessened. In accordance with flowage easement acquisition policy, all developments lying within the flood pool must be relocated; however, relocated residents would maintain the right to continue ranching operations and to use the area provided that the uses are compatible with current policy.

MITIGATING FEATURES OF THE RECOMMENDED PLAN

3.46 Several features of the total recommended plan of flood damage reduction are included specifically for purposes of mitigating certain adverse impacts of the project, which could not be avoided otherwise. These features which are proposed by the Bureau of Sport Fisheries and Wildlife (see appendix D) are as follows:

a. Relocation of the existing secondary refuge headquarters of the Upper Souris National Wildlife Refuge (several frame buildings including two residences) to adjacent high ground above the reservoir design pool for Lake Darling.

b. Riprap protection for the downstream slopes of Lake Darling Dam and refuge dams numbered 87 and 96 to withstand wave erosion during times of temporary floodwater storage in Burlington Reservoir.

c. Impoundment of additional wetlands at both the upstream and downstream areas of the Upper Souris Refuge (including, specifically, an 850-acre marsh unit downstream from the south boundary and a sediment pool above Lake Darling) and in association with the J. Clark Salyer Refuge.

d. Establishment of fish spawning habitat, possibly including intermittently flooded grassy areas, beds of gravel and boulders, submerged areas of hard sand, and artificially assembled fish cover.

e. Development of coulee heads and planting of wildlife food crops and cover in the Souris River bottomlands and at the heads of tributary coulees.

3.47 The relocation of the secondary refuge headquarters and development of the 850-acre wetland unit were included in the authorized project. Final formulation of the other items of mitigation in the recommended plan will be subject to further coordination with the Bureau of Sport Fisheries and Wildlife and to public review during studies for phase II of the General Design Memorandum.

3.48 The relocation of the secondary refuge headquarters is expected to be beneficial for purposes of refuge management because the existing buildings are converted agricultural structures, not specifically designed for refuge needs. During relocation there will be an opportunity for some remodeling and reconstruction in order to better meet modern facility requirements for wildlife management.

3.49 The impoundment of additional wetlands is expected to increase the average annual production of waterfowl on national refuge lands by over 1,000 birds. This will enhance the fulfillment of the primary mission of the three Souris loop national wildlife refuges - the augmentation of waterfowl production during drought years when upland "pothole" production is at a critically low level.

3.50 The net effect of the establishment of fish spawning habitat will depend upon the characteristics of spring flows during both years which do and years which do not require storage of floodwaters in the recommended Burlington Reservoir. When flood peaks are reached at or prior to the time of spawning and appropriate stages can be held stable over marshy and terrestrial vegetation, the spawning of at least northern pike and perch would be increased. However, it is possible that the exceptionally late and large flood could conversely result in the loss of fish spawning for an entire year. The sport fishery impact of such an event depends partly upon the age and growth status of the fish population. Where overpopulation and stunting are the case, for example, the loss of a year class can provide an opportunity for increased rates of growth leading to larger and healthier individual fish. Routine continuing studies will include an analysis of age and growth information for fish in Lake Darling in order to refine the anticipated fisheries impacts, and to provide an improved basis for planning and designing the fishery mitigation measures.

3.51 The immediate and short-term impacts of severely flooding the low woodland between the recommended Burlington Dam and existing Lake Darling Dam include the loss of deer browse. Since a period of 2 to 5 years may be required before the colonizing regrowth of the floodplain would support considerable deer feed, it is expected that the planting of wildlife food crops, possibly on a sharecropping basis, would be necessary. Since the development of quality wildlife cover, however, would require a considerably longer period of time, it is expected that the planting of permanent wildlife cover, possibly as evergreen plantations, might be desirable.

4. ADVERSE ENVIRONMENTAL IMPACTS WHICH COULD NOT BE AVOIDED WITH IMPLEMENTATION OF THE RECOMMENDED PLAN

4.01 The selection and formulation of the total recommended plan are based upon the two basically recognized planning objectives of environmental quality and economic efficiency. However, the plan represents the best possible compromise among these two objectives rather than an optimum based on any one. On this basis the implementation of the recommended plan would have certain unavoidable adverse impacts as follows.

4.02 The total acres of urban land, bottomland hardwoods, grassland, pasture and crop land, and marsh displaced by project structures would not be subject to recovery to natural biological systems via ecological succession because the structures would be maintained as necessary in order to preserve their flood control utility. The area that would be significantly affected would be the reach between the damsite and Lake Darling Dam (see table 12).

4.03 The required relocation of about 33 rural residences and ranch operations, 248 graves at McKinney Cemetery, and the purchase of 80 summer cottages at Renville County Memorial Park would not be avoidable with implementation of the plan and would be regarded as socially adverse by some persons even though present Federal policy as regards the monetary aspects of relocation are very liberal. The relocation of ranch buildings could also result in some increased expense and inconvenience to local agricultural interests because, in a few instances, this would increase travel distances between ranch lands and bases of operation.

4.04 During years which required storage of significant floodwaters in the recommended Burlington Reservoir, it would not be possible to avoid certain impacts upon biological systems. The upward and outward displacement of wildlife from the flooded bottom, which occurs to some extent with the existing situation, would be increased substantially in the reservoir area. The biological stresses induced under these circumstances would be only partly offset by the reduced flooding downstream because the area of most significant flood reduction is primarily urban and intense agricultural land. The affected wildlife would include deer, muskrat, mink, rabbit, pheasant, and others.

4.05 The temporary inundation of wetlands, open waters, and bottomland hardwoods would also be unavoidable. However, it is primarily the 700 acres of bottomland hardwoods between Burlington and Baker Bridge which would be permanently altered. The frequency of floods which would be capable of eliminating this woodland would prevent recovery to a near mature bottomland hardwood situation; although, based on approximate 50-year intervals between floods, considerable development of trees and shrubs would occur.

4.06 The loss of some fishery production might not be avoidable with operation of the recommended plan because the rise in water surface of Lake Darling, which would occur at approximate 60-year intervals with the operation of Burlington Dam, may cause temperature changes in the water overlying spawning areas; may result in sediment deposition over spawning areas; and may in extreme cases raise the littoral or productive zone of the lake sufficiently to render the fishery forage base of algae and aquatic invertebrates inaccessible to swimming fish fry. Since some loss of fishery productivity probably occurs due to water level fluctuations under existing conditions, the routine series of postauthorization studies will include an analysis of the age and growth situation in Lake Darling in order to provide a basis for a more detailed evaluation of fishery impacts and for planning and design of fishery mitigation.

4.07 The inundation of recreation sites between the recommended Burlington Dam and existing Lake Darling Dam could not be avoided for the approximate 30- to 60-year flood, and sites upstream of Lake Darling Dam would be affected with the larger (less frequent) floods. The recreation activities (primarily fishing) which occur at these sites would partly be transferred to higher elevations in the same general vicinity.

5. ALTERNATIVES TO THE RECOMMENDED ACTION

GENERAL

5.01 The recommended plan of flood damage reduction consists primarily of four basic elements, the Burlington Dam, the Des Lacs River diversion works, channel and levee improvements in four urban areas, and nonstructural measures in rural areas. Many alternatives to the recommended plan were considered on the basis of three primary objectives, including the provision of an adequate degree of flood protection, minimization of adverse environmental impacts, and economic efficiency. In addition to the "no action" alternative, all of the available nonstructural and structural measures were considered for each of the six damage reaches of the Souris River basin as shown on plate 4. Some of the measures can be viewed as alternatives to the overall recommended plan, such as total evacuation of the floodplain in reaches 1 to 6; others can be viewed as alternatives to one or more elements of the recommended plan, such as the alternative reservoir sites on the Souris River. This section of the impact statement evaluates each of the considered measures as an alternative to the recommended plan or as an alternative to an element of the recommended plan in the context of the study objectives. To enable reviewers to more efficiently evaluate the alternative measures, they are listed as follows in the order that they will be discussed;

No action

Nonstructural

- Flood warning and emergency measures
- Floodplain regulation
- Flood insurance
- Floodplain evacuation
- Flood proofing

Structural

- Channel improvements (reaches 1 to 6)
- Flood barriers - levees and floodwalls (reaches 1 to 6)
- Minot bypass tunnel
- Souris River diversions
  - International boundary route
  - Lake Darling route
  - North Minot route
  - South Minot route
- Souris River dams and storage impoundments
  - Confluence site
  - Baker Bridge site
  - Lake Darling site
- Des Lacs River diversion
  - To reservoir at Baker Bridge site
  - To reservoir at Lake Darling site
- Des Lacs River dams and storage impoundments
  - Tributary coulee sites
  - Kenmare site

NO ACTION

5.02 Table 19 presents data on urban acreage, populations, and developments in the Souris River floodplain. To implement the "no action" alternative would mean continued flooding of floodplain lands and developments with resultant hardship and suffering by the residents of the floodplain. Some flooding at Minot can be expected to occur, on an average, about once every 5 to 10 years, and a flood comparable to the 1969 flood can be expected to occur about once every 33 years. Several miles of intermittent substandard levees constructed during the 1970 flood emergency with temporary interior drainage facilities provide a limited degree of protection from the more frequent smaller floods but could not contain the larger, less frequent floods. Should a major flood occur, most of the low levees would ultimately be overtopped with extensive flooding of residential and business areas.

TABLE 19

Summary of approximate acreage, population, and developments in 100-year Souris River floodplain

			Developments			
River reach	(acres)	Population	Residences	Commercial	Schools	Churches
Burlington to Minot	1,760	660	150	-	-	-
Minot	2,775	15,900	3,800	300	7	15
Minot to Logan	2,615	150	34	-	-	
Sawyer	120	50	17	2	-	-
Velva	350	1,140	330	45	1	3
Rural area (Logan to J. Clark Salyer Refuge)	37,500	200	48	-	-	-
Total	45,120	18,100	4,379	347	8	18

5.03 Since major floods in the Souris River basin occur infrequently, continued growth at Minot and adjacent developing areas can be expected, particularly with the false sense of security provided by Lake Darling Dam and the low, partially complete emergency levees that exist at scattered locations. Based on present development of the floodplain, estimated average annual damages exceed $2 million. With projected growth and development, average annual flood damages could more than double over the next 50 to 100 years. The possible advantages of the "no action" alternative are that it would require no immediate outlay of Federal and local tax funds. Existing terrestrial and aquatic wildlife habitats and existing river aesthetics would not be disturbed by structural flood corrective measures. However, without land-use controls in the floodplain, existing environmental systems could be expected to decline. Based on the availability of other feasible alternatives, including the recommended plan, which would solve major social, economic, and environmental problems for the study area, it has not been possible to select the "no action" alternative in the present case.

NONSTRUCTURAL MEASURES

FLOOD WARNING AND EMERGENCY MEASURES

5.04 Since most of the Souris River basin above Minot lies in Saskatchewan, data required for flood warning and predictions involve coordination with Canadian officials. The National Weather Service in Fargo has informally been designated as the agency to handle the transfer of basic hydrologic data between the United States and Canada.

Coordinated snow surveys in both the United States and Canada are routinely made on 15 March in normal years. Should there be an excessive amount of snow accumulation early in the winter, a joint snow survey is made on 15 February and updated as warranted by subsequent meteorological and hydrological developments. In addition, the Souris River Board of Control meets each spring to determine the operating schedule for Lake Darling Dam, which in the past has been operated to provide at least 50,000 acre-feet of storage for flood control in years when above-normal runoff is anticipated.

5.05 Meteorological and hydrological events which led to the 1969 flood in the Souris River basin demonstrated that the existing flood warning and predictive system is inadequate. An improved system would involve the installation of telemark gaging stations at key locations throughout the basin, particularly on the Des Lacs River and Gassman Coulee. Such a system would enable instant telephone retrieval of data on river stages needed by the monitoring station to predict downstream flood stages. The advance warning by the telemark system would permit earlier evacuation of floodplain residents and thus reduce the risk of loss of life, particularly so if a flash flood originated in the Des Lacs River or Gassman Coulee subbasins. Improved warning systems on the Souris and Des Lacs Rivers might also permit earlier construction of emergency levees. However, at Minot, total reliance on improved warning systems and emergency works would be ill-advised because of:

a. The difficulty of constructing levees in a densely urbanized area.

b. The inability to accurately forecast flood levels.

c. The limited time available to construct levees, particularly if the flood originated from the Des Lacs River or Gassman Coulee.

d. The adverse weather conditions usually prevailing during the spring which could curtail construction.

e. The unavailability of Federal funds and the social problems resulting from temporary evacuation from areas where the emergency levees provided doubtful security.

5.06 Less risk would be involved at Sawyer and Velva because of their limited size, lesser development along the riverbanks, and the good levee base existing in both communities. However, even at these communities the risks are great enough to preclude reliance on emergency measures as an effective flood damage reduction alternative.

FLOODPLAIN REGULATION

5.07 Minot is the primary focal point for agriculturally associated businesses in north central North Dakota and for businesses associated with the growing coal, oil, and natural gas industry. With the continuing influx of people from rural to urban areas, the city is expected to experience substantial growth. The Souris River bottomlands are highly prized for their aesthetic quality and for the wooded shelter they afford. This is evidenced by the rapid growth that has taken place within the 6-mile-long floodplain between Minot and Burlington and the 8-mile-long floodplain between Minot and Logan where together nine new subdivisions with a population of about 800 have been developed within the past few years. Not only are the Souris River valley bottomlands valued for the development of residences but they are also valued for the development of businesses and industries because of the ready access to transportation routes and the existing developed area of the city.

5.08 The city of Minot and Ward County have adopted floodplain regulations but they apply only to the interim period until the authorized structural measures are constructed. However, if the current floodplain regulations were modified to apply to the long term, the further growth of flood damages particularly in the valley reaches upstream and downstream from Minot could be retarded. Proper long-term floodplain regulation would involve zoning to prevent unwise land use and to preclude flood-prone developments within the designated floodplain. Subdivision regulations for undeveloped areas to prohibit floodway encroachment and to govern elevations of roads and building sites together with definitive codes to prohibit basement construction and establish minimum first-floor levels above potential floods would be essential elements of a sound floodplain regulation program.

5.09 Floodplain regulations could be applied most effectively within the valley areas now undeveloped. Within Minot and other developed areas, conversion of land use except on a very gradual basis would be impractical; but new structures, if confined to flood fringe areas, could be designed in a manner which would minimize flood damages. The economic costs associated with restricting urban growth in the presently undeveloped valley areas along the Souris River would be minor as ample flat and easily developed upland areas exist. Nevertheless, the social costs related to the foregone opportunity to live in the pleasant river valley would be real and significant. Economic costs associated with reduced valley land values, increased development costs, and locational costs have not been evaluated. The benefits obtainable through reduction of new future damage-prone residential and other urban developments in valley areas would justify regulatory land-use controls. However, realization of these benefits would be dependent upon strict enforcement of the regulations.

5.10 Because of the extensive existing developments in the Souris River floodplain, particularly at Minot, remaining flood damages would continue to be high, assuming that floodplain regulation was the only flood damage alternative employed. This led to the conclusion that floodplain regulation alone could not be expected to solve the existing flood problem. However, floodplain regulation, particularly the restriction of new structures in the residual Souris River floodplain in sparsely developed and undeveloped rural areas below Burlington, is considered an important feature of the recommended plan.

FLOODPLAIN INSURANCE

5.11 Flood insurance administered by the Department of Housing and Urban Development (HUD) was made available to floodplain residents of Minot and Ward County in 1971. Ward County includes the developed floodplain areas adjacent to Minot and the community of Sawyer. To date, the city of Velva located in McHenry County has not adopted floodplain regulations and has not qualified for the insurance program. Where it is not practical or feasible to remove or otherwise protect existing floodplain developments from flood hazards, flood insurance may be used to idemnify property owners for future flood losses. Since flood insurance is subsidized by the Federal Government, premium rates are relatively low and economical to the individual property owner in the floodplain when compared to the average annual flood losses that could incur. However, the flood insurance program in Minot and Ward County has not been widely accepted. Most of the property owners who have purchased the insurance are new property owners who are required by the Federal Housing Administration (FHA) to purchase flood insurance before they can obtain a loan on floodplain property. Although a flood insurance program is beneficial from a local and regional viewpoint in that it spreads the individual property owner's cost of flooding over a wider population sector, the program is not beneficial on a national basis since it does not reduce flood damages. With only a flood insurance program, the Minot area, Sawyer, and Velva would still be susceptible to average annual damages of more than $4.5 million. However, in sparsely developed rural areas below Minot where structural measures are not feasible, flood insurance is included in the overall proposed plan as a possible means of alleviating damages to the individual owners of property in the floodplain.

EVACUATION

5.12 Consideration was given to a plan involving removal of all developments in the 100-year Souris River floodplain between Burlington and the J. Clark Salyer Refuge, including all those listed in table 19. The estimated total costs of the evacuation alternative are $179 million including social betterment costs of approximately $31 million. Non-Federal costs would amount to about $35 million. Comparing average annual benefits of about $4.6 million to average annual flood control costs (difference between total costs and social betterment costs) of $8.4 million yields an uneconomic benefit-cost ratio of about 0.5 without benefits attributable to increased local employment and about 0.7 with such benefits.

5.13 The massive relocations that would be required make the evacuation plan very questionable. About one-third of the residences, all of the schools and churches, and nearly all of the businesses would have to be replaced as either age, physical size, or construction materials would make moving the existing structures infeasible. Much of the old building material would be worth little as salvage; thus a massive cleanup program would be required to rid the floodplain of demolished buildings. The proposal, which would take from 8 to 10 years to complete, would require the construction of all new utilities, streets, and service roads at the relocation sites; revision of all existing utility lines within and along the fringe of the floodplain; and raising several major thoroughfares crossing the floodplain to permit uninterrupted cross-valley traffic during a flood. Approximately 15,900 residents of the Minot area floodplain and an additional

1,200 residents at Sawyer and Velva would be forced out of their present neighborhoods. Disruption of long-standing neighborhood and cultural ties and division of the city of Minot into northern and southern sectors could lead to serious social and institutional problems.

5.14 The estimated social betterment costs include principally the increased costs of providing improved or new residential and business buildings that will meet current codes and standards. However, social betterments may be partially or totally offset by the increased taxes and rents that dislocated property owners would be forced to bear. Since the non-Federal costs greatly exceed the fiscal capability of the local governmental units involved, financial assistance to implement the evacuation alternative would have to come from the State or be provided by the Federal Government. The significant advantages of the evacuation alternative are that flood damages would be nearly eliminated without disturbing the existing river system, and former ecosystems existent before urbanization took place could again return, leading to a net increase in environmental values. Also, the vacated floodplain, zoned and managed as a park and wildlife sanctuary, could provide recreation benefits for area residents. Although lack of economic feasibility and social acceptability precludes selection of the evacuation alternative for the urban areas of the Souris River basin, it is included in the proposed plan as a possible means of reducing damages and hardship to floodplain residents in the sparsely developed rural areas below Minot.

FLOOD PROOFING

5.15 Flood proofing involves such measures as elevating structures and access roads and streets to clear predicted flood levels; eliminating basements; providing measures for seepage control; providing bulkheads on doorway and window openings; putting check valves on sewer lines; underpinning of structures; and providing other measures to prevent damages to the structure. Because of the flat gradient of the Souris River and the large area that it drains, flood flows rise and fall slowly. Overbank flooding at Minot can prevail several weeks at depths of 8 feet or more. Valley floodplain soils are mostly clay and become highly saturated and expansive during floods. The saturated soils tend to cause differential settling around the foundations of flood proofed structures, resulting in serious structural damage or even ultimate collapse of the structure. Unless flooded or reinforced, basement walls are subject to collapse from water pressure exerted against the wall. Raising of buildings in the Minot floodplain is not practicable since raising of streets would also be required to provide access during floods. With the rapid rise in river stages that can occur at Minot from the Des Lacs River and Gassman Coulee, insufficient time would be available to implement such temporary flood proofing techniques as placement of bulkheads on doorways and windows. Furthermore, the condition of the residences and commercial buildings, many of which are 50 to 75 years old, precludes flood proofing as a viable alternative. Nevertheless, flood proofing techniques, particularly raising of existing buildings and flood proofing of new structures in areas where development is sparse and flood depths are not great, is considered as a supplemental measure in the overall proposed plan of flood damage reduction.

STRUCTURAL MEASURES

CHANNEL IMPROVEMENTS

5.16 Plans, which involved primarily channel improvement but included some levees in low areas, were evaluated through a range of sizes that would provide each of the considered damage reaches with protection from a flood of 3,000 cfs up to a level equal to the peak discharge of the estimated 100-year flood from the upper Souris River, which corresponds to a flow of 14,000 cfs at Minot and 15,500 cfs at Velva, the latter including appropriate allowances for local inflow. Channel improvements in reach 1 (see plate 2), Burlington to near Minot, would include continuous widening and straightening of the channel to obtain the desired flow capacity. Existing levees would be modified to permanent standards to reduce the amount of channel enlargement through developed areas. Because of the relatively flat slope of the Souris River, the channel would have to be about 16 feet deep with a top width varying from about 100 to 250 feet for flows of 3,000 to 14,000 cfs, respectively. Further, in order to obtain the desired channel capacity at the lower end of the reach, a substantial amount of channel improvement in the next downstream reach would be required. Nevertheless, considered as a separate undertaking, total costs would vary from about $4 million to $24.5 million for channel enlargements to carry flows of 3,000 to 14,000 cfs. The ratio of benefits to costs would decrease as the channel capacity increased and would vary from about 0.4 to less than 0.2. In addition to the lack of economic feasibility the channel enlargement in reach 1 would require removal of woodlands bordering the present channel, the excavated material would adversely affect lands selected for disposal, and local costs for lands and road and bridge modifications would be excessive. Also, channel improvement would encourage development of unoccupied areas between Burlington and Minot with the attendant deterioration of the natural environment. A plan involving predominantly channel enlargement was found to be an unacceptable alternative in reach 1.

5.17 In reach 2, primarily the city of Minot, channel improvement plans would also include continuous widening and straightening of the channel, recognizing the channel straightening and other works accomplished during the 1970 flood emergency and the channel works accomplished in accordance with recommendations included in the Minot Channel Design Memorandum. For discharges up to about 5,000 cfs, riprap lining would not be required. Above 5,000 cfs, riprap lining would be required, and above 8,000 cfs, continuous concrete lining would be required. Another, but more costly and environmentally undesirable alternative would be to provide a wider unlined channel through the city for design flows above the 5,000-cfs level. The channel improvement plan would require levees in low areas together with appurtenant interior drainage facilities at and adjacent to the upstream and downstream limits of the city and channel barrier structures to divert low flows around several channel loops severed by cutoffs. In order to obtain an approximately constant degree of protection through Minot, the channel modifications would have to be extended downstream. At the 5,000-cfs level the modifications would extend to the Bison Power Plant and at the 14,000-cfs level the modifications would be extended to a point midway between Logan and Sawyer. Costs for channel enlargement through Minot total about $6.7 million to accommodate a flow of 3,000 cfs, $17.6 million for 5,000 cfs, $47.9 million for 9,000 cfs, and $94.4 million for 14,000 cfs. The channel enlargement to accommodate a flow of 5,000 cfs provides a maximum of net benefits, about $1.3 million, and a benefit-cost ratio of about 2.3 as an independent undertaking and assuming allowances for future growth.

5.18 A high channel design discharge through Minot is desirable to reduce the frequency of reservoir usage and associated adverse environmental and social impacts in the reservoir storage area. However, environmental and social adverse effects, high local costs, and the lack of independent economic feasibility preclude development beyond a design level of 5,000 cfs. Lesser environmental and social adverse effects and lesser local costs would be involved with a channel design to convey flows less than 5,000 cfs. However, a channel design capacity of at least 5,000 cfs in conjunction with the reservoir and diversion tunnel would provide Minot with protection against about 80 percent of both the Souris River and Des Lacs River standard project floods and more than 50 percent of standard project flood from the local uncontrolled drainage area. Thus, the greater degree of protection together with the lesser adverse impacts that would occur in the reservoir area favored the adoption of a channel design capacity of 5,000 cfs over a lesser design capacity.

5.19 Reach 3 (Bison Power Plant to Logan) is sparsely developed, including only about 20 scattered residences experiencing a variety of flood problems, ranging from inundated access roads to first-floor flooding depending upon the magnitude of the flood. Flood protection for these residences could conceivably be provided by means of widening and straightening the channel considered for reach 2 and extending the channel work farther downstream. However, channel improvements within this reach at any design discharge level would lack economic feasibility by a wide margin, with first costs ranging from about $4 million to $14 million and benefit-cost ratios ranging from only 0.04 to 0.06; and gains would not be commensurate with the environmental damages that would result from the channel widening and straightening.

5.20 Plans involving predominantly channel improvements at Sawyer (reach 4) and Velva (reach 5) would involve widening and straightening of the channel through each community and for a considerable distance downstream of both communities. The first costs for channel improvements at Sawyer would range from about 0.4 million at the 3,500-cfs design discharge level to about $3.6 million at the 15,500-cfs design discharge level with corresponding benefit-cost ratios of 0.03 to 0.04. At Velva the first costs for channel improvements would range from about $1.3 million at the 4,000-cfs design discharge level to $7.6 million at the 15,500-cfs level with corresponding benefit-cost ratios of 0.04 to 0.10. Since plans involving levees at both communities would be less costly and less damaging to the channel environment, plans involving predominantly channel improvements at Sawyer and Velva were not given further consideration.

5.21 Approximately 50 scattered rural residences and ranches lie within the reach of the lower Souris River floodplain between Logan and the J. Clark Salyer Refuge (reach 6). Protection by means of channel improvements would require continuous widening and straightening of about 160 miles of channel within this reach and the removal of all trees, at least on one side of the channel. In reach 6 the first costs for continuous channel widening and straightening would range from about $11 million at a design discharge level of 3,500 cfs to $70 million at a design discharge level of 15,500 cfs, with a benefit-cost ratio of only 0.01 for both design discharge levels. Accordingly, plans involving channel improvements were dismissed on the basis of their environmental and economic impracticability.

FLOOD BARRIERS

5.22 Plans involving predominantly flood barriers (levees and floodwalls) were also considered for the potential damage reaches up to a level equivalent to the 100-year peak flow from the upper Souris River. Within the Burlington to near Minot reach (reach 1), existing emergency levees presently provide the nine scattered subdivision areas with temporary protection up to a discharge level of about 3,500 cfs. However, a permanent levee program in this reach would require installation of interior drainage facilities designed to function whenever flows exceeded 3,000 cfs. In addition, protection above a 3,000-cfs level would require reshaping, raising, and extending existing levees to permanent standards. Since the existing levees are located close to many of the residences and encroach upon the channel, some channel widening and cutoffs would be required to permit flattening the riverward slope of the levees. For the higher discharge levels, 5,000 cfs and above, channel cutoffs would be required to reduce the amount of levee work required.

5.23 First costs of levee improvements for flows from 3,000 to 14,000 cfs would vary from $600,000 to $13.6 million. The relationship of benefits to costs for modifying the existing levees to permanent design standards and providing appropriate interior drainage works would approximate 0.9 for assured protection up to 3,000 cfs and would decrease to about 0.4 for 100-year (14,000-cfs) protection. Although not economically feasible, levee improvement in reach 1 (up to a design flow of 5,000 cfs) was considered the most viable alternative both from the standpoint of cost effectiveness and environmental quality if the flow capacity at nondamaging levels were to be increased and is desirable in combination with the other recommended improvements. Levee plans in reach 1 with a design discharge of less than 5,000 cfs, although more economical, were considered infeasible because of the need for a reliable degree of flood protection from the upstream drainage area and because of the desire to reduce the frequency of reservoir storage and its associated adverse environmental and social impacts.

5.24 In Minot (reach 2) a continuous system of levees and floodwalls along both banks of the 12-mile river reach in the city would be required. To accommodate the desired flows, the flood barriers would range from 8 to about 17 feet in height, and would be set back from the channel banks some 50 feet to avoid causing excess stage increases due to channel constriction. First costs would vary from about $8.8 million to $132 million for levees designed to accommodate flows from 3,000 to 14,000 cfs, respectively. Benefit-cost relations vary from about 0.5 to 0.3, the latter for the works required to contain a 14,000-cfs flow. The massive levees and the broad floodway that would be needed would require relocation of many property owners in the floodplain and would completely change the riverfront within the city. Levee-floodwall plans at Minot were found to be totally unacceptable as property costs would be excessive and environmental changes would be great.

5.25 In rural areas downstream from Minot (reaches 3 and 6) a near continuous system of levees with appurtenant interior drainage works would have to be constructed along both banks of the approximate 170-mile river reach in order to provide the some 70 scattered ranches and rural residences with protection against excess river flows. The first costs of a continuous levee system in reaches 3 and 6 would range from about $9 million at the 3,500-cfs design discharge level to about $64 million at a design discharge level of 15,500 cfs. The benefit-cost ratio at all design discharge levels would be less than 0.05. In view of the severe environmental damages that would result from the removal of nearly all of the channel vegetation along both channel banks and in view of the lack of economic feasibility, continuous levee plans in reaches 3 and 6 were considered to be totally impracticable and thus, were given no further consideration.

5.26 Other improvements such as levees around some of the individual farmsteads and nonstructural measures including raising of buildings and access roads and flood insurance where the depth and frequency of flooding is not too great or permanent evacuation of some developments to a location above the floodplain, where feasible, and zoning of the residual floodplain were found to be the most viable measures for protecting the existing scattered developments and any potential future developments in reaches 3 and 6 against a maximum flow of 5,000 cfs from the reservoir plus appropriate allowances for local inflow. Such measures would not be damaging to the environment and would cost much less than structural measures alone involving continuous channel improvements or continuous levee systems. However, the implementation of such measures depends upon local and State acceptability. Further coordination with the water management boards of both Ward and McHenry Counties and the North Dakota State Water Commission will be required during studies for phase II of the general design memorandum.

5.27 At Sawyer and Velva (reaches 4 and 5), levees constructed during the 1969 flood emergency provide a good base for a permanent levee system. Levees in both communities provide temporary protection up to a level of about 4,500 cfs. However, interior drainage works would need to be constructed to function for flows at or above a 3,000-cfs level, and the levees at both communities would have to be extended, reshaped, raised, and modified to permanent standards. Also, some channel modifications including bank stabilization and channel cutoffs would be required at a design discharge level of 5,000 cfs or above. First costs to obtain assured protection for flows up to 7,700 cfs would approximate $500,000 at Sawyer and $2.7 million at Velva. A permanent levee system at Sawyer and Velva designed for a flow of up to 7,500 cfs would cause minimal environmental damages since a near complete levee system now exists at both communities. Thus, although permanent levee plans at Sawyer and Velva are economically infeasible as independent undertakings, they are found to be the most viable means of protecting these communities against a flow of up to 7,700 cfs, equivalent to the maximum reservoir release rate plus appropriate allowances for local inflow.

MINOT BYPASS TUNNEL

5.28 Diversion of the Souris River via a tunnel under Minot would serve the same functional purpose as the recommended channel improvement plan. The approximate 2-mile-long tunnel would be aligned to the east along the south side of the city with the diversion structure located near the upstream city limits and the outlet structure located near the downstream city limits. With the existing channel capable of conveying about 1,800 cfs with minimum damages, the tunnel could be designed to convey any flow up to about 3,200 cfs such that the total conveyance capacity of the channel plus tunnel would be about 5,000 cfs. Inside tunnel diameters of about 16 and 22 feet would be required to convey flows of 1,200 cfs and 3,200 cfs, respectively. With the tunnel plan, levees upstream from the diversion structure and channel improvements downstream from the outlet structure would be required similar to the scope required for a 5,000-cfs channel improvement plan. In addition, three channel cutoffs in Minot, excavated during the 1970 flood emergency, would have to be modified to permanent standards. With costs ranging from $15 million at the 1,200-cfs level up to $24 million at the 3,200-cfs level, the tunnel plan would be economically feasible as an independent undertaking and would be advantageous in that it would cause minimal damages to existing environmental and social values and local costs would be about $1 million less than the local costs of a channel improvement plan providing an equivalent measure of flood protection. However, the overall costs for the tunnel alternative at a design level of 5,000 cfs, recognizing the additional costs of the necessary levees and channel improvements are about $6.4 million greater than the costs of the recommended channel improvement plan at Minot. Thus, on the basis of overall costs the tunnel alternative was considered unacceptable.

SOURIS RIVER DIVERSION

5.29 Diversion of the Souris River around Minot would serve as an alternative to the recommended Burlington Reservoir in that the diversion channel could be designed to provide the city with an equivalent measure of protection from the upper Souris River.

5.30 At the request of the Citizens Advisory Committee, four alternative diversion routes were investigated including a route paralleling the international boundary, a route from Lake Darling to the Lower Souris River via Deep River, and routes around the north and south sides of Minot, as shown on plate 4. Both pumped and gravity flow diversions were evaluated on the basis of providing Minot with protection against a flow of 14,000 cfs, equivalent to the estimated peak flow from a 100-year Upper Souris River flood. All of the diversion channel plans were found to be lacking economic feasibility by a wide margin with costs ranging from $88 million to $215 million and benefit-cost ratios ranging from 0.2 to 0.4, due primarily to the more than 150-foot excavation cuts that would be required for gravity flow channels or the large pumping systems and the electrical energy that would be required for the pumped diversion schemes to raise diverted flows against a head of more than 150 feet as well as the channel work and velocity control structures required to return diverted flows to the river. Lake Darling Reservoir would provide a natural forebay for a diversion pumping station. However, pumping stations for the other three diversion routes would require forebays that would cause adverse impacts on Souris River bottomlands. A pumping station for the international boundary route could require a forebay backing water into Saskatchewan. A pumping station for the north Minot route would require a forebay backing water to the present Lake Darling Dam and a pumping station for the south Minot route would require a forebay backing water to above Burlington on both the Souris and Des Lacs Rivers. Diversion along the international boundary and Lake Darling routes would outlet flood flows into J. Clark Salyer Refuge and increase peak flows in the refuge and in Manitoba. All of the gravity diversion channel schemes would require the disposal of several million cubic yards of spoil and would affect normal surface and groundwater flow patterns. In addition, the diversion channel schemes would require the purchase of several thousand acres of agricultural and prairie lands and would affect many roads and farm operations. Thus, because of their many economic, environmental, and social disadvantages, plans involving diversion of the Souris River around Minot were not given further consideration.

SOURIS RIVER DAMS AND STORAGE IMPOUNDMENTS

5.31 - In addition to the recommended Burlington site, consideration was given to flood control storages obtainable by construction of dams located at three other sites on the Souris River above Minot. The sites, which are shown on plate 4, include a site near Burlington below the confluence of the Souris and Des Lacs Rivers (confluence site); a site near the south boundary of the Upper Souris National Wildlife Refuge at the Federal Aid Secondary (FAS) Route 929 (Baker Bridge site); and a site involving a raise of Lake Darling Reservoir (Lake Darling site).

Canadian interests have indicated that they would not be receptive to any plan which would require reservoir storage or increased flood levels on their lands. Thus, storage in all of the considered reservoir sites on the Souris River was limited to elevation 1620, the approximate elevation of the valley bottom near the international boundary. Since there is very little contributing drainage area between Burlington and Lake Darling Dams, the operating plans and the effects at Minot on flood peaks for equivalent volumes of storage at each site would be the same. The following paragraphs describe the merits of reservoirs at the confluence site, the Baker Bridge site, and the Lake Darling site as alternatives to the recommended Burlington site.

a. Confluence site. - A reservoir at the confluence site located near Burlington below the confluence of the Souris and Des Lacs Rivers would have nearly the same effects as a reservoir at the Burlington site except for the additional adverse effects caused by inundation of lands in the Des Lacs River valley. The most important additional environmental resources subject to possible damages along the Des Lacs River would be about 200 acres of woodland and 800 acres of grassland and cropland. Additional relocations required along the Des Lacs River would involve rerouting about 7 miles of the main transcontinental track line of the Soo Line Railroad and rerouting about 3 miles of U.S. Highway 52 in rugged coulee terrain above the Des Lacs River valley. Development of the dam at the site below the confluence of the Des Lacs River would also produce additional adverse social effects not found with the Burlington site. In this case about 30 medium to low value residences would require relocation of the present occupants to comparable safe and sanitary dwellings. Also, the Old Settlers Park with its trees and picnic facilities would have to be acquired, along with relocating the nearby Burlington Cemetery to higher ground. In addition, the wells now providing domestic water to the community of Burlington would have to be protected during flood periods, and the community's sewage lagoon system would have to be relocated. The confluence dam would be advantageous in that it would provide the same measure of control over Souris River floods as the recommended Burlington Reservoir and it would provide complete protection over Des Lacs River floods by virtue of the storage provided in the Souris River valley. However, a total flood control plan involving the confluence dam with 617,000 acre-feet of usable storage (elevation 1620) plus downstream channel works designed to convey 5,000 cfs would cost about $86 million and would exceed the limits of economic feasibility with a benefit-cost ratio of about 0.95. The lack of economic feasibility, but, more important, the additional environmental and social adverse impacts that would result were considered to be sufficient deterrents to selection of a plan involving the confluence dam.

b. Baker Bridge site. - At the Baker Bridge site a usable storage of about 470,000 acre-feet could be developed without exceeding elevation 1620. About 22,000 acres would be flooded at elevation 1620, including about 18,000 acres of land and water in the Upper Souris River Refuge. North of Baker Bridge the effects of reservoir storage on the valley would be similar to the effects of reservoir storage at the Burlington site except that the marsh units below Lake Darling and other lands within the refuge and lands north of the refuge would be inundated more frequently and for longer periods of time. It is for this reason that the Bureau of Sport Fisheries and Wildlife strongly objects to the Baker Bridge site and assigns it the greatest costs for mitigation (see appendix D). With the construction of a dam at the Baker Bridge site nót all of the adverse social and environmental impacts between the alternate damsite and Burlington would be avoided since the 850-acre marsh impoundment proposed by the Bureau, requiring fee taking of 1,300 acres of private lands, would affect about 40 percent of the area. However, at storage elevation 1620, adverse social impacts that would be avoided with construction of a dam at the Baker Bridge site as compared to construction of a dam at the Burlington site include the relocation of about 11 ranchers and other rural residents, and flowage easement acquisition on 2,300 acres of private lands. At the 100-year storage level[1] adverse environmental impacts that would be avoided include inundation of approximately 220 acres of river-fringe woodlands, 930 acres of grassland-pasture, and about 130 acres of hay, crop, and other bottomlands. A total plan involving a reservoir at the Baker Bridge site with 470,000 acre-feet of usable storage (elevation 1620), downstream channel works to convey 5,000 cfs, and a Des Lacs River diversion tunnel are designed to control 65 percent of the Souris and Des Lacs River standard project floods, would cost an estimated $83.5 million and would be economically feasible with a 1.03 benefit-cost ratio (see table 20). With a reservoir at the Baker Bridge site, average annual damages would be mostly eliminated. However, should a flood larger than the reservoir's storage capability occur, damages at Minot and other downstream areas

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(1) Based on an equivalent volume of usable storage of 220,000 acre-feet with storage to elevation 1602 in a reservoir at the Burlington site and storage to elevation 1607 in a reservoir at the Baker Bridge site.

could amount to several million dollars. For instance, damages at Minot could amount to an estimated $40 million under present day conditions with the occurrence of a flood having a peak flow equivalent to 75 percent of the Souris River standard project flood, if the volume of the storage reservoir were restricted to 470,000 acre-feet, the maximum capacity of the Baker Bridge site at elevation 1620. The lesser storage volume would also permit less flexibility in the method of reservoir operation, an important factor to consider since flood forecasting is highly unpredictable. Accordingly, these factors coupled with the objections by the Bureau of Sport Fisheries and Wildlife were of sufficient consequence to preclude selection of the Baker Bridge damsite alternative.

c. Lake Darling site. - The Lake Darling damsite is located immediately below the site of the existing Lake Darling Dam. At elevation 1620 a usable storage of about 330,000 acre-feet could be developed. About 18,000 acres would be flooded at elevation 1620, including about 11,300 acres of water surface in Lake Darling and an additional 3,000 acres of refuge area. North of Lake Darling Dam, the effects of reservoir storage on the valley would be similar to the effects of reservoir storage at either the recommended Burlington site or the Baker Bridge site except for increased frequency and duration of inundation. Only those roads and utilities located above Lake Darling would have to be modified. FAS Route 932 on the Lake Darling Dam could be placed on the new dam. At maximum storage elevation 1620, private property owners would be affected similarly to those affected by the dam at Baker Bridge since all of the valley between Lake Darling Dam and Baker Bridge lies within the federally owned Upper Souris National

Wildlife Refuge and since the 850-acre fish and wildlife marsh impoundment below Baker Bridge would be required with construction of the dam at the present Lake Darling damsite (see appendix D). As compared to the Burlington site, adverse social impacts that would be avoided between Burlington and Baker Bridge include the relocation of about 12 ranchers and other rural residents; flowage easement acquisition on about 2,400 acres of private lands; and fee title purchase of about 200 acres of private lands. At the 100-year storage level, adverse environmental impacts that would be avoided include inundation of about 900 acres of marshlands including the managed marsh impoundment between Lake Darling Dam and Baker Bridge and inundation of about 100 acres of river-fringe woodlands, 1,200 acres of grassland-pasture, and 100 acres of hay, crop, and other bottomlands. Since inundation of the managed marshlands could be avoided by construction of the dam at the Lake Darling site, the Bureau of Sport Fisheries and Wildlife favors the alternative and assigns it the least costs for mitigation (see appendix D). The raise Lake Darling alternative is favored by ranchers residing between Burlington and Baker Bridge as well as the local chapter of the Izaak Walton League which regards the raise Lake Darling alternative as the next best alternative to total evacuation of the Minot floodplain.

The costs of a plan involving storage at the Lake Darling site to elevation 1620 plus channel works downstream designed to convey 5,000 cfs would approximate $62.8 million and would be economically feasible with a benefit-cost ratio of about 1.3. However, such a plan would only provide protection against about 50 percent of the Souris River standard project flood and only about 25 percent of the Des Lacs River standard project flood. The least costly and least environmentally damaging means of providing increased protection from the Des Lacs River would be by means of a diversion tunnel. However, a 4-mile-long tunnel would be required. An overall plan consisting of the reservoir channel works and diversion would provide protection against 60 percent of the standard project flood from both the Souris and Des Lacs Rivers but would cost about $92.8 million and would have an uneconomic benefit-cost ratio of about 0.9. As in the case of a reservoir at the Baker Bridge site, several million dollars of damages could occur at Minot should a flood greater than the design storage capacity occur. Also, the lesser volume of reservoir storage (see table 20) would allow for less flexibility in the method of reservoir operation. Based on these factors the Lake Darling site was ruled an unacceptable alternative to the recommended

Burlington site, which together with the diversion and downstream channel works would provide protection against about 80 percent of the standard project flood from both the Souris and Des Lacs Rivers and more than 50-percent standard project flood protection from the local uncontrolled drainage area above Minot. Table 21 presents a summary of the social and environmental impacts of reservoirs at each of the alternative Souris River sites for various storage volumes.

TABLE 20

Estimated costs and benefits of alternative reservoirs and related improvements

Item	Lake Darling site	Baker Bridge site	Burlington site
Reservoir			
Design pool elevation	1620	1620	1620
Usable storage capacity (ac-ft)(1)	330,000	470,000	595,000
Degree of Souris River control (percent of standard project flood)	50	65	80
Channel works (reaches 1-6)			
Design capacity (cfs)	5,000	5,000	5,000
Des Lacs River diversion			
Design capacity (cfs)	5,000	6,600	9,000
Tunnel diameter (ft)	20	20	23
Tunnel length (ft)	20,000	9,000	7,500
Degree of Des Lacs River control (percent of standard project flood)	50	65	80
First costs ($million)			
Reservoir	36.00	41.30	44.00
Related channel works	26.75	26.75	26.75
Des Lacs River diversion	30.00	15.50	13.00
Total first costs	92.75	83.55	83.75
Average annual costs ($million)			
Reservoir	2.384	2.710	2.902
Related channel works	1.467	1.467	1.467
Des Lacs River diversion	1.900	0.974	0.800
Total annual costs	5.751	5.151	5.169
Average annual benefits ($million)			
Reservoirs and channel works	4.290	4.491	4.565
Des Lacs River diversion	0.150	0.200	0.200
Rehabilitate Lake Darling Dam	0.621	0.621	0.621
Total annual benefits	5.061	5.312	5.386
Average annual net benefits($million)	-0.690	0.161	0.217
Average annual remaining damages ($million)	0.493	0.242	0.168
Benefit-cost ratio	0.88	1.03	1.04

(1) Maximum obtainable without affecting lands in Saskatchewan.

TABLE 21

Summary of Social and Environmental Impacts of Souris River Reservoir Alternatives

Item	Burlington site			Baker Bridge site		Lake Darling site		Confluence site	
Pertinent data									
A. Design pool elevation	1602	1615	1620	1607	1620	1613	1620	1602	1620
B. Usable storage capacity (acre-feet)	220,000	470,000	595,000	220,000	470,000	220,000	330,000	226,000	617,000
C. Surface area of pool (acres)	19,000	23,500	25,300	17,600	21,700	16,000	18,100	19,310	26,600
D. Length of pool - valley miles	42	53	57	43	50	37	42	3 (1)	5 (1)
E. Degree of Souris River protection (2) (percent of standard project flood)	35	65	80	35	65	35	50	35	82
Social impact									
A. Required relocations									
1. Ranches	15	21	26	11	19	11	18	17	29
2. Rural residences	5	6	7	2	3	3	3	27	31
3. Cemeteries	1	1	1	1	1	1	1	2	2
4. Historical sites	0	0	0	0	0	0	0	0	0
B. Parks affected	1	1	1	1	1	1	1	2	2
C. Severed property owners	31	57	74	18	51	27	50	55	101
D. Private lands required (acres)									
1. Fee title	1,500	1,500	1,500	1,500	1,500	1,300	1,300	1,600	1,600
2. Flowage easement	1,700	4,500	5,700	1,500	3,400	2,100	3,300	2,000	6,200
E. Transportation routes affected									
1. Highway-Federal and State (miles)	0	0.5	0.5	0	0.5	0.5	0.5	1	2.5
2. Highway-county (miles)	22	34	37	12	23	13	16	22	37
3. Railroad-miles of track	1	1	1	1	1	1	1	5	10
Environmental impacts									
A. Refuge lands periodically inundated (acres)									
1. Open water	12,150	12,230	12,250	12,170	12,250	11,300	11,300	12,150	12,250
2. Marsh	1,750	2,250	2,250	1,950	2,250	880	880	1,750	2,250
3. Woods	550	830	850	730	850	560	570	550	850
4. Grasslands-pasture	750	1,310	1,900	900	1,900	660	1,200	750	1,900
5. Hay-crop-bottomland	350	380	380	320	380	50	70	350	380
6. Miscellaneous	-	300	330	-	330	300	330	-	330
Total	15,550	17,500	17,960	16,070	17,960	13,750	14,350	15,550	17,960
B. Private lands periodically inundated (acres)									
1. Open water	200	500	550	50	350	160	350	320	730
2. Marsh	70	100	130	30	60	35	60	100	230
3. Woods	600	1,100	1,350	200	830	460	830	750	1,540
4. Grassland-pasture	1,130	1,350	1,600	50	70	60	70	1,200	1,830
5. Hay-crop-bottomland	1,300	2,800	3,460	1,200	2,290	1,495	2,290	1,400	4,060
6. Miscellaneous	150	150	250	-	120	-	20	180	250
Total	3,450	6,000	7,340	1,530	3,720	2,210	3,720	3,950	8,640
C. Refuge impoundments affected									
1. Pools located between south boundary of refuge and Lake Darling	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes
2. Lake Darling	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Pool behind dam 41	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D. Fish and wildlife mitigation requirements									
1. Mitigation dam required below Baker Bridge	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Approximate cost of mitigation measures (3) ($million)	9.2	9.2	9.2	9.8	9.8	8.2	8.2	9.2	9.2

(1) Length of Des Lacs pool.
(2) Assumes a maximum reservoir release rate of 5,000 cfs.
(3) Costs for fish and wildlife mitigation obtained from the Bureau of Sport Fisheries and Wildlife. (See appendix D.)

DES LACS RIVER DIVERSION

5.32 The tunnel diversion plan, in conjunction with a storage reservoir on the Souris River is an alternative to a reservoir below the confluence of the Souris and Des Lacs Rivers or the construction of an independent storage system on the Des Lacs River to control flash floods which might exceed the channel capacity through downstream urban areas. If the Souris River dam were located at Baker Bridge, the diversion works could be at the same point as the recommended diversion, about 1½ miles downstream from Foxholm (see plate 4), but the tunnel would have to be aligned in a more northerly direction to discharge above Baker Bridge, increasing the tunnel length to about 9,000 feet. Constructing the Souris River dam at the Lake Darling damsite would require locating the diversion works about 5 valley miles above Foxholm and requiring about 20,000 feet of tunnel extending to the northeast to exit into Lake Darling near the existing dam. The inlet and outlet works for all three tunnel schemes would be similar. The inlet works would include a low-head diversion dam, with ungated outlet works and an entrance channel to the tunnel portal. A concrete energy dissipator and channel works would be provided at the outlet of the tunnel. A diversion tunnel could be constructed to provide any degree of control up to the level of the standard project flood above the point of diversion and, except for land required by flowage easement for the diversion impoundment, and the land required for spoil disposal, environmental and social disturbances would be minimal.

5.33 A plan including a reservoir at the Lake Darling site, local protection measures to accommodate a flow of 5,000 cfs, and tunnel diversion of the Des Lacs River, would not be economically feasible due to the excessive costs of the 4-mile-long tunnel that would be required (see above discussion). In addition, the diversion structure would have to be located so far above the mouth of the Des Lacs River that it would not be as effective in reducing flood damages at Minot. The diversion structure for tunnels to reservoirs at the Burlington site and the Baker Bridge site can be located at about the same point above the mouth of the Des Lacs River. Thus, from the standpoint of the drainage area controlled, both would be equally as effective. However, a tunnel to a reservoir at the Burlington site would cost about $2.5 million less than a tunnel to a reservoir at the Baker Bridge site due to the shorter length and smaller diameter required; but the primary advantage of the Burlington Reservoir-Des Lacs River diversion alternative is the greater degree of Souris River protection afforded by the Burlington Reservoir.

DES LACS RIVER BASIN STORAGE IMPOUNDMENTS

5.34 Damsites on the main stem of the Des Lacs River between Burlington and the Des Lacs National Wildlife Refuge were not considered because of the presence of closely spaced valley communities, the Soo Line Railroad tracks, and U.S. Highway 52. However, consideration was given to dams on the 19 larger coulees which drain into the Des Lacs River between the Des Lacs wildlife refuge and the mouth of the Des Lacs River in conjunction with a dam on Gassman Coulee. The coulee reservoirs would have a total storage capacity of about 27,000 acre-feet; however, they would only reduce flood damages at Minot by about 10 percent since they would control only about 20 percent of the Des Lacs River drainage area. In addition, the coulee reservoirs would cause a severe impact on the wooded coulee draws and would entail excessive costs (about $22.8 million) because of the high dams that would be needed to provide the necessary storage. In view of these factors, the system of coulee dams could not be considered as a favorable flood damage reduction alternative.

5.35 An alternative involving a dam on the Des Lacs River just above Kenmare was investigated during the preauthorization study phase. However, detailed hydrologic studies at that time indicated that such a dam could not be justified, since the series of small reservoirs in the Des Lacs National Wildlife Refuge already provided a measure of control of the drainage basin above Kenmare, and the downstream coulees, the principal source of flood peaks arising on the Des Lacs River, would remain uncontrolled.

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

6.01 The most significant changes that would occur in the project area would result from implementation of the Burlington Reservoir, the principal feature of the overall recommended plan for flood control. To determine the net effect of the project, short-term versus long-term, requires a projection of what might be expected to occur in the project area in the absence of the project and what might be expected to occur with the project, recognizing that other changes can be expected to occur under both conditions.

6.02 Approximately 70 percent of the proposed flood storage area presently exists as the Upper Souris National Wildlife Refuge, over half of which is occupied by Lake Darling Reservoir. The refuge area is presently managed by the Bureau of Sport Fisheries and Wildlife for the production of waterfowl and wildlife, although some lands are leased to ranchers for cropping and livestock production. In the absence of the proposed reservoir, it is expected that minimal land-use change will take place on the refuge over the long term; thus, it might be expected that future generations would be able to use the refuge nearly as it exists in its present state. The remaining 30 percent of the proposed flood storage area north and south of the refuge is privately owned. Most of these lands are used by some 30 to 35 ranchers for the production of livestock, grains and hay, and for cattle grazing. In the absence of the project it is expected that agricultural production on the private lands might be intensified depending upon technological advances and the need for food products.

With increasing agricultural growth existing natural resources, vegetation and wildlife, might be expected to decline.

6.03 With the proposed project the periodic inundation of the wildlife marsh impoundments below Lake Darling Dam and the wooded fringe along the Souris River between the damsite and Lake Darling Dam perhaps constitute the most significant adverse environmental impacts of the recommended project. The significance of these impacts is dependent upon the frequency and timing of floods and upon the ability of the ecosystems to recover from a period of inundation. It is expected that the marsh units would be able to recover within a relatively short period of time following an extended period of inundation. However, the mature trees along the river would most likely succumb to inundation and successional stages probably will never reach maturity due to the frequency of inundation. Another adverse environmental impact resulting from the storage of floodwaters is the loss of the stream fishery between Lake Darling Dam and Baker Bridge during the years that floodwater is stored.

6.04 With the project, future generations of ranchers would be permitted to continue to use the floodwater storage area for crop and livestock production, except for that area needed for the dam and appurtenant structures and for fish and wildlife mitigation. However, other uses not compatible with the terms of the flowage easement such as the construction of buildings and other structures susceptible to damage would not be permitted. In the future, ranchers would have to contend with the disturbances to their ranching operations caused by periodic inundation such as disruptions to normal crop rotational practices, and severed roads which provide access to their fields, and loss of wooded shelter for their cattle. Also, valley residents would be faced with the loss of Renville County Memorial Park, a favorite social gathering place. In areas downstream from the dam, and in the absence of the project, future generations would be able to live in the pleasant wooded surroundings of the Souris River floodplain; however, they would continually be subject to the hardships and economic losses associated with flooding, with the resultant effect being continued economic decline. With the proposed project, future generations would not be permitted to occupy those areas subject to a residual flood threat. However, those who now occupy the floodplain or those who occupy floodplain areas where improvements are proposed, can be expected to enjoy a greater sense of well-being knowing that they would be free from the anxieties and hardships associated with flooding. Also, elimination of the flood threat would permit local government officials greater flexibility in planning for their communities.

7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

7.01 On a short-term basis the energy (hydrocarbon fuels), labor and materials (sand, gravel, steel, etc.) needed for the construction of the proposed flood control project would appear to represent an irretrievable commitment of natural resources. However, in the absence of the project, the energy required to implement emergency works and to rehabilitate floodplain developments on a cumulative basis may offset the energy needed to construct the project such that over the long term there may be a positive net effect on the natural resource base. Periodic inundation of upper Souris River valleylands could result in habitat or land-use changes which might be viewed as an irretrievable commitment of natural resources. For instance, the wooded fringe along the Souris River between Burlington and Lake Darling may be altered from an ecosystem now comprised of mature trees to a successional stage comprised of a more dense growth of small trees and shrubs and a change in wildlife species composition. The proposed fish and wildlife mitigation impoundment will result in converting about 850 acres of terrestrial habitat to a semiaquatic habitat, and the land needed for the dam and other structures would be committed for flood control use. Also, periodic inundation might result in changing the management plan for the Upper Souris National Wildlife Refuge.

7.02 In regard to the floodplain below Burlington, the provision of a high degree of flood protection probably will enhance land values and accelerate economic growth particularly in the suburban areas both upstream and downstream from Minot. However, whether substantial economic growth would not take place in the absence of the project is questionable since neither Minot nor Ward County currently has permanent ordinances restricting development in the floodplain and since substantial economic growth did take place prior to adoption of the current temporary regulations due to the infrequency of flooding and the false sense of security provided by Lake Darling Reservoir.

7.03 The recommended plan provides for zoning of the residual floodplain between Burlington Reservoir and the J. Clark Salyer Refuge. This provision, if ultimately adopted and strictly enforced, would ensure that the present, wild state of the floodplain would be protected from private development. However, this cannot be viewed as an irreversible process since the abandonment of the regulations at any time in the future could open the floodplain to development.

8. COORDINATION

8.01 Coordination for the Phase I Design Memorandum included as a first step the formation of a Citizens Advisory Committee. The 12-member committee was comprised of representatives of various State and local groups concerned with the flood problems in the Souris River basin and included representatives of the Ward County Water Management District, the Ward County Board of Commissioners, the cities of Minot and Velva, the North Dakota State Water Commission, and ranchers from both the upper and lower Souris River areas and the Des Lacs River area. The principal objective of the committee was to review alternative solutions to the flood problem in the Minot area and, based on a consideration of all effects, both favorable and unfavorable, to reach a consensus regarding the scope and nature of the improvement plan considered to be in the best public interest.

8.02 During a time span of about 9 months the committee held 16 meetings at which it evaluated the relative merits of the various flood damage reduction alternatives with technical guidance provided by representatives of the St. Paul District. The meetings were open to the public and were attended by local citizens as well as representatives from various agencies, organizations, and institutions, including the Bureau of Sport Fisheries and Wildlife, Bureau of Reclamation, the Souris-Red-Rainy River Basins Commission, Minot State College, and the Izaak Walton League of America. The meeting culminated with the adoption of a position paper by the committee, covering 17 proposals they agreed should be taken into account in the final plan recommended by the

effects of the reservoir operation proposed. The meeting concluded that the remaining differences could be clarified by a conference at field level. On 8 November 1973, a meeting was held in the District office primarily to clarify hydraulic and hydrologic questions regarding the operation plan for the Burlington Dam and the probable effects on the refuges. No further meetings or discussions have taken place. Copies of pertinent correspondence are included in appendix D.

8.04 At the request of the Citizens Advisory Committee, the Bureau of Reclamation analyzed the feasibility of utilizing floodwater storage for irrigation and found that the expected irrigation benefits would not justify the associated costs because of the infrequent storage and availability of floodwaters for irrigation use.

8.05 To determine the impact of reservoir operation on Canadian lands in Manitoba, the St. Paul District has contracted with the U.S. Geological Survey to conduct detailed reservoir routing studies from the damsite to the lower Manitoba boundary crossing near Westhope. The St. Paul District, Corps of Engineers will make detailed reservoir backwater studies to determine the effects, if any, on Canadian lands in Saskatchewan. The results of the routing and backwater studies, together with the views of Canadian interests will be presented in a report by the International Souris-Red River Engineering Board to the International Joint Commission. Canadian interests have indicated that they would be receptive to any proposed reservoir plan which, based on hydrologic studies, would not cause appreciable increased flooding in Saskatchewan or Manitoba.

8.06 This environmental impact statement together with the environmental impact statement covering the Minot channel improvement project will be made available to all known interests including Federal, State, and local officials, organizations, and individuals for review and comment. For the benefit of others who may have an interest and who wish to comment on the proposed flood control project, copies of the statement will be made available at local libraries, and information concerning its contents and where it can be obtained will be presented over local news media. Those individuals who wish to obtain a personal copy of the impact statement may do so by writing to the following address:

St. Paul District, Corps of Engineers
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

8.07 A list of Government officials and private interests to whom copies of this impact statement will be sent and a list of libraries where copies of this statement will be made available are as follows:

Congressional

Honorable Quentin N. Burdick
United States Senate

Honorable Milton R. Young
United States Senate

Honorable Mark Andrews
House of Representatives

Federal Agencies

U.S. Department of Agriculture
Soil Conservation Service
Forest Service

U.S. Department of Commerce

U.S. Environmental Protection Agency, Region VIII

Federal Power Commission

U.S. Department of Health, Education and Welfare
Public Health Service

U.S. Department of Housing and Urban Development

U.S. Department of the Interior

U.S. Department of State

U.S. Department of Transportation
Federal Highway Administration

Office of Economic Opportunity

Federal Commissions

Upper Mississippi River Basin Commission
Regional Office

Water Resources Council

State Officials

Honorable Arthur Link
Governor of North Dakota

Honorable Morris C. Anderson, State Senator

Honorable John D. Coughlin, State Senator

Honorable Lee Christensen, State Senator

Honorable Chester Reiten, State Senator

Honorable Walter Erdman, State Senator

Honorable Ernest M. Sands, State Senator

Honorable Roland Redlin, State Senator

State Officials (cont)

Honorable Richard J. Backes, State Representative

Honorable Hal Christensen, State Representative

Honorable James E. Froeber, State Representative

Honorable Bynhild Haugland, State Representative

Honorable Fern Lee, State Representative

Honorable Norman Livingston, State Representative

Honorable James A. Peterson, State Representative

Honorable Leonard Rice, State Representative

Honorable Mike Timm, State Representative

Honorable Roy Rued, State Representative

Honorable Lawrence Marsden, State Representative

Honorable Arnold Nermyr, State Representative

Honorable Robert D. Hartl, State Representative

Honorable Marge Kermott, State Representative

State Agencies

Commissioner, North Dakota Department of Agriculture and Labor

Commissioner, North Dakota Game and Fish Department

State Geologist, North Dakota State Geological Survey

State Health Officer, North Dakota State Department of Health

State Forest Service

Commissioner, North Dakota State Highway Department

President, North Dakota State Historical Society

President, North Dakota Indian Affairs Commission

State Agencies (cont)

North Dakota Outdoor Recreation Agency

Director, North Dakota State Planning Agency

North Dakota State Water Commission

North Dakota State Soil Conservation Committee

County Officials

Ward County Agricultural Agent

Ward County Water Management Board

Ward County Board of Commissioners

Renville County Agricultural Agent

Renville County Board of Commissioners

McHenry County Board of Commissioners
Bottineau County Board of Commissioners

City Officials

Honorable Chester Reiten, Mayor of Minot
Mr. John Arnold, City Manager, Minot

Mr. Oscar N. Berg, Executive Director,
Urban Renewal Agency, Minot

Mr. Mike Nilson, Superintendent of Parks, Minot

Minot City Planning Board

Mr. Burt Peckam, City Engineer, Minot

Honorable Ernie Schwandt, Mayor of Burlington

Honorable Albert Beck, Mayor of Sawyer

Honorable Hayden H. Thompson, President of Towner

Honorable Edward Bickler, President of Velva

Honorable Lester Hansen, Mayor of Kenmare

Honorable John D. Banker, Mayor of Mohall

Organizations

Souris River Flood Control Planning Commission
Ralph Christensen, Chairman

Garrison Diversion Conservancy District

Eaton Irrigation Board

Executive Director
Izaak Walton League of America, Inc.

Natural Resources Defense Council, Inc.

Northern Environmental Council

Chairman, Sierra Club

Environmental Defense Fund

Ducks, Unlimited

National Audubon Society
West Central Regional Office

Bernice Palmer, Lewis & Clark Environmental Assn.

National Wildlife Federation
Midwestern Field Representative

Ed Dobson, Friends of the Earth

Brent Blackwelder, Environmental Policy Center

Northern Plains Resource Council

Dr. Keith Harmon, Wildlife Management Institute, Fargo

North Dakota Wildlife Federation, Bismarck, North Dakota

North Dakota Association of Soil Conservation District

Universities and Colleges

Minot State College, Mr. Arthur Haskins

Institute for Ecological Studies, University of North Dakota

Tri-College University, Center for Environmental Studies

University of Wisconsin, Green Bay
Mr. Robert Ditton, Water Resources Literature Clearinghouse

Transportation Interests

Chief Engineer, Burlington Northern, Inc.

Chief Engineer, Soo Line Railroad Company

Individuals

Mr. Tom Glorvigin

Mr. James Lunan

Mr. Robert L. Storch

Ms. Lorraine Smith

List of Libraries

Library, North Dakota Agricultural College

Library, University of North Dakota

Library, Minot State College

Library, Bismarck Junior College

Library, Mary College, Bismarck, North Dakota

Rauquest Library, Jamestown University, North Dakota

Library, North Dakota State University

Library, Bemidji State College

Library, Concordia College, Moorhead, Minnesota

Stutsman County Library, Jamestown, North Dakota

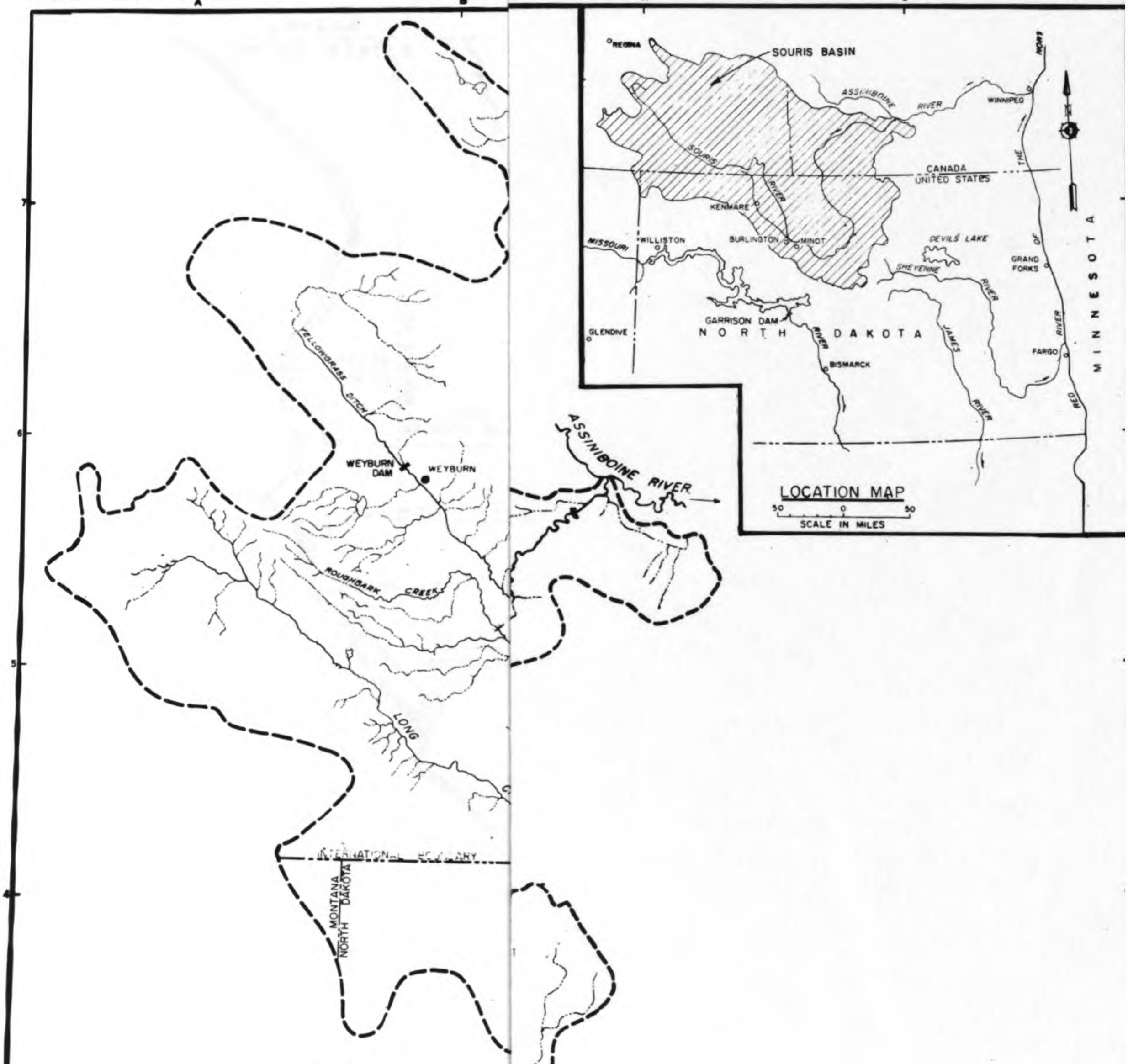
Minot Public Library, Minot, North Dakota

Mohall Public Library, Mohall, North Dakota

Library, State Historical Society of North Dakota

Veterans Memorial Public Library, Bismarck, North Dakota

Alfred Dickey Free Library, Jamestown, North Dakota



LEGEND

- RIVER BASIN BOUNDARY
- INTERNATIONAL BOUNDARY
- STATE OR PROVINCE BOUNDA
- AUTHORIZED CHANNEL IMPROVEME
- OUTLINE FOR AUTHORIZED RESE
- M. 100 MILES ABOVE MOUTH
- EXISTING DAM
- AUTHORIZED DAM SITE

10 0 10 20 30
SCALE IN MILES

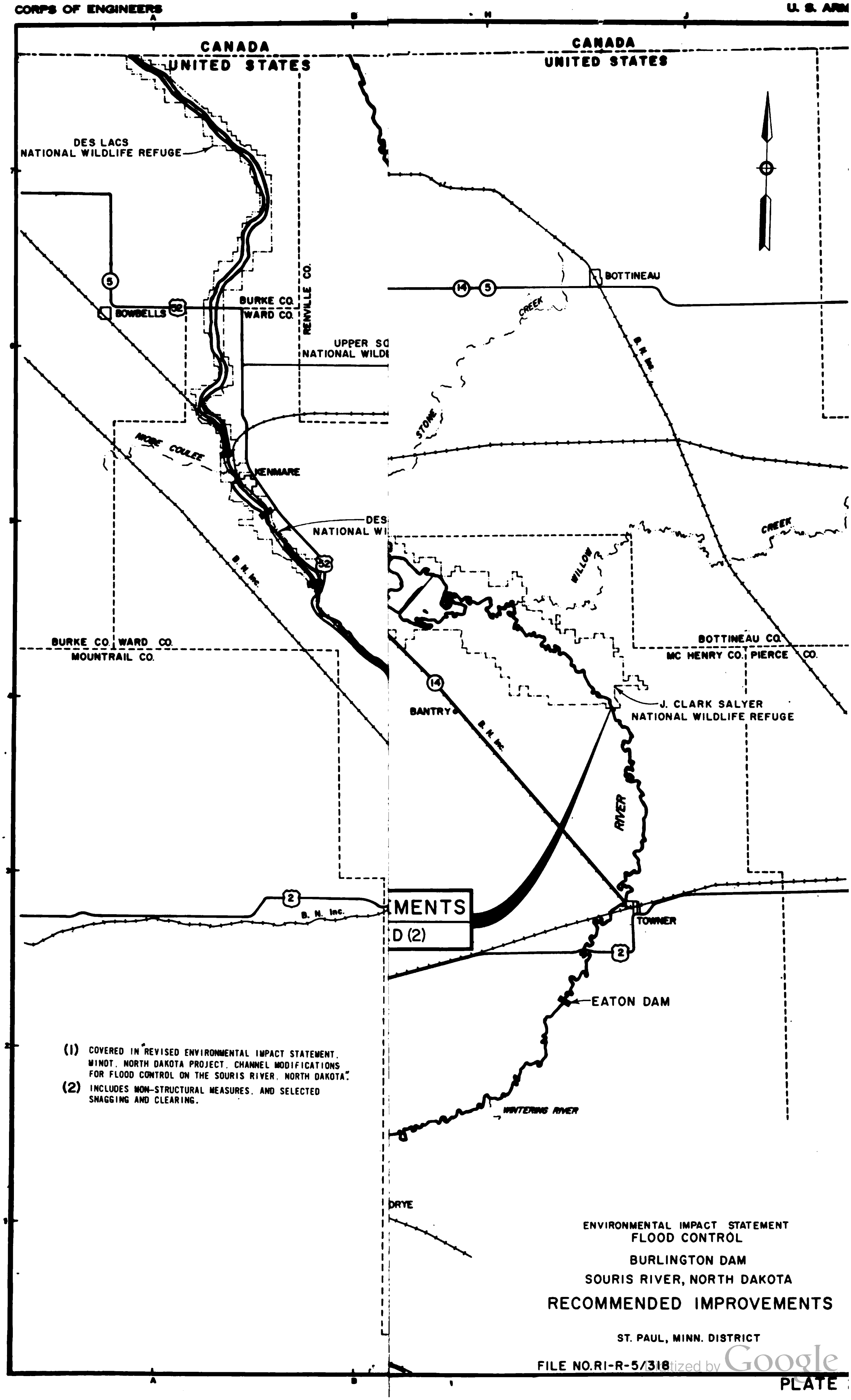
ENVIRONMENTAL IMPACT STATEMENT
FLOOD CONTROL
BURLINGTON DAM
SOURIS RIVER, NORTH DAKOTA

AUTHORIZED IMPROVEMENTS

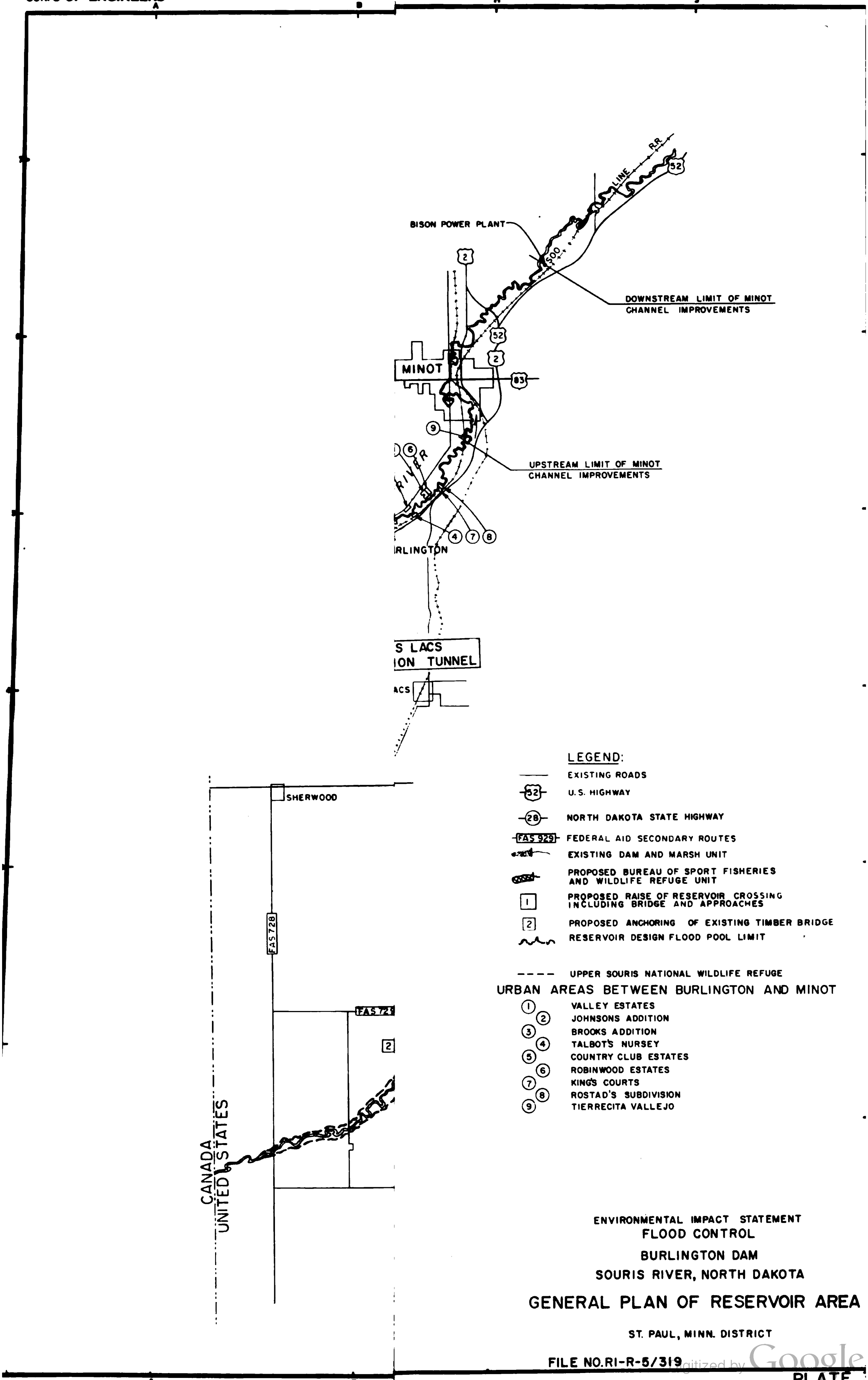
ST. PAUL, MINN. DISTRICT

FILE NO. RI-R-5/317

PLATE I


CORPS OF ENGINEERS
U. S. ARM
CANADA
UNITED STATES
CANADA
UNITED STATES
DES LACS
NATIONAL WILDLIFE REFUGE
BOTTINEAU
BOWBELLS
BURKE CO.
WARD CO.
RENVILLE CO.
UPPER SO
NATIONAL WILDL
CREEK
STONE
MORE COULEE
KENMARE
DES
NATIONAL WI
CREEK
WILLOW
BOTTINEAU CO.
MC HENRY CO.
PIERCE CO.
BURKE CO.
WARD CO.
MOUNTRAIL CO.
BANTRY
J. CLARK SALYER
NATIONAL WILDLIFE REFUGE
RIVER
MENTS
D (2)
TOWNER
EATON DAM
WINTERING RIVER
DRYE
(1) COVERED IN "REVISED ENVIRONMENTAL IMPACT STATEMENT. MINOT, NORTH DAKOTA PROJECT. CHANNEL MODIFICATIONS FOR FLOOD CONTROL ON THE SOURIS RIVER, NORTH DAKOTA".
(2) INCLUDES NON-STRUCTURAL MEASURES, AND SELECTED SNAGGING AND CLEARING.
ENVIRONMENTAL IMPACT STATEMENT
FLOOD CONTROL
BURLINGTON DAM
SOURIS RIVER, NORTH DAKOTA
RECOMMENDED IMPROVEMENTS
ST. PAUL, MINN. DISTRICT
FILE NO. RI-R-5/318
PLATE

CORPS OF ENGINEERS U. S. ARMY



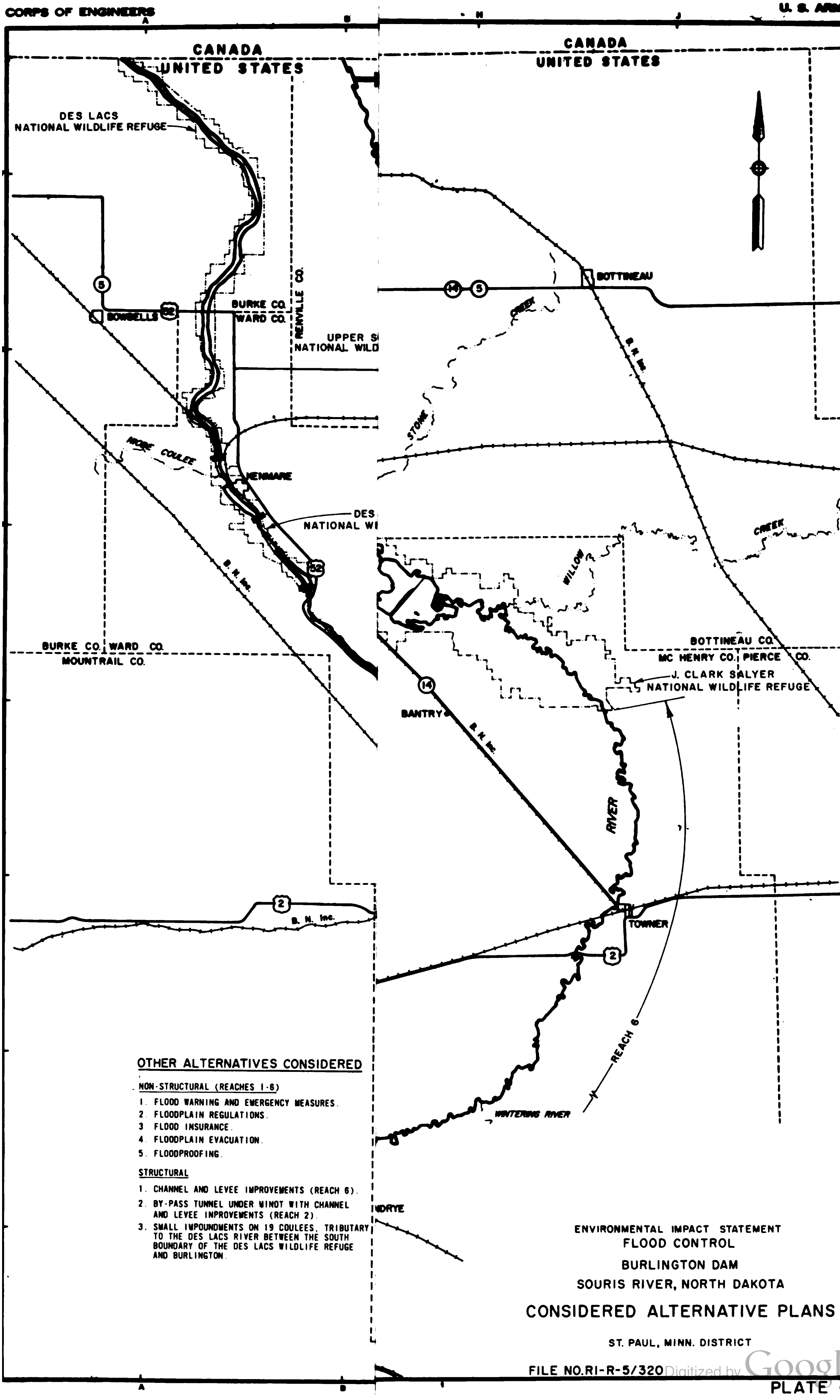
ENVIRONMENTAL IMPACT STATEMENT
FLOOD CONTROL
BURLINGTON DAM
SOURIS RIVER, NORTH DAKOTA

GENERAL PLAN OF RESERVOIR AREA

ST. PAUL, MINN. DISTRICT

FILE NO. RI-R-5/319

PLATE



OTHER ALTERNATIVES CONSIDERED

NON-STRUCTURAL (REACHES 1-6)

1. FLOOD WARNING AND EMERGENCY MEASURES.
2. FLOODPLAIN REGULATIONS.
3. FLOOD INSURANCE.
4. FLOODPLAIN EVACUATION.
5. FLOODPROOFING.

STRUCTURAL

1. CHANNEL AND LEVEE IMPROVEMENTS (REACH 6).
2. BY-PASS TUNNEL UNDER MINOT WITH CHANNEL AND LEVEE IMPROVEMENTS (REACH 2).
3. SMALL IMPOUNDMENTS ON 19 COULEES, TRIBUTARY TO THE DES LACS RIVER BETWEEN THE SOUTH BOUNDARY OF THE DES LACS WILDLIFE REFUGE AND BURLINGTON.

ENVIRONMENTAL IMPACT STATEMENT
FLOOD CONTROL
BURLINGTON DAM
SOURIS RIVER, NORTH DAKOTA

CONSIDERED ALTERNATIVE PLANS

ST. PAUL, MINN. DISTRICT

FILE NO. RI-R-5/320

PLATE 4

DEPARTMENT OF THE ARMY
St. Paul District, Corps of Engineers
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

DRAFT REVISED

ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL

BURLINGTON DAM

SOURIS RIVER, NORTH DAKOTA

APPENDIX A

BIOLOGICAL INVENTORY OF THE SOURIS RIVER BASIN

APPENDIX A

Appendix A represents a provisional biological inventory of the Souris River basin, compiled by Minot State College under contract from the St. Paul District Corps of Engineers. Four basic community types have been developed to facilitate the study on a systematic basis. They are: the Grassland biota (prairie), which represents the largest community in the basin in terms of land mass; the Marsh biota, representing the managed marsh units of the Upper Souris and J. Clark Salyer National Wildlife Refuges and scattered oxbows along the Souris River; the open water community, representing Lake Darling and the Souris River; and the floodplain forest community, represented by the wooded coulees and woodlands along the Souris River.

GRASSLAND BIOTA

FLORA

Scientific Name	Common Name
(1) Achillea millfolia	(1) yarrow (milfoil)
(2) Agoseris glauca	(2) prairie dandelion
(3) Agropyron trachycaulum	(3) slender wheatgrass
(4) Agrostis scabra	(4) hair grass
(5) Ambrosia psilostachya	(5) perennial ragweed
(6) Andropogon gerardi	(6) big bluestem grass
(7) Andropogon hellii	(7) sandhills bluestem
(8) Andropogon scoparius	(8) little bluestem grass
(9) Androsace occidentalis	(9) fairy candelabra
(10) Anemone canadensis	(10) Canada anemone
(11) Antennaria glauca	(11) pussy-toes
(12) Artemesia frigida	(12) fringed sage
(13) Artemesia glauca	(13) green sage
(14) Artemesia ludoviciana	(14) white sage
(15) Asclepias spp.	(15) milkweed
(16) Aster coerulescens	(16) tall aster
(17) Aster ericoides	(17) white prairie aster
(18) Aster laevis	(18) white prairie aster
(19) Aster novae-angliae	(19) aster
(20) Bouteloua curtipendula	(20) side-oats grama grass
(21) Bouteloua gracilis	(21) blue grama
(22) Calamovilfa longifolia	(22) big sandgrass
(23) Campanula rotundifolia	(23) bluebell
(24) Carex brevior	(24) sedge
(25) Carex interior	(25) sedge
(26) Carex sartwellii	(26) sedge
(27) Carex tetanica	(27) sedge
(28) Cerastium arvense	(28) mouse-ear chickweed
(29) Chenopodium album	(29) lamb's quarters
(30) Chrysopsis villosa	(30) golden aster
(31) Cirsium arvense	(31) Canada thistle
(32) Convolvulus sepium	(32) large bindweed
(33) Crepis runcinata	(33) hawksbeard
(34) Echinacea angustifolia	(34) purple coneflower
(35) Elymus canadensis	(35) Canada wildrye
(36) Elymus virginicus	(36) Virginia wild rye
(37) Equisetum laevigatum and other spp.	(37) smooth scouring-rush
(38) Eriogonom flavum	(38) yellow-umbrella plant
(39) Glycyrrhiza lepidota	(39) wild licorice
(40) Hedeoma hispida	(40) pennyroyal
(41) Helianthus maximiliari	(41) narrow-leaved sunflower
(42) Helianthus spp.	(42) sunflower
(43) Hordeum jubatum	(43) wild barley
(44) Koeleria cristata	(44) june grass

grassland continued

(45)	Lactuca pulchella	(45)	wild lettuce
(46)	Lilium philadelphicum	(46)	wild lily
(47)	Monarda fistulosa	(47)	wild bergamot
(48)	Muhlenbergia richardsonis	(48)	mat muhly
(49)	Panicum virgatum	(49)	switchgrass
(50)	Parnassia glauca	(50)	grass of parnassus
(51)	Petalostemum purpureum	(51)	purple prairie clover
(52)	Petalostemum candidum	(52)	white prairie clover
(53)	Phlox hoodii	(53)	moss phlox
(54)	Poa palustris	(54)	fowl bluegrass
(55)	Poa pratensis	(55)	Kentucky bluegrass
(56)	Potentilla spp.	(56)	cinquefoil
(57)	Psoralea spp.	(57)	scurf pea
(58)	Ranunculus abortivus and other spp.	(58)	small-flowered crowfoot
(59)	Rosa arkansana	(59)	prairie rose
(60)	Rosa blanda	(60)	smooth rose
(61)	Rosa woodsii	(61)	common wild rose
(62)	Selaginella densa	(62)	little club-moss
(63)	Sisyrinchium angustifolium	(63)	blue-eyed grass
(64)	Solidago altissima	(64)	goldenrod
(65)	Solidago canadensis	(65)	tall goldenrod
(66)	Solidago missouriense	(66)	goldenrod
(67)	Solidago nemoralis	(67)	goldenrod
(68)	Solidago rigida	(68)	goldenrod
(69)	Spartina pectinata	(69)	prairie cordgrass
(70)	Sporobolus cryptandrus	(70)	sand dropseed
(71)	Sporobolus heterolepis	(71)	prairie dropseed
(72)	Sporobolus spp.	(72)	dropseed
(73)	Stachys palustris	(73)	hedge nettle
(74)	Stipa comata	(74)	neddge and thread spear grass
(75)	Stipa spartea	(75)	speargrass
(76)	Stipa viridula	(76)	green needle grass
(77)	Symphoricarpos occidentalis	(77)	wolfberry
(78)	Tragopogon dubius	(78)	goatsbeard
(79)	Taraxacum officinale	(79)	dandelion
(80)	Zizia aptera	(80)	meadow parsnip

BIRDS

KEY:

PR Permanent Resident
(present during all seasons; breeds in summer)
SR Summer Resident
(present during summer; breeds)
WV Winter Visitor
(present for indefinite periods during winter)
SV Summer Visitor
(present for indefinite periods during summer; does not breed)
TV Transient Visitor
(spring and/or fall migrant)
CV Casual Visitor
(a few noted but not every year)
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grassland continued

	Common Name	Scientific Name	Occurrence
(1)	greater prairie chicken	Tympanuchus cupido	PR - *
(2)	sharp-tailed grouse	Pedioecetes phasianellus	PR - c
(3)	ring-necked pheasant	Phasianus colchicus	PR - r
(4)	gray partridge	Perdix perdix	PR - c
(5)	short-eared owl	Asio flammeus	PR - u
(6)	black-billed magpie	Pica pica	PR - c
(7)	starling	Sturnus vulgaris	PR - c
(8)	house sparrow	Passer domesticus	PR - a
(9)	Swainson's hawk	Buteo swainsoni	SR - o
(10)	ferruginous hawk	Buteo regalis	SR - o
(11)	marsh hawk	Circus cyaneus	SR - c
(12)	sparrow hawk	Falco sparverius	SR - r TV - c
(13)	killdeer	Charadrius vociferus	SR - a
(14)	upland plover	Bartramia longicauda	SR - c
(15)	marbled godwit	Limosa fedoa	SR - c
(16)	mourning dove	Zenaidura macroura	SR - a
(17)	burrowing owl	Spetyto cunicularia	SR - u
(18)	common nighthawk	Chordeiles minor	SR - c
(19)	eastern kingbird	Tyrannus tyrannus	SR - a
(20)	western kingbird	Tyrannus verticalis	SR - a
(21)	Say's phoebe	Sayornis saya	SR - c
(22)	horned lark	Eremophila alpestris	SR - a WV - c
(23)	bank swallow	Riparia riparia	SR - c
(24)	rough-winged swallow	Stelgidopteryz ruficollus	SR - r
(25)	barn swallow	Hirundo rustica	SR - a
(26)	cliff swallow	Petrochelidon pyrrhonota	SR - c
(27)	rock wren	Salpinctes obsoletus	SR - r
(28)	catbird	Dumetella carolinensis	SR - c
(29)	brown thrasher	Toxostoma rufum	SR - c
(30)	Sprague's pipit	Anthus spraugueii	SR - c
(31)	bobolink	Dolichonyx orzivours	SR - c
(32)	western meadowlark	Sturnella neglecta	SR - a
(33)	Brewer's blackbird	Euphagus cyanocephalus	SR - c
(34)	brown-headed cowbird	Molothurs ater	SR - c
(35)	Lazuli bunting	Passerina amoena	SR - r
(36)	dickcissel	Spiza americana	SR - c
(37)	American goldfinch	Spinus tristis	SR - c
(38)	lark bunting	Calamospiza melanocorys	SR - c
(39)	savannah sparrow	Passerculus sandwichensis	SR - a
(40)	grasshopper sparrow	Ammodramus savannarum	SR - u
(41)	Baird's sparrow	Ammodramus bairdii	SR - c
(42)	Le Conte's sparrow	Passerherbulus caudacutus	SR - r
(43)	vesper sparrow	Poecetes grammineus	SR - c
(44)	lark sparrow	Chondestes grammacus	SR - c
(45)	chipping sparrow	Spizella passerina	SR - u
(46)	clay-colored sparrow	Spizella pallida	SR - a

grassland continued

(47)	field sparrow	Spizella pusilla	SR - o	
(48)	song sparrow	Melospiza melodia	SR - c	
(49)	McCown's longspur	Rhynchophanes mccownii	SR - r	
(50)	chestnut-collared longspur	Calcarius ornatus	SR - c	
(51)	rough-legged hawk	Buteo lagopus	WV - r	
(52)	gyrfalcon	Falco rusticolus	WV - c	
(53)	prairie falcon	Falco mexicanus	WV - r	
(54)	snowy owl	Myctea scandiaca	WV - r	
(55)	northern shrike	Lanius excubitor	WV - r	
(56)	hoary redpoll	Acanthis hornemanni	WV - c	
(57)	common redpoll	Acanthis flammea	WV - c	
(58)	lapland longspur	Calcarius lapponicus	WV - c	TV - a
(59)	snow bunting	Plectrophenax nivalis	WV - a	
(60)	Harlan's hawk	Buteo harlani	TV - r	
(61)	broad-winged hawk	Buteo playpterus	TV - o	
(62)	peregrine falcon	Falco peregrinus	TV - r	
(63)	pigeon hawk	Falco columbarius	TV - r	
(64)	sandhill crane	Grus canadensis	TV - a	
(65)	semi-palamated plover	Charadrius semipalmatus	TV - u	
(66)	American golden plover	Pluyialis dominica	TV - u	
(67)	black-bellied plover	Squatarola squatarola	TV - u	
(68)	ruddy turnstone	Arenaria interpres	TV - o	
(69)	common snipe	Capella gallinago	TV - r	
(70)	solitary sandpiper	Tringa solitaria	TV - r	
(71)	greater yellowlegs	Totanus melanoleucus	TV - u	
(72)	lesser yellowlegs	Totanus flavipes	TV - c	
(73)	pectoral sandpiper	Erolia melanotos	TV - c	
(74)	white-rumped sandpiper	Erolia fuscicollis	TV - o	
(75)	Baird's sandpiper	Erolia bairdii	TV - c	
(76)	least sandpiper	Erolia minutilla	TV - a	
(77)	short-billed dowitcher	Limnodromus griseus	TV - o	
(78)	long-billed dowitcher	Limonodromus scolopaceus	TV - a	
(79)	stilt sandpiper	Micropalama himantopus	TV - u	
(80)	semipalamated sandpiper	Ereuntes pusillus	TV - a	
(81)	western sandpiper	Ereunetes mauri	TV - o	
(82)	buff-breasted sandpiper	Tryngites sulbruficollis	TV - o	
(83)	hudsonian godwit	Limosa haemastica	TV - o	
(84)	sanderling	Crocethia alba	TV - o	
(85)	northern phalarope	Lobipies lobatus	TV - a	
(86)	mountain bluebird	Sialia currucoides	TV - u	
(87)	water pipit	Anthus spinoletta	TV - c	
(88)	tree sparrow	Spizella arborea	TV - a	
(89)	white-crowned sparrow	Zonotrichia leucophrys	TV - a	
(90)	Lincoln's sparrow	Melospiza lincolnii	TV - c	
(91)	Smith's longspur	Calcarius pictus	TV - r	
(92)	Townsend's solitaire	Myadestes townsendii	CV	
(93)	scissor-tailed-flycatcher	Muscivora forificata	AV	
(94)	common raven	Corvus corax	AV	

grassland continued

MAMMALIA

	Common Name	Scientific Name	Occurrence
(1)	deer mouse	*Peromyscus maniculatus*	Common
(2)	meadow vole	*Microtus pennsylvanicus*	Common
(3)	western jumping mouse	*Zapus princeps*	Common
(4)	meadow jumping mouse	*Zapus hudsonius*	Common
(5)	Gapper's red-backed mouse	*Clethrionomys gapperi*	Common
(6)	northern grasshopper mouse	*Onychomys leucogaster*	Common
(7)	prairie vole	*Microtus ochrogaster*	Uncommon
(8)	western harvest mouse	*Reithrodonotomys megalotis*	Rare
(9)	olive-backed pocket mouse	*Perognathus fasciatus*	Common
(10)	plains pocket mouse	*Perognathus flavescens*	Rare
(11)	house mouse	*Mus musculus*	Common
(12)	masked shrew	*Sorex cinereus*	Common
(13)	pygmy shrew	*Microsorex hoxi*	Rare
(14)	short-tailed shrew	*Blarina brevicauda*	Uncommon
(15)	northern pocket gopher	*Thomomys talpoides*	Common
(16)	Franklin's ground squirrel	*Citellus franklinii*	Common
(17)	Richardson's ground squirrel	*Citellus richardsonii*	Common
(18)	Thirteen-lined ground squirrel	*Citellus tridecamlineatus*	Common
(19)	porcupine	*Erethizon dorsatum*	Common
(20)	coyote	*Canis latrans*	Common
(21)	red fox	*Vuples vulpes*	Common
(22)	gray fox	*Urocyon cinereoargenteus*	Rare
(23)	raccoon	*Procyon lotor*	Common
(24)	shorttail weasel	*Mustela erminea*	Common
(25)	least weasel	*Mustela rixosa*	Common
(26)	longtail weasel	*Mustela frenata*	Common
(27)	mink	*Mustela vison*	Uncommon
(28)	badger	*Taxidea taxus*	Common
(29)	striped skunk	*Mephitis mephitis*	Common
(30)	Canadian lynx	*Felis canadensis*	Uncommon
(31)	bobcat	*Felis rufus*	Rare
(32)	whitetail deer	*Odocoileus virginianus*	Common
(33)	white-tailed jack rabbit	*Lepus townsendii*	Common

AMPHIBIA

	Common Name	Scientific Name	Occurrence
(1)	great plains toad	Bufo cognatus	Common
(2)	Dakota toad	*Bufo hemiophrys*	Common

grassland continued

(3) leopard frog	*Rana pipiens*	Common

REPTILIA

Common Name	Scientific Name	Occurrence
(1) hognose snake	*Heterodon nasicus*	Common
(2) plains garter snake	*Thamnophis radix*	Common

MARSH BIOTA

FLORA

	Scientific Name		Common Name
(1)	Agropyron repens	(1)	quackgrass
(2)	Alisma gramineum	(2)	narrow-leaved water plantain
(3)	Alisma plantago-aquatica	(3)	broad-leaved water plaintain
(4)	Alisma subcordatum	(4)	manna grass
(5)	Aleopecurus aequalis	(5)	shortawn foxtail grass
(6)	Beckmannia syzigachne	(6)	sloughgrass
(7)	Calamagrostis canadensis	(7)	bluejoint grass
(8)	Calamagrostis inexpansa	(8)	northern reedgrass
(9)	Calamagrostis neglecta	(9)	reedgrass
(10)	Carex atherodes	(10)	slough sedge
(11)	Carex laeviconica	(11)	sedge
(12)	Carex lanuginosa	(12)	sedge
(13)	Carex praegracilis	(13)	sedge
(14)	Carex spp.	(14)	sedge
(15)	Ceratophyllum demersum	(15)	hornwort (coontail)
(16)	Cirsium arvense	(16)	Canada thistle
(17)	Deschampsia caepitosa	(17)	tufted hairgrass
(18)	Eleocharis acicularis	(18)	spike-rush
(19)	Eleocharis compressa	(19)	spike-rush
(20)	Eleocharis palustris	(20)	spike-rush
(21)	Eleocharis spp.	(21)	spike-rush
(22)	Glyceria grandis	(22)	tall mannagrass
(23)	Juncus balticus	(23)	Baltic rush
(24)	Lemna minor	(24)	common duckweed
(25)	Lemna trisulca	(25)	star duckweed
(26)	Mentha arvensis	(26)	wild mint
(27)	Myriophyllum exalbescens	(27)	water milfoil
(28)	Phalaris arundinacea	(28)	reed-canary grass
(29)	Phragmites australis (communis)	(29)	common reed grass
(30)	Polygonum amphibium	(30)	smartweed
(31)	Polygonum coccineum	(31)	long-rooted smartweed
(32)	Potamogeton pectinatus	(32)	sago pondweed
(33)	Puccinellia nuttalliana	(33)	alkali grass
(34)	Ranunculus gmelini	(34)	yellow water crowfoot
(35)	Ranunculus spp.	(35)	crowfoot
(36)	Ricciocarpus natans	(36)	liverwort
(37)	Rumex crispus	(37)	curled dock
(38)	Rumex occidentalis	(38)	western dock
(39)	Sagittaria cuneata	(39)	arrowhead
(40)	Scirpus acutus	(40)	hardstem bulrush
(41)	Scirpus americanus	(41)	three-square bulrush
(42)	Scirpus atrovirens	(42)	darkgreen bulrush
(43)	Scirpus fluviatilis	(43)	river bulrush
(44)	Scirpus heterochaetus	(44)	slender bulrush
(45)	Scirpus nevadensis	(45)	bulrush

marsh continued

(46)	Scirpus validus	(46)	softstem bulrush
(47)	Scolochloa festucacea	(47)	whitetop grass
(48)	Sparganium eurycarpum	(48)	burreed
(49)	Sparganium multipedunculatum	(49)	burreed
(50)	Spirodela polyrhiza	(50)	duckweed
(51)	Stachys palustris	(51)	hedge nettle
(52)	Triglochin maritima	(52)	arrowgrass
(53)	Triglochin palustris	(53)	arrowgrass
(54)	Typha angustifolia	(54)	cattail
(55)	Typha glauca	(55)	cattail (hybrid)
(56)	Typha latifolia	(56)	common cattail
(57)	Utricularia vulgaris	(57)	common bladderwort

BIRDS

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	Common Name	Scientific Name	Occurrence
(1)	short-eared owl	Asio flammeus	PR - u
(2)	starling	Sturnus vulgaris	PR - c
(3)	red-necked grebe	Podiceps grisegena	SR - r
(4)	horned grebe	Podiceps auritus	SR - u
(5)	eared grebe	Podiceps caspicus	SR - c
(6)	western grebe	Aechmophorus occidentalis	SR - c
(7)	pied-billed grebe	Podilymbus podiceps	SR - c
(8)	double-breasted cormorant	Phalacrocorax auritus	SR - u
(9)	great blue heron	Ardea herodias	SR - c
(10)	black-crowned night heron	Nycticorax nycticorax	SR - c
(11)	American bittern	Botaurus lentiginosus	SR - c
(12)	mallard	Anas platyrhynchos	SR - a
(13)	black duck	Anas rubripes	SR - c
(14)	gadwall	Anas strepera	SR - a
(15)	pintail	Anas acuta	SR - a
(16)	green-winged teal	Anas carolinensis	SR - u
(17)	blue-winged teal	Anas discors	SR - a
(18)	American widgeon	Mareca americana	SR - c
(19)	shoveler	Spatula clypeata	SR - c

marsh continued

(20)	redhead	Aythya americana	SR - c	
(21)	ring-necked duck	Aythya collaris	SR - r	
(22)	canvasback	Aythya valisineria	SR - u	
(23)	lesser scaup	Aythya affinis	SR - u	TV - a
(24)	white-winged scoter	Melanitta deglandi	SR - c	
(25)	ruddy duck	Oxyura jamaicensis	SR - c	
(26)	marsh hawk	Circus cyaneus	SR - c	
(27)	Virginia rail	Rallus limicola	SR - u	
(28)	sora	Porzana carolina	SR - c	
(29)	American coot	Fulica americana	SR - c	
(30)	spotted sandpiper	Actitis macularia	SR - c	
(31)	willet	Catoptrophorus semipalmatus	SR - c	
(32)	American avocet	Recurvirostra americana	SR - u	
(33)	Wilson's phalarope	Steganopus tricolor	SR - c	
(34)	Forster's tern	Sterna forsteri	SR - u	
(35)	black tern	Childonias niger	SR - a	
(36)	tree swallow	Iridoprocne bicolor	SR - u	
(37)	bank swallow	Riparia riparia	SR - c	
(38)	rough-winged swallow	Stelgidopteryx ruficollus	SR - r	
(39)	long-billed marsh wren	Telmatodytes palustris	SR - c	
(40)	short-billed marsh wren	Cistothorus platensis	SR - u	
(41)	yellowthroat	Geothlypis trichas	SR - c	
(42)	bobolink	Dolichonyx oryzivours	SR - c	
(43)	yellow-headed blackbird	Xanthocephalus xanthocephalus	SR - c	
(44)	red-winged blackbird	Agelaius phoeniceus	SR - a	
(45)	Brewer's blackbird	Euphagus cyanocephalus	SR - c	
(46)	common grackle	Quiscalus quiscula	SR - a	
(47)	Le Conte's sparrow	Passerherbulus caudacutus	SR - r	
(48)	sharp-tailed sparrow	Ammospiza caudacuta	SR - c	
(49)	white pelican	Pelecanus erythrorhynchos	SV - a	
(50)	Franklin's gull	Larus pipixcan	SV - a	
(51)	whistling swan	Olor columbianus	TV - c	
(52)	Canada goose	Branta canadensis	TV - c	
(53)	white-fronted goose	Anser albifrons	TV - c	
(54)	snow goose	Chen hyperborea	TV - r	
(55)	blue goose	Chen caerulescens	TV - r	
(56)	bald eagle	Haliaeetus leucocephalus	TV - r	
(57)	osprey	Pandion haliaetus	TV - o	
(58)	pigeon hawk	Falco columbarius	TV - r	
(59)	whooping crane	Grus americana	TV - o	
(60)	sandhill crane	Grus canadensis	TV - a	
(61)	semi-palmated plover	Charadrius semipalmatus	TV - u	
(62)	American golden plover	Pluvialis dominica	TV - u	
(63)	black-bellied plover	Squatarola squatarola	TV - u	
(64)	ruddy turnstone	Arenaria interpres	TV - o	
(65)	common snipe	Capella gallinago	TV - r	
(66)	solitary sandpiper	Tringa solitaria	TV - r	
(67)	greater yellowlegs	Totanus melanoleucus	TV - u	

marsh continued

(68)	lesser yellowlegs	Totanus flavipes	TV - c
(69)	pectoral sandpiper	Erolia melanotos	TV - c
(70)	white-rumped sandpiper	Erolia fuscicollis	TV - o
(71)	Baird's sandpiper	Erolia bairdii	TV - c
(72)	least sandpiper	Erolia minutilla	TV - a
(73)	short-billed dowitcher	Limnodromus griseus	TV - o
(74)	long-billed dowitcher	Limnodromus scolopaceus	TV - a
(75)	stilt sandpiper	Micropalama himantopus	TV - u
(76)	semipalmated sandpiper	Ereuntes pusillus	TV - a
(77)	western sandpiper	Ereunetes mauri	TV - o
(78)	buff-breasted sandpiper	Tryngites sulbruficollis	TV - o
(79)	hudsonian godwit	Limosa haemastica	TV - o
(80)	sanderling	Crocethia alba	TV - o
(81)	northern phalarope	Lobipies lobatus	TV - a
(82)	swamp sparrow	Melospiza georgiana	TV - r
(83)	little blue heron	Florida caerulea	AV
(84)	common egret	Casmerodius albus	AV
(85)	snowy egret	Leucophoyx thula	AV
(86)	European widgeon	Mareca penelope	AV
(87)	cinnamon teal	Anas cyanoptera	AV

MAMMALS

	Common Name	Scientific Name	Occurrence
(1)	western jumping mouse	Zapus princeps	Common
(2)	meadow jumping mouse	Zapus hudsonius	Common
(3)	artic shrew	Sorex articus	Rare
(4)	porcupine	Erethizon dorsatum	Rare
(5)	muskrat	Ondatra zibethicus	Common
(6)	raccoon	Procyon lotor	Common
(7)	shorttail weasel	Mustela erminea	Common
(8)	longtail weasel	Mustela frenata	Common
(9)	mink	Mustela vison	Common
(10)	striped skunk	Mephitis mephitis	Common
(11)	whitetail deer	Odocoileus virginianus	Common
(12)	white-tailed jack rabbit	Lepus townsendi	Common

AMPHIBIA

	Common Name	Scientific Name	Occurrence
(1)	boreal chorus frog	Pseudacris triseriata	Common
(2)	leopard frog	Rana pipiens	Common
(3)	tiger salamander	Ambystoma tigrinum	Common

marsh continued

REPTILIA

	Common Name	Scientific Name	Occurrence
(1)	garter snake	*Thamnophis sp.*	Common
(2)	snapping turtle	*Chelydra serpentina*	Common
(3)	painted turtle	*Chrysemys picta*	Common

OPEN BIOTA

FLORA

	Scientific Name		Common Name
(1)	Ceratophyllum demersum	(1)	hornwort (coontail)
(2)	Callitriche hermaphroditica	(2)	marsh starwort
(3)	Chara spp.	(3)	muskgrass (algae)
(4)	Myriophyllum spicatum var. exalbescens	(4)	water milfoil
(5)	Potamogeton pectinatus	(5)	sago pondweed
(6)	Potamogeton richardsonii	(6)	pondweed
(7)	Utricularis vulgaris	(7)	common bladderwort

BIRDS

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	Common Name	Scientific Name	Occurrence
(1)	western grebe	Aechmophorus occidentalis	SR - c
(2)	double-crested cormorant	Phalacrocorax auritus	SR - u
(3)	lesser scaup	Aythya affinis	SR - u TV - a
(4)	hooded merganser	Mercus merganser	SR - o
(5)	piping plover	Charadrius melodus	SR - r
(6)	killdeer	Charadrius vociferus	SR - c
(7)	spotted sandpiper	Actitis macularia	SR - c
(8)	Forster's tern	Sterna forsteri	SR - u
(9)	common tern	Sterna hirundo	SR - u
(10)	belted kingfisher	Megaceryle alcyon	SR - u
(11)	bobolink	Dolichonyx cryzivours	SR - c
(12)	white pelican	Pelecanus erythrorhynchos	SV - a
(13)	ring-billed gull	Larus delawarensis	SV - c
(14)	common loon	Gavia immer	TV - o
(15)	whistling swan	Olor columbianus	TV - c
(16)	Canada goose	Branta canadensis	TV - c
(17)	white-fronted goose	Anser albifrons	TV - c
(18)	snow goose	Chen hyperborea	TV - r
(19)	blue goose	Chen caerulescens	TV - r

open continued

(20)	common goldeneye	Bucephala clangula	TV - u
(21)	bufflehead	Bucephala albeola	TV - r
(22)	common merganser	Mergus merganser	TV - c
(23)	red-breasted merganser	Mergus serrator	TV - u
(24)	bald eagle	Haliaeetus leucocephalus	TV - r
(25)	osprey	Pandion haleaetus	TV - o
(26)	whooping crane	Grus americana	TV - o
(27)	sandhill crane	Grus canadensis	TV - a
(28)	semi-palmated plover	Charadrius semipalmatus	TV - u
(29)	American golden plover	Pluvialis dominica	TV - u
(30)	black-bellied plover	Squatarola squatarola	TV - u
(31)	ruddy turnstone	Arenaria interpres	TV - o
(32)	common snipe	Capella gallinago	TV - r
(33)	solitary sandpiper	Tringa solitaria	TV - r
(34)	greater yellowlegs	Totanus melanoleucus	TV - u
(35)	lesser yellowlegs	Totanus flavipes	TV - c
(36)	pectoral sandpiper	Erolia melanotos	TV - c
(37)	white-rumped sandpiper	Erolia fusciocollis	TV - o
(38)	Baird's sandpiper	Erolia bairdii	TV - c
(39)	least sandpiper	Erolia minutilla	TV - a
(40)	short-billed dowitcher	Limnodromus griseus	TV - o
(41)	long-billed dowitcher	Limnodromus scolopaceus	TV - a
(42)	stilt sandpiper	Micropalama himantopus	TV - u
(43)	semipalmated sandpiper	Ereuntes pusillus	TV - a
(44)	western sandpiper	Ereuntes mauri	TV - o
(45)	buff-breasted sandpiper	Tryngites sulbruficollis	TV - c
(46)	hudsonian godwit	Limosa haemastica	TV - o
(47)	sanderling	Crocethia alba	TV - o
(48)	northern phalarope	Lobipies lobatus	TV - a
(49)	herring gull	Larus argentatus	TV - o
(50)	California gull	Larus californicus	TV - o
(51)	Bonaparte's gull	Larus philadelphia	TV - o
(52)	little blue heron	Florida caerulea	AV
(53)	common egret	Casmerodius albus	AV
(54)	snowy egret	Leucophoyx thula	AV
(55)	European widgeon	Mareca penelope	AV
(56)	harlequin duck	Histrionicus histrionicus	AV

MAMMALIA

	Common Name	Scientific Name	Occurrence
(1)	beaver	Castor canadensis	Common
(2)	muskrat	Ondatra zibethicus	Common
(3)	mink	Mustela vison	Common

open continued

	Common Name	Scientific Name	Occurrence
(1)	leopard frog	Rana pipiens	Common

FISHES

	Scientific Name	Common Name	Abundance
Family Esocidae			
(1)	Esox lucius	northern pike	Very common
Family Cyprinidae			
(2)	Rhinichthys atratulus	blacknose dace	
(3)	R. cataractae	longnose dace	
(4)	Chrosomus eos	northern redbelly dace	Common
(5)	Semotilus atromaculatus	creek chub	Common
(6)	S. margarita	northern dace	Common
(7)	Notropis hudsonius	spottail minnow	Uncommon
(8)	Notropis cornutus	common shiner	Common
(9)	Pimephales natatus	bluntnose minnow	
(10)	Pimephales promelas	fathead minnow	Very Common
(11)	Hybopsis biguttata	hornyhead chub	
(12)	H. gracilis	plains flathead chub	
(13)	Notropis atherinoides	emerald shiner	
(14)	N. dorsalis	bigmouth shiner	
Family Catostomidae			
(15)	Catostomus commersoni	white sucker	Very Common
(16)	Catostomus catostomus	northern sucker	Common
(17)	Carpoides carpio	river carpsucker	Uncommon
Family Ictaluridae			
(18)	Ictalurus melas	black bullhead	Very Common
(19)	I. nebulosus	brown bullhead	Very Common
Family Percopsidae			
(20)	Percopsis omiscomaycus	trout perch	Uncommon
Family Percidae			
(21)	Perca flavescens	yellow perch	Very Common
(22)	Stizostedion vitreum	walleye	Very Common
(23)	Hadropterus maculatus	blacksided darter	Common
(24)	Etheostoma nigrium	johnny darter	Common
Family Gasterosteidae			
(25)	Culaea inconstans	5-spined stickleback	Common

open continued

Family Centrarchidae

(26)	Pomoxxs annularis	white crappie	Uncommon
(27)	P. nigromaculatus	black crappie	Uncommon
(28)	Micropterus dolomieui	small mouth bass	Uncommon

open continued

Phytoplankton Survey

June 1969

	River Mile	Total no/ ml	Predominate Genera
Canada	358.2		
	353.5	1,287	Scenedesmus
	326.7	3,324	Trachelomonas
Lake Darling	305.8	2,508	Ankistrodesmus
	278.4	792	Melosira
	243.5	1,056	Ankistrodesmus
Minot	228.9	2,904	Ankistrodesmus
	222.1	5,442	Ankistrodesmus
	185.6	27,984	Scenedesmus
	161.0	29,568	Scenedesmus
	101.9	18,606	Scenedesmus
	98.7	14,586	Scenedesmus
Upham	73.4	7,062	Scenedesmus
	16.7	2,740	Crucigenica
	7.9	4,422	Ankistrodesmus
Canada	0.0		

open continued

October 1969

	River Mile	Total no/ml	Predominate Genera
Canada	358.2		
	353.3	1,024	Chlamydomonas
	326.7	4,752	Scenedesmus
	305.8	9,174	Aphanizomenon
Lake Darling	278.4	8,182	Aphanizomenon
	243.5	2,706	Ankistrodesmus
Minot	228.9	3,696	Ankistrodesmus
	222.1	5,280	Scenedesmus
	185.6	7,524	Scenedesmus
	161.0	3,564	Oocystis
	101.9	3,686	Scenedesmus
	98.7	4,538	Scenedesmus
Upham	73.4	2,640	Oocystis
	16.7	11,552	Scenedesmus
	7.9	20,856	Scenedesmus
Canada	0.0		

BOTTOM INVERTEBRATES, Souris River, October 1969.

(number per square foot) P = Present

River Mile	358.2 Canada	326.7	305.8 Lake Darling	278.4	267.4	228.9 Minot	185.6	108.0	101.5 Towner	80.1 J. Clark 62.9 Salyer Refuge	42.4	21.6	7.9 Canada 1.1	0.0
Organism														
						Sensitive Organisms								
COLEOPTERA														
Simsonia	-	-	-	-	-	-	-	-	-	4	-	-	-	-
Stenelmis	-	-	-	-	-	-	-	-	-	P	-	-	-	-
EPHEMEROPTERA														
Baetis	P	-	-	-	P	-	-	-	-	-	-	-	-	-
Caenis	-	-	-	-	16	-	P	-	16	-	-	-	-	128
Heptagenia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexagenia	-	-	-	-	-	-	-	-	64	-	-	-	-	-
Stanonema	P	-	-	-	-	-	P	P	P	P	-	-	P	-
PLELOPTERA														
Parlesta	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRICOPTERA														
Athripsodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche	P	-	-	-	-	-	-	P	P	P	-	-	P	P
Hydropsyche	-	-	-	-	-	-	-	P	-	-	-	-	-	-
Limnephilus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molanna	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neophlax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neureclipsis	-	-	-	-	P	-	-	-	P	-	-	-	P	-
Oecetis	-	-	-	-	4	-	-	-	-	-	-	-	-	-
Polycentropus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL	3	0	0	0	22	0	2	3	83	7	0	0	3	129
SUBTOTAL KINDS	3	0	0	0	4	0	2	3	5	4	0	0	3	2

Organism														
							Intermediate Organisms							
COLEOPTERA														
Dineutus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dytiscus	-	-	-	-	-	-	-	8	-	-	-	-	-	-
Gyrinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Halipus	-	-	-	-	-	-	-	-	32	-	-	-	-	-
Hydaticus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrocanthus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroporus	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Hydrophilus	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Laccodytes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peltodytes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRUSTACEA														
Gammarus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyalella azteca	P	4	-	-	4	-	-	P	48	P	-	-	P	80
Orconectes virilia	-	-	-	-	-	-	-	-	P	-	-	-	-	-
DIPTERA														
Chaborus	-	64	-	-	-	-	-	-	-	-	-	-	-	-
Chironomus	-	-	16	64	32	-	-	8	-	-	-	P	-	16
(Cryptochironosus)														
C. (Dictotendipes)	-	-	-	-	P	-	-	-	-	P	-	-	P	-
C. (Endochironomus)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus	-	-	-	-	P	-	-	-	-	-	-	-	-	-
Crytotendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dasyhelea	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glyptotendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harnischia	-	-	-	16	-	-	-	-	-	-	-	-	-	-
Palypomyia tibialis	-	16	176	64	16	16	-	-	32	-	-	-	-	-
Polypendilum	-	-	48	16	-	-	-	-	-	-	-	-	-	400
Procladius	-	-	144	32	48	96	-	88	40	-	-	-	-	160
Probezzia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psectrocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudochironomus	-	-	-	96	-	-	-	-	-	-	-	-	-	-
Simulium	-	-	-	-	-	-	-	P	P	P	-	-	-	-

River Mile	Canada 358.2	326.7	Lake Darling 305.8	278.4	267.4	Minot 228.9	185.6	108.0	Towner 101.5	Clark Sayler Refuge 80.1 62.9	42.4	Canada 21.6 7.9	1.1	0.0
Organism														
					Intermediate Organisms, cont.									
Tanytarsus	-	-	-	-	-	-	-	-	-	P	-	-	-	-
Tanypus	-	56	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA														
Aplexa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ferrissia	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Fossaris	-	-	-	-	-	-	-	4	208	1584	-	-	-	-
Gyroaulus	-	-	-	-	352	-	-	-	-	192	-	-	P	P
Helisoma	-	-	-	16	-	-	-	-	-	-	-	-	-	-
Lioplax	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lymnaea	-	-	-	-	P	-	-	-	-	-	-	-	-	P
Lyogyrus	P	-	-	-	-	-	-	-	-	-	-	-	-	-
Paludestrina	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Promenetus	-	-	-	-	-	-	-	-	-	16	-	-	-	-
Pseudosuccinea	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Valvata	-	-	-	16	2240	352	-	-	-	720	-	4	-	16
HEMIPTERA														
Corixidae	-	-	-	-	P	-	-	P	-	-	-	16	-	-
ODONATA														
Argia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enallagma	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hetaerina	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ischnura	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PELYCYPODA														
Alasmidonata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amblema	-	-	-	-	-	-	-	-	288	16	-	-	-	-
Eupera	-	-	496	-	-	-	-	-	-	-	-	-	-	-
Lampsilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Musculium	P	432	48	-	64	172	-	-	80	32	-	-	-	16

Organism														
					Intermediate Organisms, cont.									
Pisidium	-	-	544	362	336	16	-	16	-	32	-	-	-	-
Sphaerium	-	-	160	80	96	64	-	P	148	48	-	-	-	-
SUBTOTAL	3	572	1632	762	3189	716	1	128	879	2644	0	26	3	691
SUBTOTAL KINDS	3	5	8	10	13	6	1	9	11	12	0	5	3	9
						Tolerant Organisms								
DIPTERA														
Chironomus	-	80	544	48	32	16	P	-	-	-	-	-	-	-
C. (Einfeldia)	-	-	-	16	-	-	-	-	-	-	-	P	-	P
Culicidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODA														
Physa	-	-	-	-	16	-	P	-	-	-	656	-	8	P
HIRUNDINEA	-	4	-	16	-	-	-	4	P	-	-	-	-	P
OLIGOCHAETA														
Lumbriculidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tubificidae	-	8	1248	192	608	80	-	900	244	176	-	12	-	1264
SUBTOTAL	0	92	1792	272	656	96	2	904	245	832	0	21	1	1267
SUBTOTAL KINDS	0	3	2	4	3	2	2	2	2	1	1	2	1	4
GRAND TOTAL/SQ. FT.	6	664	3424	1034	3867	812	5	1035	1207	3483	0	47	7	2087
NUMBER OF KINDS	6	8	10	14	20	8	5	14	18	18	0	8	7	15

FLOODPLAIN FOREST BIOTA

FLORA

	Scientific Name		Common Name
(1)	*Acer negundo*	(1)	box elder
(2)	*Ambrosia trifida*	(2)	ragweed
(3)	*Anemone canadensis*	(3)	Canada anemone
(4)	*Aralia nudicaulis*	(4)	wild sarsparilla
(5)	*Arctium minus*	(5)	burdock
(6)	*Artemesia frigida*	(6)	fringed sagewort
(7)	*Bromus inermis*	(7)	smooth brome
(8)	*Carex sprengelii*	(8)	sedge
(9)	*Cornus stolonifera*	(9)	red osier dogwood
(10)	*Crataegus rotundifolia*	(10)	hawthorne
(11)	*Echinocystis lobata*	(11)	wild cucumber
(12)	*Elymus virginicus*	(12)	Virginia wild-rye
(13)	*Fraxinus pennsylvanicus*	(13)	green ash
(14)	*Galium boreale*	(14)	northern bedstraw
(15)	*Galium triflorum*	(15)	sweet-scented bedstraw
(16)	*Humulus americanus*	(16)	hops
(17)	*Laportea canadensis*	(17)	wood nettle
(18)	*Lathyrus ochroleucus*	(18)	pea vine
(19)	*Lythrum alatum*	(19)	loosestrife
(20)	*Lysimachia ciliata*	(20)	fringed loosestrife
(21)	*Poa palustris*	(21)	fowl bluegrass
(22)	*Poa pratense*	(22)	Kentucky bluegrass
(23)	*Prunus virginiana*	(23)	chokecherry
(24)	*Quercus macrocarpa*	(24)	bur oak
(25)	*Ranunculus macounii*	(25)	Macoun's buttercup
(26)	*Ribes americanum*	(26)	gooseberry
(27)	*Ribes missouriensis*	(27)	gooseberry
(28)	*Ribes sitosa*	(28)	gooseberry
(29)	*Rosa arkansana*	(29)	prairie rose
(30)	*Rosa woodsii*	(30)	common wild rose
(31)	*Scutellaria lateriflora*	(31)	skullcap
(32)	*Smilax herbacea*	(32)	carrion flower
(33)	*Smilecina stellata*	(33)	star-flowered Solomon's-seal
(34)	*Sonchus arvensis*	(34)	sow thistle
(35)	*Stachys palustris*	(35)	hedge nettle
(36)	*Symphoricarpos occidentalis*	(36)	wolfberry
(37)	*Thalictrum sp.*	(37)	meadow rue
(38)	*Ulmus americana*	(38)	American elm
(39)	*Urtica procera*	(39)	nettles
(40)	*Vicia americana*	(40)	wild vetch
(41)	*Viola spp.*	(41)	violets

floodplain forest continued

BIRDS

KEY:

PR Permanent Resident (present during all seasons; breeds in summer)
SR Summer Resident (present during summer; breeds)
WV Winter Visitor (present for indefinite periods during winter)
SV Summer Visitor (present for indefinite periods during summer; does not breed)
TV Transient Visitor (spring and/or fall migrant)
CV Casual Visitor (a few noted but not every year)
AV Accidental Visitor (one, or at most, very few records)

a - abundant (occurs in large numbers)
c - common (occurs regularly in moderate numbers)
u - uncommon (occurs regularly in small numbers)
r - rare (a few noted every year)
o - occasional (a few noted, but not every year)
* - Last observed in 1956

	Common Name	Scientific Name	Occurrence	
(1)	ring-necked pheasant	Phasianus colchicus	PR - r	
(2)	screech owl	Otus asio	PR - r	
(3)	great horned owl	Bubo virginianus	PR - u	
(4)	hairy woodpecker	Dendrocopos villosus	PR - u	
(5)	downy woodpecker	Dendrocopos pubescens	PR - c	
(6)	black-billed magpie	Pica pica	PR - c	
(7)	black-capped chickadee	Parus atricapillus	PR - c	
(8)	white-breasted nuthatch	Sitta carolinensis	PR - r	
(9)	starling	Sturnus vulgaris	PR - c	
(10)	house sparrow	Passer domesticus	PR - a	
(11)	double-crested cormorant	Phalacrocorax auritus	SR - u	
(12)	great blue heron	Ardeo herodias	SR - r	
(13)	black-crowned night heron	Nycticorax nycticorax	SR - c	
(14)	hooded merganser	Mergus merganser	SR - o	
(15)	sharp shinned hawk	Accipiter striatus	SR - r	
(16)	Cooper's hawk	Accipter cooperii	SR - r	
(17)	red-tailed hawk	Buteo jamaicensis	SR - u	
(18)	Swainson's hawk	Buteo swainsoni	SR - o	
(19)	sparrow hawk	Falco sparverius	SR - r	TV - c
(20)	mourning dove	Zenaidura macroura	SR - c	
(21)	yellow-billed cuckoo	Coccyzus americanus	SR - o	
(22)	black-billed cuckoo	Coccyzus erythrophthalmus	SR - u	
(23)	long-eared owl	Asio otus	SR - r	
(24)	ruby-throated hummingbird	Archilochus colubris	SR - r	
(25)	yellow-shafted flicker	Colaptes auratus	SR - c	
(26)	red-shafted flicker	Colaptes cafer	SR - r	
(27)	eastern kingbird	Tyrannus tyrannus	SR - a	
(28)	western kingbird	Tyrannus verticalis	SR - a	
(29)	great crested flycatcher	Myiarchus crinitus	SR - r	
(30)	eastern phoebe	Sayornis phoebe	SR - r	
(31)	Traill's flycatcher	Empidonax traillii	SR - c	
(32)	least flycatcher	Empidonax minimus	SR - c	
(33)	eastern wood pewee	Contopus virens	SR - r	

floodplain forest continued

(34)	tree swallow	Iridoprocne bicolor	SR - u	
(35)	bank swallow	Riparia riparia	SR - c	
(36)	rough-winged swallow	Stelgidopteryx ruficollus	SR - r	
(37)	barn swallow	Hirundo rustica	SR - a	
(38)	cliff swallow	Petrochelidon pyrrhonota	SR - c	
(39)	purple martin	Progne subis	SR - c	
(40)	blue jay	Cyancocitta cristata	SR - r	
(41)	common crow	Corvus brachyrhynchos	SR - c	TV - a
(42)	house wren	Troglodytes aedon	SR - a	
(43)	catbird	Dumetella carolinensis	SR - c	
(44)	brown thrasher	Toxostoma rufum	SR - c	
(45)	robin	Turdus migratorius	SR - c	
(46)	veery	Hylocichla fiscescens	SR - c	
(47)	eastern bluebird	Sialia sialia	SR - r	
(48)	cedar waxwing	Bombycilla cedrorum	SR - c	
(49)	loggerhead shrike	Lanius ludovicianus	SR - u	
(50)	red-eyed vireo	Vireo olivaceus	SR - c	
(51)	warbling vireo	Vireo gilvus	SR - c	
(52)	black-and-white warbler	Mniotilta varia	SR - r	
(53)	yellow warbler	Dondrocia petechia	SR - c	
(54)	yellowthroat	Geothlypis trichas	SR - c	
(55)	yellow-breasted chat	Icteria virens	SR - u	
(56)	American redstart	Setophaga ruticilla	SR - u	
(57)	redwinged blackbird	Agelaius phoeniceus	SR - a	
(58)	orchard oriole	Icterus spurius	SR - r	
(59)	Baltimore oriole	Icterus galbula	SR - c	
(60)	common gackle	Quiscalus auiscula	SR - a	
(61)	rose-breasted grosbeak	Pheucticus ludovicianus	SR - r	
(62)	black-headed grosbeak	Pheucticus melancephalus	SR - o	
(63)	lazuli bunting	Passerina amoena	SR - r	
(64)	pine siskin	Spinus pinus	SR - o	TV - c
(65)	American goldfinch	Spinus tristis	SR - c	
(66)	rufous-sided towhee	Pipile erythrophthalmus	SR - u	
(67)	chipping sparrow	Spizella passerina	SR - u	
(68)	song sparrow	Melospiza melodia	SR - c	
(69)	golden eagle	Aquila chrysaetos	WV - r	
(70)	boreal owl	Aegolius funereus	WV - o	
(71)	saw-whet owl	Aegolius acadicus	WV - o	
(72)	Bohemian waxwing	Bombycilla garrula	WV - c	
(73)	northern shrike	Lanius excubitor	WV - r	
(74)	pine grosbeak	Pinicola enucleator	WV - o	
(75)	hoary redpoll	Acanthis hornemanni	WV - o	
(76)	common redpoll	Acanthis flammea	WV - c	
(77)	wood duck	Aix sponsa	SR - u	
(78)	hooded merganser	Lophodytes cucullatus	SR - u	
(79)	common merganser	Mergus merganser	TV - c	
(80)	Harlan's hawk	Buteo harlani	TV - r	
(81)	broad-winged hawk	Buteo platypterus	TV - o	

floodplain forest continued

(82)	pigeon hawk	Falco columbarius	TV - r
(83)	yellow-bellied sapsucker	Sphyrapicus varius	TV - r
(84)	yellow-bellied flycatcher	Empidonax flaviventris	TV - o
(85)	olive-sided flycatcher	Nuttallornix borealis	TV - r
(86)	red-breasted nuthatch	Sitta canadensis	TV - u
(87)	brown creeper	Certhia familiaris	TV - u
(88)	winter wren	Troglodytes troglodytes	TV - o
(89)	hermit thrush	Hylocichla guttata	TV - r
(90)	Swainson's thrush	Hyocichla ustulata	TV - c
(91)	gray-cheeked thrush	Hylocichla minima	TV - c
(92)	mountain bluebird	Sialia currucoides	TV - u
(93)	golden-crowned kinglet	Regulus satrapa	TV - u
(94)	ruby-crowned kinglet	Regulus calendula	TV - u
(95)	yellow-throated vireo	Vireo flavifrons	TV - r
(96)	solitary vireo	Vireo solitarius	TV - r
(97)	Philadelphia vireo	Vireo philadelphicus	TV - r
(98)	Tennessee warbler	Vermivora peregrina	TV - c
(99)	orange-crowned warbler	Vermivora celata	TV - c
(100)	magnolia warbler	Dendroica magnolia	TV - r
(101)	Cape May warbler	Dendroica trigrina	TV - o
(102)	myrtle warbler	Dendroica coronata	TV - c
(103)	black-throated green warbler	Dendroica virens	TV - o
(104)	blackburnian warbler	Dendroica fusca	TV - o
(105)	chestnut-sided warbler	Dendroica pennsylvanica	TV - o
(106)	bay-breasted warbler	Dendroica castanea	TV - o
(107)	blackpoll warbler	Dendroica striata	TV - c
(108)	palm warbler	Dendroica palmarum	TV - r
(109)	ovenbird	Seiurus aurocapillus	TV - u
(110)	northern waterthrush	Seiurus noveboracensis	TV - u
(111)	Connecticut warbler	Oporornis agilis	TV - o
(112)	mourning warbler	Oporornis philadelphia	TV - u
(113)	MacGillivary's warbler	Oporornis tolmiei	TV - r
(114)	Wilson's warbler	Wilsonia pusilla	TV - c
(115)	Canada warbler	Wilsonia canadensis	TV - r
(116)	rusty blackbird	Euphagus carolinus	TV - r
(117)	purple finch	Carpodacus purpureus	TV - r
(118)	slate-colored junco	Junco hyemalis	TV - a
(119)	Oregon junco	Junco oreganus	TV - o
(120)	tree sparrow	Spizella arborea	TV - a
(121)	Harris's sparrow	Zonotrichia querula	TV - a
(122)	white-crowned sparrow	Zonotrichia leucophrys	TV - a
(123)	white-throated sparrow	Zonotrichia albicollis	TV - a
(124)	fox sparrow	Passerella iliaca	TV - r
(125)	Lincoln's sparrow	Melospiza lincolnii	TV - c
(126)	mockingbird	Mimus polyglottos	CV
(127)	Townsend's solitaire	Myadestes townsendii	CV

floodplain forest continued

(128)	evening grosbeak	Hesperiphona vespertina	CV
(129)	red crossbill	Loxia curvirostra	CV
(130)	white-winged crossbill	Loxia leucoptera	CV
(131)	wood duck	Aix sponsa	AV
(132)	turkey vulture	Cathartes aura	AV
(133)	goshawk	Accipiter gentilis	AV
(134)	red-shouldered hawk	Buteo lineatus	AV
(135)	whippoorwill	Caprimulgus vociferus	AV
(136)	common raven	Carvus corax	AV
(137)	indigo bunting	Passerina cyanea	AV
(138)	lesser goldfinch	Spinus psaltria	AV

MAMMALIA

	Common Name	Scientific Name	Occurrence
(1)	deer mouse	Peromyscus maniculatus	Common
(2)	white-footed mouse	Peromyscus leucopus	Uncommon
(3)	western jumping mouse	Zapus princeps	Common
(4)	meadow jumping mouse	Zapus hudsonius	Common
(5)	Gapper's red-backed mouse	Clethrionomys gapperi	Common
(6)	house mouse	Mus musculus	Common
(7)	masked shrew	Sorex cinereus	Common
(8)	pygmy shrew	Microsorex hoxi	Rare
(9)	fox squirrel	Sciuras niger	Common
(10)	gray squirrel	Sciuras carolinesis	Rare
(11)	red squirrel	Tamiasciurus hudsonicus	Common
(12)	porcupine	Erethizon dorsatum	Common
(13)	beaver	Castor canadensis	Common
(14)	coyote	Canis latrans	Common
(15)	red fox	Vuples vulpes	Common
(16)	gray fox	Urocyon cinereoargenteus	Rare
(17)	raccoon	Procyon lotor	Common
(18)	shorttail weasel	Mustela erminea	Common
(19)	least weasel	Mustela rixosa	Common
(20)	longtail weasel	Mustela frenata	Common
(21)	mink	Mustela vison	Uncommon
(22)	striped skunk	Mephitis mephitis	Common
(23)	bobcat	Felis rufus	Rare
(24)	Canadian lynx	Felis canadensis	Rare
(25)	whitetail deer	Odocoileus virginianus	Common
(26)	moose	Alces alces	Rare
(27)	eastern cottontail	Sylvilagus floridanus	Common
(28)	snowshoe rabbit	Lepus americanus	Uncommon
(29)	little brown bat	Myotis lucifugus	
(30)	Keen's myotis	Myotis Keenii	

floodplain forest continued

AMPHIBIA

	Common Name	Scientific Name	Occurrence
(1)	wood frog	Rana sylvatica	Uncommon

REPTILIA

	Common Name	Scientific Name	Occurrence
(1)	red-sided garter snake	Thamophis sirtalis	Common
(2)	smooth green snake	Opheodrys vernalis	Common

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ENVIRONMENTAL IMPACT STATEMENT

FLOOD CONTROL

BURLINGTON DAM

SOURIS RIVER, NORTH DAKOTA

APPENDIX B

INVENTORY OF RECREATION SITES IN THE UPPER SOURIS RIVER VALLEY, BURLINGTON TO THE INTERNATIONAL BOUNDARY

Appendix B. Recreation sites from Burlington upstream to the Canadian border.

1. <u>Baker Bridge</u>

Baker Bridge is a five to seven acre site located 15 miles north of Minot on Ward County road 15 where it crosses the Souris River. It is used mainly for bank fishing and fishing party picnicking. According to day use information recorded at the Upper Souris NWR office, this site receives about 30 percent of the total refuge management area use, with the heaviest loads in the months of May with 2281.50 use days, June with 2664,60 use days, and July with 1975,50 use days.

2. <u>St. Mary's Bridge (Silver Bridge)</u>

Located two miles upstream from Baker Bridge, this four acre site is used for bank fishing and related picnicking activities. It receives about ten percent of the total Upper Souris NWR management area use, with the heaviest loads in the months of May with 760 use days, June with 888 use days, and July with 658 use days.

3. <u>Lake Darling Picnic Site</u>

This is a four acre site located just below and adjacent to the Lake Darling Dam itself. It is used for bank fishing and picnicking with cooking and toilet facilities and receives about twenty percent of the total refuge management area use. The heaviest use occurs in the month of May (1,521 use days), June (1,776 use days), and July (1,317 use days).

4. <u>Landing No. One</u>

Landing No. 1 is located on the west shore of Lake Darling about 150 yards north of the dam itself and is used for boat launching and bank fishing. It receives about 10 percent of the total refuge management area use. Day use figures are the same as for Silver Bridge.

5. <u>Landings No. Two and No. Three</u>

These boat landings are on the west shore of Lake Darling about one-half mile north of Landing No. 1. Combined, these landings receive the same amount of use as Landing No. 1.

6. Grano Crossing

Grano crossing receives about fifteen percent of the total refuge management area use days, with the heaviest loads in the months of May (1,140 use days), June (1,332 use days), and July (987 use days). This 45 acre site is used for boat launching and bank fishing and related picnicking. It has a comfort station and picnic tables as well as boat docks and a concrete boat launching ramp.

7. Greene Crossing

Greene Crossing is a five acre site located west and south of Mohall on State Highway 28 where it crosses Lake Darling. This site is used for bank fishing and related picnicking and receives about five percent of the total refuge management area use. The heaviest use loads occur in the months of May (380 use days), June (444.10 use days) and July (329.25 use days).

8. Mouse River Park

This is a twenty acre recreational area located just outside the boundaries of the Upper Souris Refuge in Renville County, four miles north of Tolley, North Dakota. This 20 acre area consists of eighty summer homes, weekend retreats, and permanent residences. There are picnic tables, children's open play areas, restaurant and refreshment buildings, indoor dancing and rollerskating building, beach areas for swimming, and bank and boat fishing. According to the local residents, there are about 30,500 use days per season which runs from May 20th through September 15th.

9. Ward County Road 15

This road follows the east side of the river starting at Minot, and carries the bulk of travel from Minot to Baker Bridge (13 miles). It varies in elevation from 1576± to 1607±.

10. Kirkelie Township Road

This road follows the west side of the Sóuris River from Burlington in the Old Settler's Park to Baker Bridge (10 miles). The road is not only used by ranchers and farmers to gain access to their fields and pastures, but also is used by sightseers and fishermen. The elevation of this road varies from 1575± to 1607±.

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FLOOD CONTROL

BURLINGTON DAM

SOURIS RIVER, NORTH DAKOTA

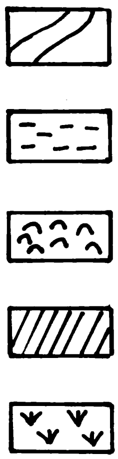
APPENDIX C

VEGETATION MAPS OF THE UPPER SOURIS RIVER VALLEY, BURLINGTON TO THE INTERNATIONAL BOUNDARY

APPENDIX C

Vegetation Maps of the Souris River from Burlington upstream to the Canadian border and the Des Lacs River from Burlington to Foxholm

Key to Habitat Types



Open Water

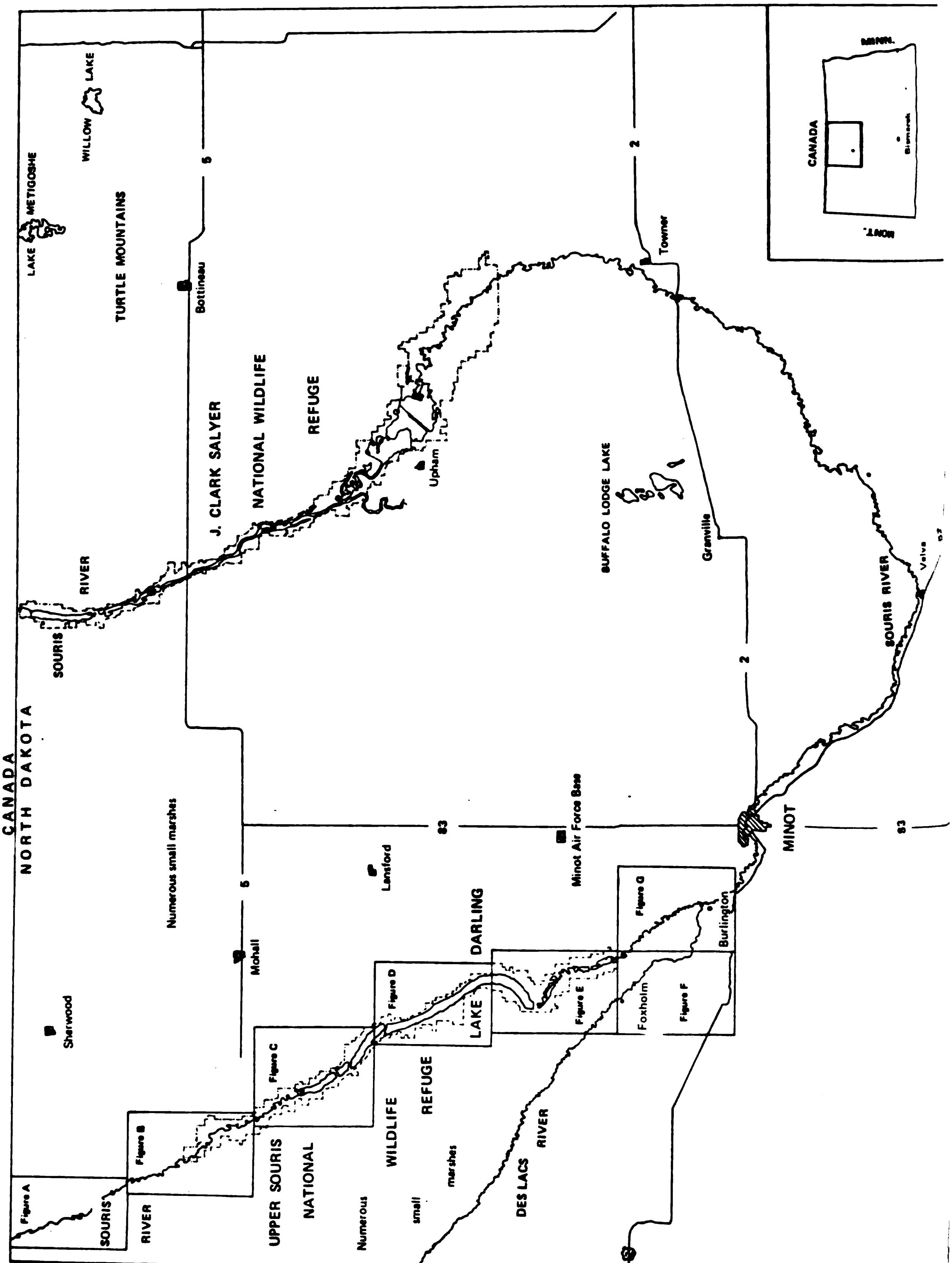
Marsh

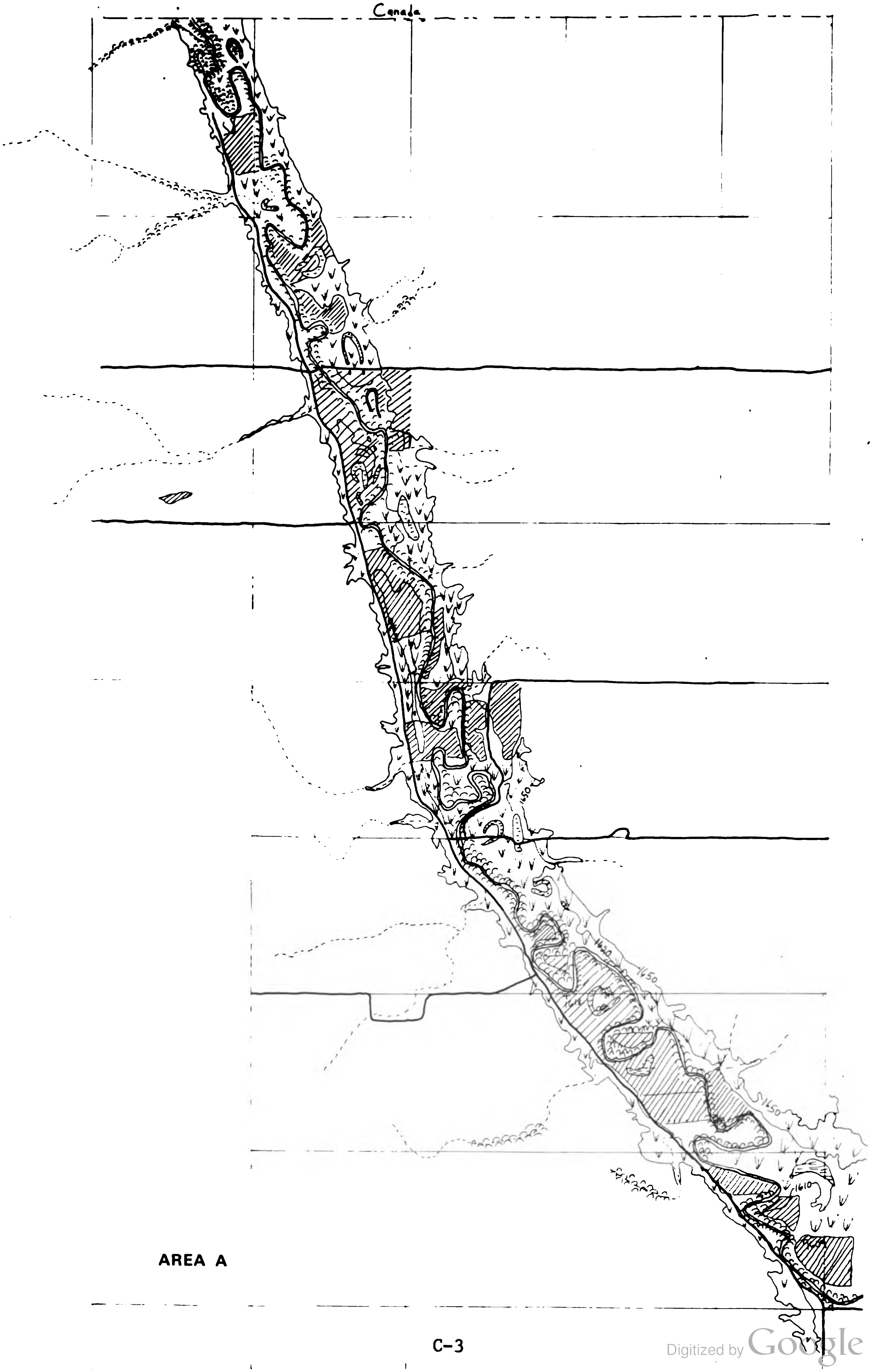
Floodplain forest

Cropland

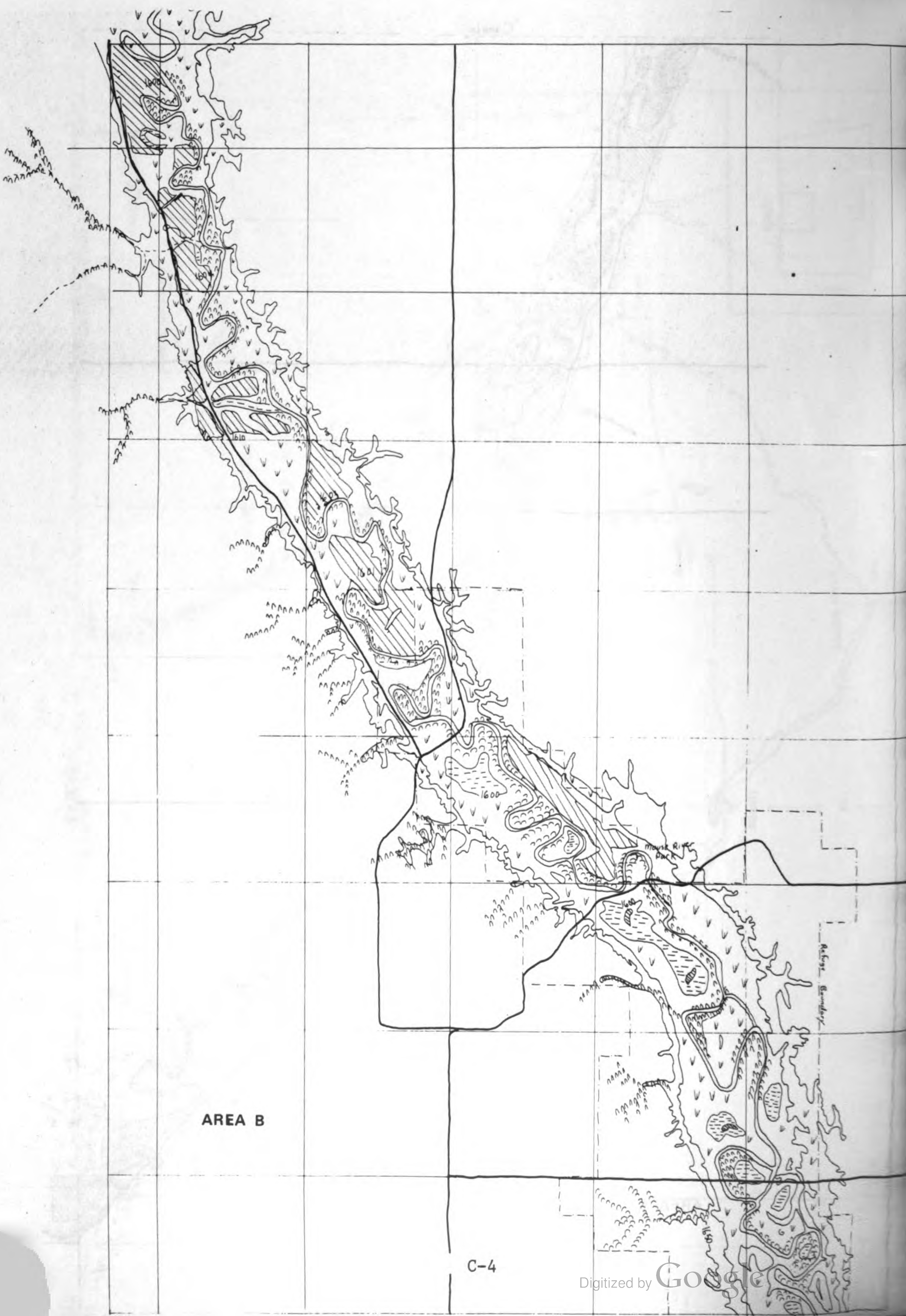
Grassland

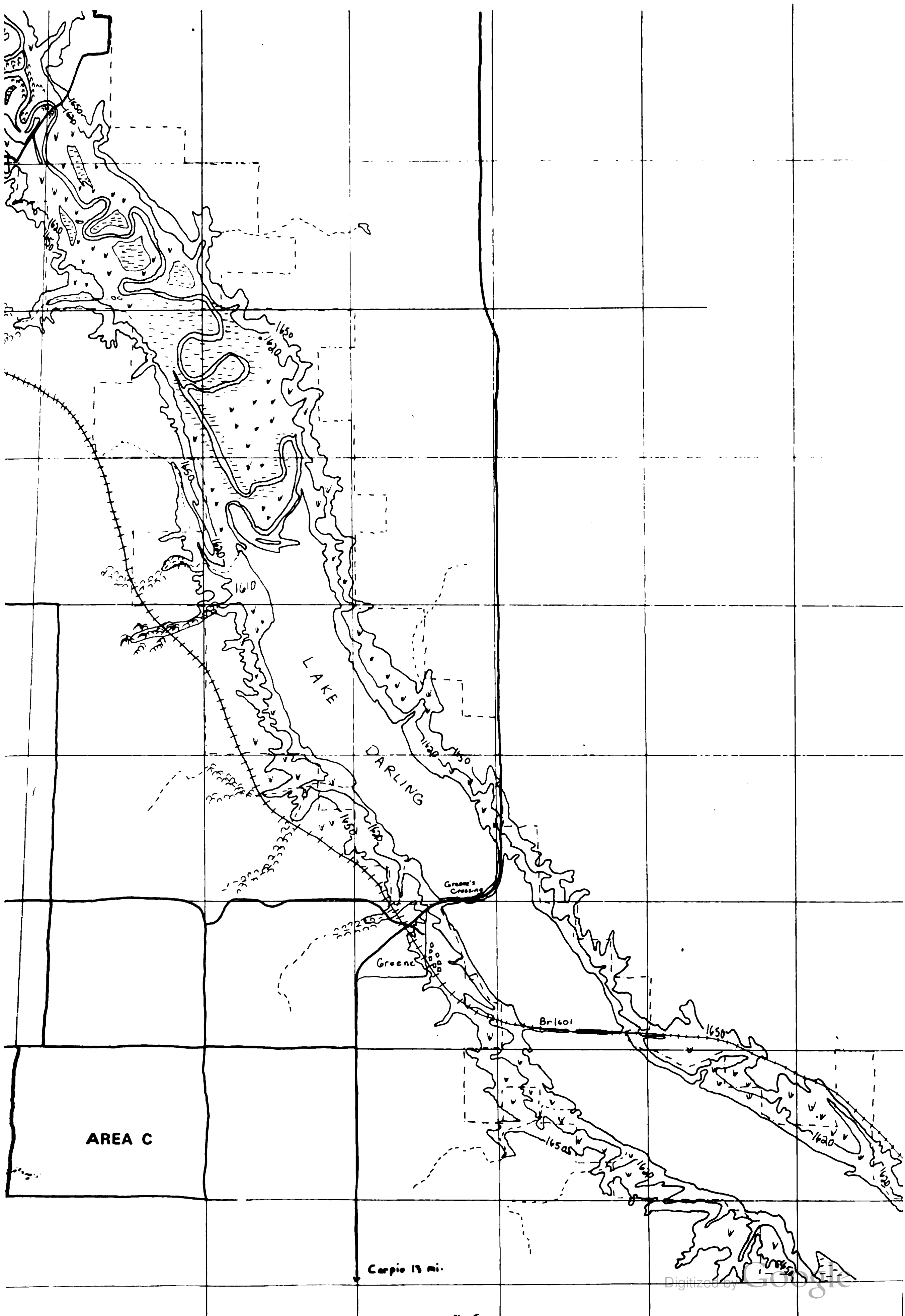
mile


CANADA
NORTH DAKOTA
LAKE METIGOSHE
WILLOW LAKE
TURTLE MOUNTAINS
Bottineau
5
2
Towner
J. CLARK SALYER
NATIONAL WILDLIFE
REFUGE
Upham
BUFFALO LODGE LAKE
Granville
SOURIS RIVER
Velva
MINOT
83
Minot Air Force Base
Lansford
DARLING
LAKE
Mohall
Numerous small marshes
Sherwood
Figure A
Figure B
Figure C
Figure D
Figure E
Figure F
Figure G
Burlington
Foxholm
SOURIS
RIVER
UPPER SOURIS
NATIONAL
WILDLIFE
REFUGE
Numerous
small
marshes
DES LACS
RIVER
CANADA
MINN.
MONT.
Bismarck

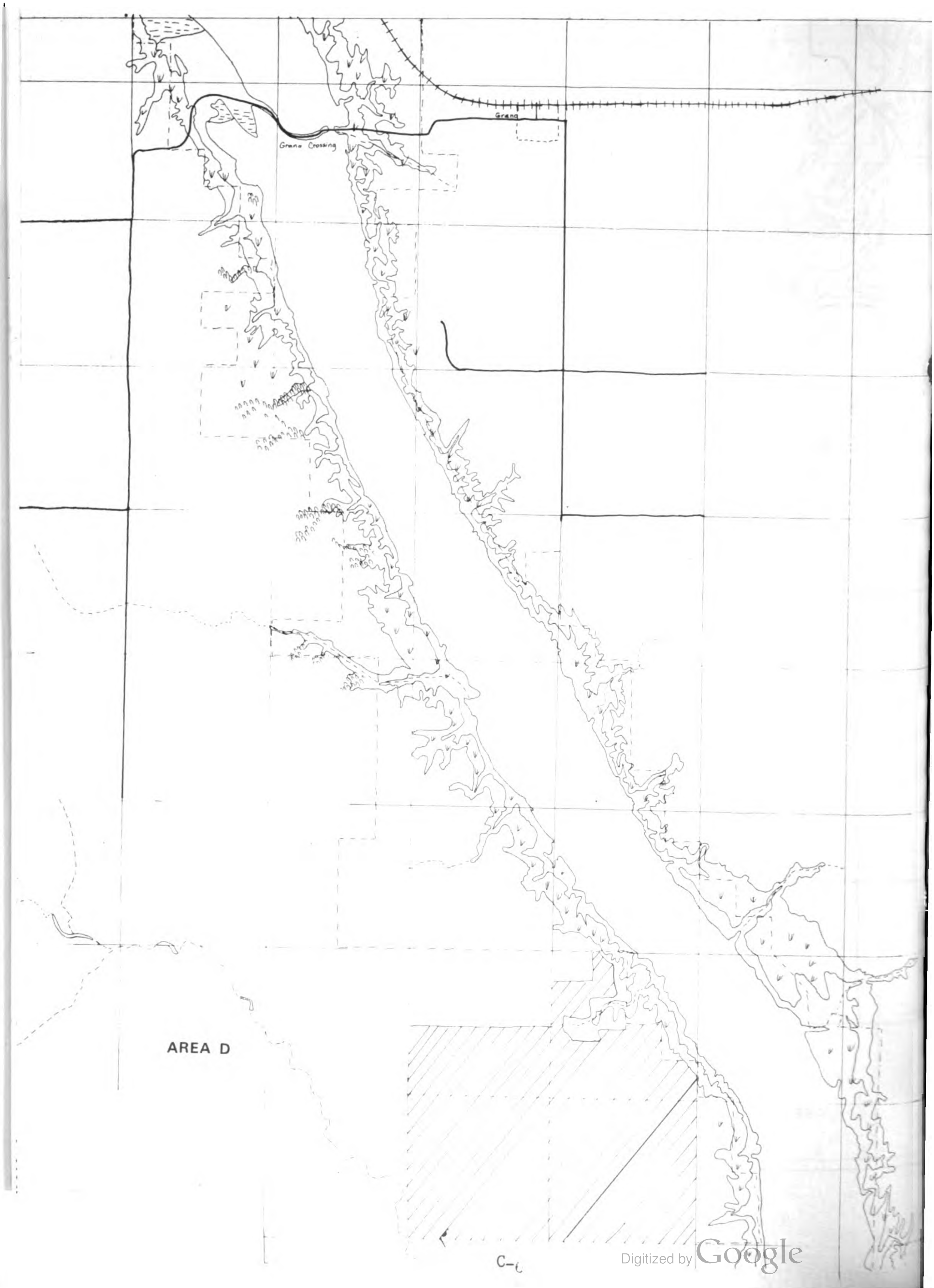


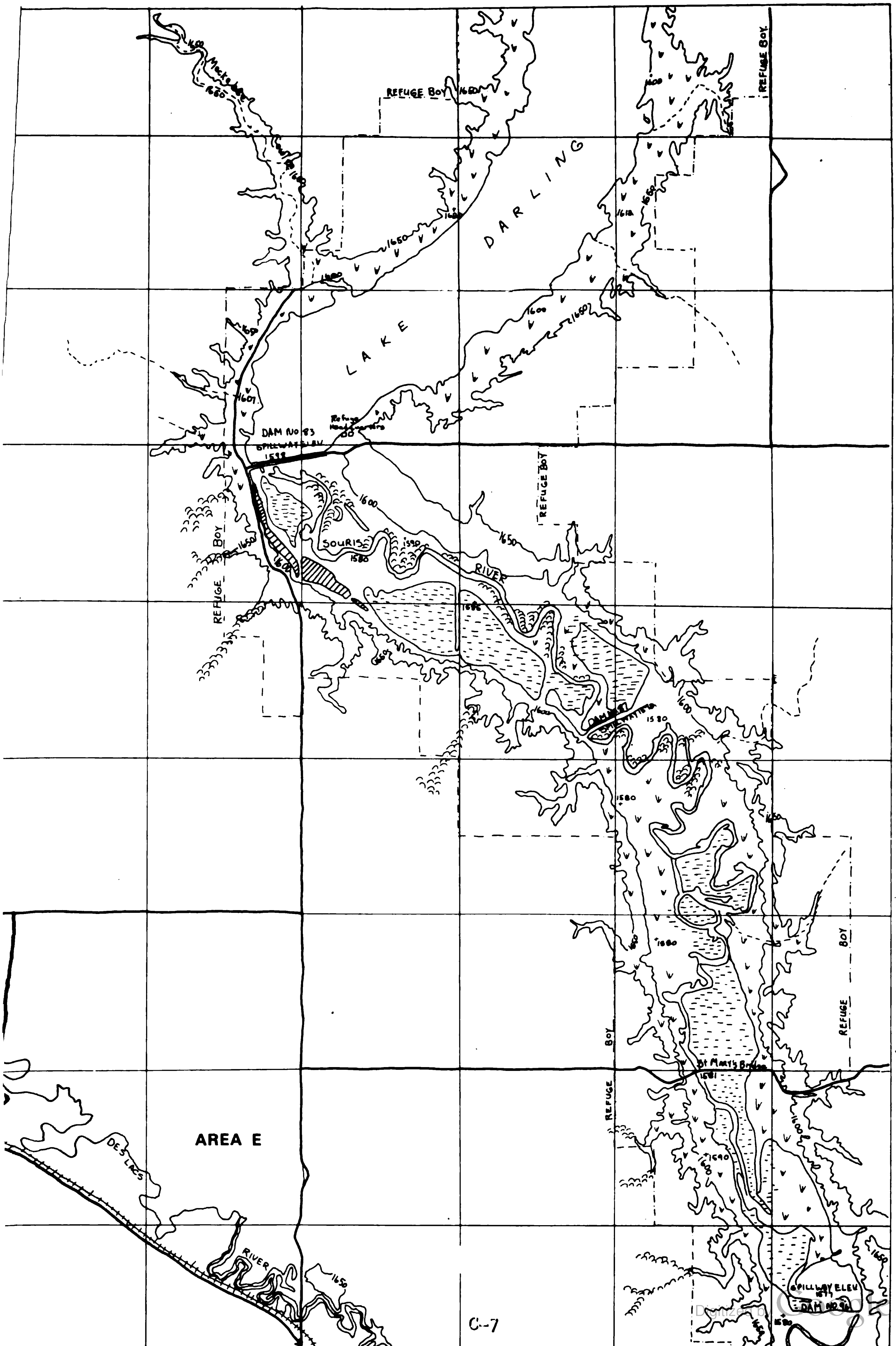
AREA A


1600
1610
1601
Mouse River Park
Refuge Boundary
AREA B

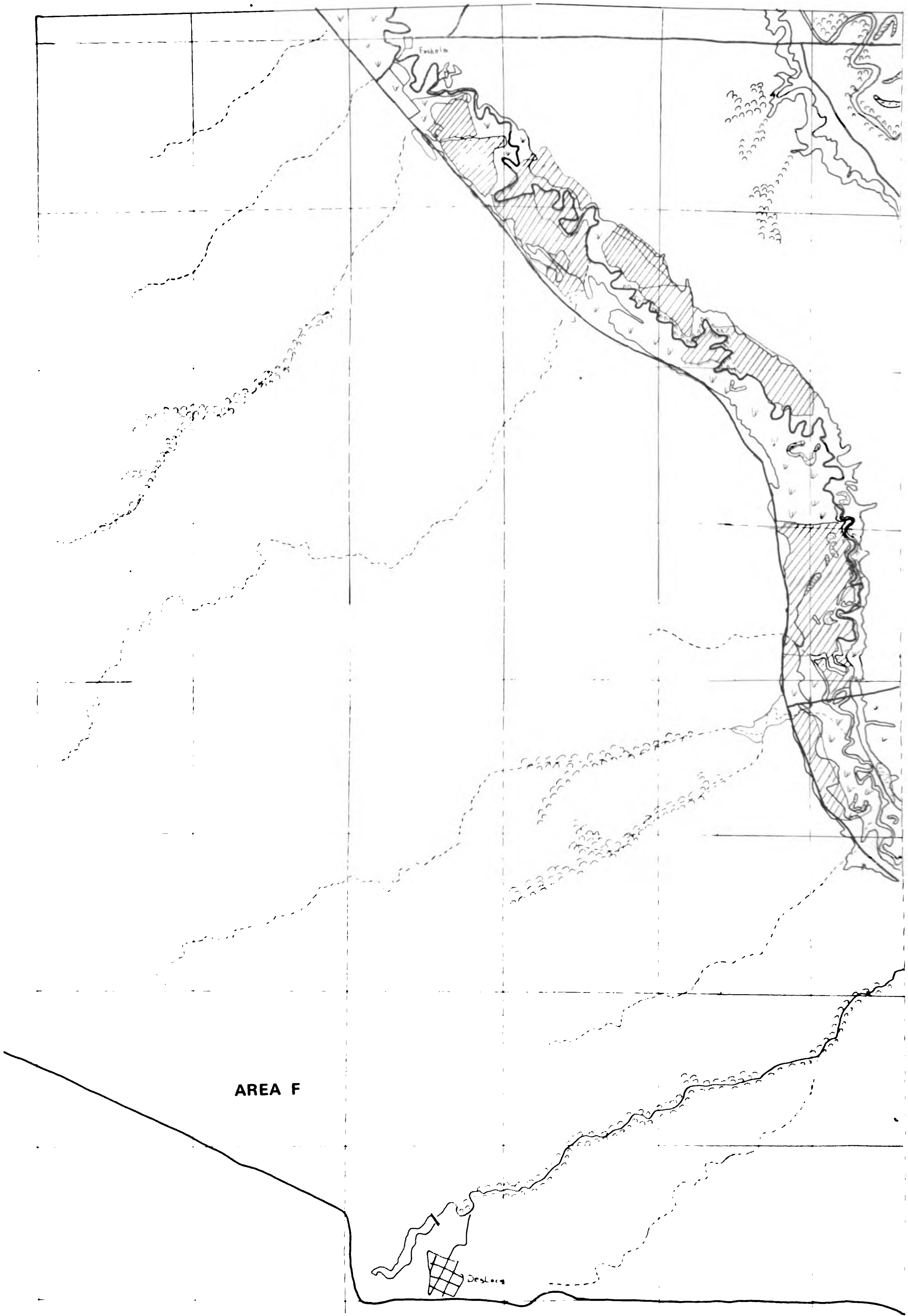


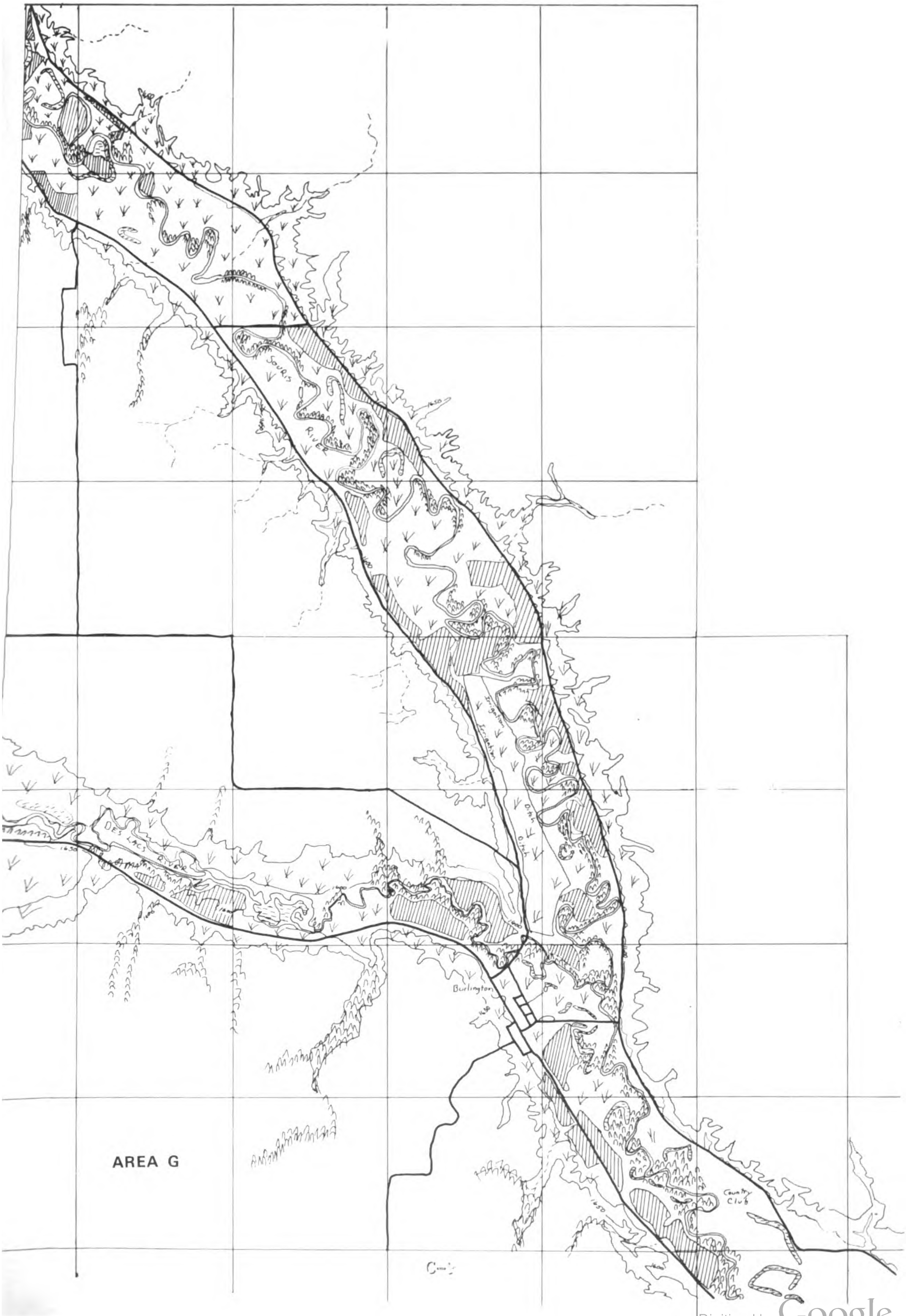
LAKE
DARLING
Greene's Crossing
Greene
Br 1601
AREA C
Carpio 13 mi.
1650
1620
1610


Grand
Grand Crossing
AREA D



LAKE DARLING
REFUGE BDY
DAM No 83
SOURIS
RIVER
AREA E
DES LACS
RIVER
St Mary's Bridge
SPILLWAY ELEV


Foxholm
AREA F
Deslacs



Souris River
1650
Irrigation Ditch
Des Lacs River
1650
Burlington
Country Club
1650
AREA G

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FLOOD CONTROL

BURLINGTON DAM

SOURIS RIVER, NORTH DAKOTA

APPENDIX D

COORDINATION WITH OTHERS

APPENDIX D

Pertinent information contained in this appendix include a position paper presenting the final views of the Souris River Flood Control Planning Committee concerning flood control improvements in the Souris River basin, correspondence with the U.S. Bureau of Sport Fisheries and Wildlife concerning their views on alternative flood control plans and mitigation measures, and correspondence with the local chapter of the Izaak Walton League concerning their views on alternative plans and the overall planning effort. This information is included in this environmental impact statement to indicate the varying views regarding the flood problems in the Souris River basin and probable solutions thereto.

SOURIS RIVER FLOOD CONTROL PLANNING COMMITTEE

POSITION PAPER

The Souris River Flood Control Planning Committee was organized early in 1972, made up of representatives from upstream area, from Minot and environs and from downstream areas. Its objective was to weigh various alternatives to deal with serious flood threats on the Souris River and make recommendations representing the interest of and viewpoints of residents and communities all along the river.

"Generally, the committee confined its recommendations to courses of action within the prescribed limitations imposed upon the Corps of Engineers for such projects. But there are exceptions that committee members felt worthy of consideration in applying local solutions to local problems.

" A great deal of compromise went into the recommendations finally adopted with representatives of the various sections of the river willing to "each take our lumps." as one committeeman put it, in order to offer the Corps of Engineers a consensus on a meaningful course of action.

These are the top priorities that went into the decisions made: the protection of people, the least possible damage or disruption to property upstream or downstream and the preservation of the environment, plus its enhancement wherever psssible.

"These are the positions taken on the project by the committee:

"1. Resolution of the flood problem through the basic general concepts of an upstream storage reservior and increasing the channel capacities.

"2. Except for relatively uninhabited areas where damage would be minimal and cost too high, a 5,000 cubic feet per second channel should prevail from the site chosen for the upstream dam through Velva with adequate freeboard.

"3. The upstream holding structure should be operated, without exception, as a dry dam. Even in years of floods of 100-year frequency, the reservoir should be drained before March 15 of the year following.

"4. A channel improvement program, primarily clearing and snagging, should be undertaken by the corps from Logan downstream on the Souris River.

"5. A plan if favored which would involve utilizing the upstream flood control dam only in years when the river flow in the Minot - Velva region reaches 5,000 cfs except when emergency conditions at downstream points require a reducti in flow. This plan involves a greater utilization of enlarged channel capacity in the big runoff years in order to limit the need for reservoir flood control storage to an average of three time in 100 years. This plan is conditional on a channel improvement plan which will adequately protect against serious internal drainage problems in communities below the control structure.

"6. The committee agrees upon a site for a [illegible] of Souris and Des Lacs rivers as acceptable but leaves the final selection question open pending more detailed investigations by the Corps of Engineers of human, economic, functional and environmental factors. The committee also feels on this point that the corps must be left in a flexible position to deal with the various agencies and pressures that must be delt with in flood control projects. The committee favors the least possible infringement on private property in selection of a site and urges every effort to utilize public lands where feasible.

"7. The committee recommends a flood control plan which would provide for a flood of the magnitude that occurs once in 100 years. We feel economic and environmental factors would preclude planning for protection of floods greater than those which occur once in 150 years.

"8. Continuation of flood control zoning after the project is in operation is favored where risks remain.

"9. A tunnel of adequate capacity connecting the Des Lacs River and the Souris River and related works is favored. The plan would insure limiting the downstream flow on the Souris to 5,000 cfs even when the Des Lacs River has a major flood.

"10. The committee asks full Corps of Engineers cooperation in a state and local program to provide diking, road raising and other protective measures for people living downstream where the channel will not handle a 5,000 cfs flow.

"11. An upstream land acquisition policy - to be reviewed by this committee which will provide adequate compensation to all who are displaced. This policy is to be broad enough to recognize all the difficult factors involved in relocation including location of new water sources, loss of feeding areas, loss of valley protection and adequate severance damage is urged in any and all cases where this would apply.

"12. Giving all possible options to landowners within the reservoir area.

"13. Replacing to the fullest extent possible any tax losses suffered by local governmental units in land acquisition for the dam and reservoir area.

"14. A diligent effort to build and operate the flood control dam and all river channel work in such a way as to minimize environmental losses and to offset these losses with an environmental enhancement program.

"15. That the flood control dam and river channel also be operated in such a way as to minimize economic losses.

"16. The committee favors releases from the flood control dam in the years in which it operates at a level not to exceed its inflow (or 500 cfs, whichever is greater) during the planting, growing and harvest season.

"17. That the Corps of Engineers continue to meet with this committee or some other properly constituted body to act as a liaison body, to make forcefully known the viewpoints of the people in the valley and to work to resolve problems that arise. This body would continue to be active in the planning, consturction and operational phases of the flood control project."

Adopted this 30th. Day of November, 1972

MEMBERS:

Ralph Christensen - Minot - Chairman

*Stephen Ashley - Velva

Earl Beck - Minot

*Wally Beyer - Velva

Jack Bone - Minot

Robert Brooks - Burlington

Harold Brunner - Rural Minot

Walfrid Hankla - Minot

Al Kramer - Minot

Kyle Miller - Bantry

Robert Moe - Minot

Lloyd Nygard - Rural Minot

Clair Southam - Mohall

* Stephen Ashley replaced Wally Beyer.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
RB

August 31, 1972

Col. Rodney E. Cox
District Engineer
U. S. Army Engineer District
St. Paul
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Col. Cox:

Mr. J. R. Calton's letter of August 18, 1972 (File NCSED-PB), requested that we provide you with a realistic cost for mitigating fish and wildlife losses attributable to the construction of a flood retention reservoir at one of several sites under consideration below Lake Darling Dam, Souris River, North Dakota. We understand that we are to provide you with our preliminary mitigation cost estimates by September 19, 1972, when the next Local Flood Control Committee meeting convenes in Minot. Other associated problems relate to possible channel modification required to effect necessary reservoir releases.

Since two major National Wildlife Refuges, totaling 90,785.9 acres of land and water, would be adversely affected by water retention, flow releases, and related channel modifications in the Souris Basin, you can well understand our concern. It is a matter of record that we do not favor major development on the mainstem of the Souris River. Yet, we recognize that a flood problem does exist and for the sake of project feasibility we previously agreed to a Burlington Dam site proposal, providing a number of features and precautions were adopted in project formulation to protect our interests. We now find that the currently considered Burlington Reservoir operations will be more damaging to our refuge system than formerly anticipated; and a potential dam-site relocation is also being considered that would affect our National Wildlife Refuges more seriously than any Burlington Dam proposal. We can no longer think in terms of mitigating (minimizing) fish and wildlife losses but must require compensatory action to realize full replacement of all biological and related values destroyed through such project implementation.

However, it is not possible for us to give you these compensatory costs until we receive adequate engineering data to work with. Your office has not provided our Bureau with a composite analysis of a specific plan for the Baker Bridge Dam site, let alone a composite analysis of a specific plan for the Burlington or Confluence Dam sites. In fact, we are thoroughly confused over proposed storage requirements, elevation and size of pools, flow regulation schemes, and related downstream flow schedules.

We have received copies of various charts and graphs from your office illustrating flood frequencies, elevations, and days of inundation caused by reservoir storage, for both the proposed Baker Bridge and Burlington Dam sites. These charts and graphs were presented to the Souris River Flood Control Committee in a series of meetings starting on March 7, 1972, and were designed to answer the Committee's specific questions concerning effects of several flow regulation schemes for the two dam sites. However, we have not received corresponding information for the Confluence Dam site nor did we receive information to indicate downstream effects we might expect at the Bantry Gauging Station or J. Clark Salyer NWR.

The charts we have show the effects of several flow regulation schemes on elevations and days flooding in the area of our Upper Souris National Wildlife Refuge. None of the charts show corresponding effects of these operations on downstream locations such as the Towner area, Bantry Gauge, or J. Clark Salyer NWR. It seems to us that we must evaluate "the combined package" effects on both Upper Souris and J. Clark Salyer National Wildlife Refuges and the entire Souris loop before we can assign compensatory costs to a specific dam site or a particular plan of reservoir operation.

Tables 1, 2, and 3 (attached) are summarized from data presented by your staff at the Minot Committee meetings since March 7, 1972, and from earlier data you gave our office prior to Burlington Reservoir authorization. Based on this data alone, we did conclude that both the Baker Bridge Dam and Burlington Dam, if operated with an early flow release cutoff date of May 1 or May 15, will cause extremely long inundation of the various pools of Upper Souris Refuge. Inundations of this nature unquestionably will destroy a large share of the biological values of these units.

According to other charts furnished by your office to the Committee in Minot on May 2, 1972, the frequency of inundation of our Upper Souris Refuge pools will also increase. For example, pre-authorization studies indicated that our lower refuge units (Upper Souris NWR) would "flood-out" only once in six or seven years. The May 2, 1972, curves indicate that with a 3,500 cfs maximum release and planned early flow reductions by May 15, Baker Bridge or Burlington Dams will both inundate these refuge units every two to three years. We do not have your comparative flood-frequency data for a 2,500 cfs release rate and May 1 flow release cutoff date (Table 1), but presume that flooding conditions would be even more frequent for this operation plan.

We wonder if the local Flood Control Committee realizes that the Federal Government has already invested over five million dollars in Upper Souris NWR alone, which at today's costs would amount to probably well over ten million. And this value takes into account only the current market worth of land, water, and installations and does not include the refuge's potential value for fish and wildlife and related recreational opportunity. Does the Committee realize, too, that the refuge provides 4,545,400 days of waterfowl use through the spring and fall seasons, plus its waterfowl production contribution to the Central Flyway? Furthermore, 58,000 days of annual use by fishermen takes place on refuge property; and fishing beyond the refuge boundaries which depends almost entirely on Lake Darling recruitment accounts for another estimated 50,000 days of use. Reliable studies further indicate that these fishermen annually spend more than $1,000,000 in the general area in the pursuit of this sport. Supporting data indicate, too, that days of general recreational use of the refuge area at least equals the time spent on the specific sport of fishing. Private expenditures towards general recreation (excluding fishing) is estimated to exceed $1,000,000 annually.

It is easy to recognize that the Upper Souris NWR amounts to "big business". Compensation for its loss would require a tremendous expenditure of funds, if such action was possible from the technical standpoint.

Our opposition to the Baker Bridge Dam site remains firm as stated to you in our letter of August 11, 1972. We cannot, and will not, compromise our position on this issue. Flood water retention at Baker Bridge not only would destroy the waterfowl production and use of Upper Souris NWR but would practically eliminate the extremely valuable fishery of Lake Darling. Furthermore, there are no comparable replacement areas located nearby unless, of course, the entire valley between Minot and Baker Bridge, including portions of the Des Lacs were purchased and developed for our use. Even such an undertaking would not compensate for the current value and lost fishery potential of Lake Darling. We could "live" with a site like Burlington with an operation schedule closer to that which was contemplated during project authorization studies. However, we are unwilliing to be a partner to the destruction of the Upper Souris NWR when there are other seemingly feasible flood control alternatives open to the city of Minot and others (including Canada) who will receive major benefits from the project.

We would like to see more of a joint effort to establish reservoir storage in Canada. Flood retention above Upper Souris appears to have considerable merit and a reservoir in this area would still allow us to operate the Upper Souris NWR for its intended purpose. If such retention is not possible because of international difficulties and possible lack of engineering feasibility, perhaps a 6,000 cfs capacity channel should be constructed through Minot proper in connection with lesser upstream storage retention. Evacuation of the 100-year Minot flood plain also deserves more consideration. Perhaps some combination of these alternatives might achieve the most desirable project.

In conclusion, we request that your office provide us with the following information so that we may adequately evaluate other project effects on both our Souris River Refuges:

1. Elevation-duration data for a Burlington and Confluence Dams 2,500 cfs release schedule, but with a June 1 cutoff date (similar to data attached with J. R. Calton's July 31, 1972, letter for the 1948, 1951, 1955, and ten year synthetic floods, as shown on attached Table 1.).

2. Both observed and projected hydrographs at the Bantry USGS gauge for the conditions and years referred to in 1 above.

3. Similar data to 1 and 2 above, for the years 1970 and 1972.

4. Current area-capacity curves, surface area figures, reservoir outline maps, and estimates of needed land acquisition for all proposed reservoir sites.

In each case (above items 1--3) a 1594 starting elevation in Lake Darling is satisfactory with the exception of the year 1970. A starting elevation of 1594 in Lake Darling in late April 1970, as shown on your earlier flood routings is not realistic. In actual experience and with a downstream flood reservoir, Lake Darling would partly fill from initial runoff early in April 1970 and would more likely be at elevation 1596.4 at the start of flood releases. A definite flood threat did not exist until the heavy rains occurred on April 28, 1970. Consequently, we think a starting level in Lake Darling for that year should be 1596.4 instead of 1594.0 for flood routing purposes.

Sincerely,

Travis S. Roberts

Travis S. Roberts
Regional Director

cc: North Dakota Department of Fish And Game

TABLE I - DAYS EXCEEDED FOR FLOOD YEAR INDICATED - AT EACH OF THREE POSSIBLE DAM LOCATIONS

Unit	Spillway Elev.	1951 (8 year event) Confluence Dam	1951 (8 year event) Burlington	1951 (8 year event) Baker Bridge	1955 (12 year event) Confluence	1955 (12 year event) Burlington	1955 (12 year event) Baker Bridge	10 year Synthetic Confluence	10 year Synthetic Burlington	10 year Synthetic Baker Bridge	1948 (17 year event) Confluence	1948 (17 year event) Burlington	1948 (17 year event) Baker Bridge
Dam 83 spillway	1598		0	0		0	0		0	0		80	133
Dam 87 spillway	1578		52	72*		61	91*		72	102*		153	163*
Dam 96 spillway	1577		56	**		68	**		78	**		157	**
850 acre impoundment spillway (proposed)	1575		63	**		74	**		88	**		150	**

Assumptions:

(1) Lake Darling at elevation 1594 at start of flood.

(2) Reservoir releases based on 2,500 cfs until May 1, then 500 cfs, minus the DesLacs River flow. The 1951 DesLacs River flow was used for the ten year synthetic flood. Flows were increased to 1,000 cfs in September and 800 cfs in October for 1948 flood.

(3) Assume that the first 36,500 acre-feet of runoff in excess of reservoir releases is stored in Lake Darling.

* Extrapolated from data shown on USCE chart dated 6-22-72 and furnished with 7-20-72 letter from USCE.

** Not available from data shown on USCE chart dated 6-22-72 and furnished with 7-20-72 letter from USCE.

TABLE II - ELEVATION-DURATION COMPARISON - BURLINGTON RESERVOIR STUDY

	Authorized Project (July 15, 1969 report) (2,300 cfs constant at Minot)		May 2, 1972, Plan (3,500 cfs Max. Reservoir Release-To 300 cfs on May 15)		
	Elev.	Duration (days)	Elev.	Duration (days)	
(a) 10 year event:	-	-	(Max.) 1590	0	
	(Max.) 1585	0	1585	80	
	1580	28	1580	125	
	1578	32	1578	135	Unit 87 spillway-Upper Souris
	1577	34	1577	140	Unit 96 spillway-Upper Souris
	1575		1575	148	Proposed 850 acre impoundment
(b) 25 year event:	(not shown) (on chart)		(Max.) 1600	50	
			1598	107	Unit 83 (Lake Darling spillway)
			1535	185	
			1578	207	Unit 87 spillway
			1577	210	Unit 96 spillway
			1575	215	Proposed 850 acre impoundment
(c) 50 year event:	(Max.) 1608+	1	-	-	
	1603	55	(Max.) 1603	90	
	1598	92	1598	160	Unit 83 spillway (Lake Darling)
	1578	155	1578	265	Unit 87 spillway
	1577	157	1577	270	Unit 96 spillway
	1575	158	1575	275	Proposed 850 acre impoundment
(d) 100 year event:	(Max.) 1616.8	0	-	-	
	1608	97	(Max.) 1608+	125	
	1598	160	1598	245	Unit 83 spillway (Lake Darling)
	1578	220	1578	Not shown	Unit 87 spillway
	1577	220	1577	"	Unit 96 spillway
	1575	222	1575	"	Proposed 850 acre impoundment

Reference: Handouts by USCE at 5-21-72 Minot Committee Hearing and data received with March 2, 1964, letter from USCE.

TABLE III ANTICIPATED RESERVOIR EFFECTS ON KEY FEATURES OF UPPER SOURIS NATIONAL WILDLIFE REFUGE

Feature	Min or Ground Elev.	Surface Area (acres)	Aug. 2,1965 BSFW Report Burlington Reservoir Av. Recurrence Interval (years)*	May 2, 1972, Minot Hearing Plans Burlington Reservoir Av. Recurrence Interval (years)**	May 2, 1972, Minot Hearing Plans Baker Bridge Av. Recurrence Interval (years
Spillway level, Marsh Unit #96	1577.0	943	6.0	3.0	(not shown)
Spillway level, Marsh Unit #87	1578.0	323	6.25	3.5	(not shown)
Recreation Area, immediately below #83 (Sec.6, T.157N., R.84W.)	1581.0		7.7	4.5	(not shown)
Spillway level-Units below #83					
"A" - Mile 83.7	1582.5	62	8.0	5.5	(not shown)
"B" - Mile 85	1581.0	193	--	--	--
"C" - Mile 86	1580.0	135	7.3	4.0	(not shown)
Secondary Headquarters Residence	1585.0+		10.0	6.5	(not shown)
Spillway level, Unit #83 (Lake Darling)	1598.0	9,900	23.0	18	8
Refuge Shop area and Road	1610.0+		59.0	(not shown)	62
Headquarters Residences	1622.0+		150.00	--	--

* Based on 2,300 cfs maximum flow at Minot and a Lake Darling starting elevation of 1596.0

** Outflow increased to maximum of 3,500 cfs but reduced to 300 cfs on May 15, and a Lake Darling starting elevation of 1596

United States Department of the Interior

FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
RB

October 2, 1972

Col. Rodney E. Cox
District Engineer
U. S. Army Engineer District
St. Paul
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Col. Cox:

We appreciate receiving the information enclosed with your September 22, 1972, letter concerning Souris River Reservoir Studies in North Dakota. We wish to advise that the table listing private land area summary requirements is interesting, but is not meaningful without an accompanying layout map showing actual "blocked out" acreage.

You asked for our views and rough estimates of mitigation requirements for the alternative reservoir plans prior to October 4, 1972. I'm sure you recognize that it will be difficult for us to provide you with mitigation requirements and related costs for any of the three dam sites or plans currently under investigation. The reason, of course, is that no specific plan of reservoir operation has been chosen for any of the three sites.

We have attempted to review the various combinations of dam sites and operational plans prepared by your office and presented to the Souris River Flood Control Committee at the 1972 series of meetings held in Minot, North Dakota. We also requested and received additional reservoir operational data for a specific set of criteria outlined in recent correspondence between our respective offices. Based on this information, we conclude that two of the three reservoir sites could be operated in a manner reasonably compatible with our interests in the Souris Valley. These are the Burlington and Confluence locations. Reservoirs at either of these two sites, combined with an acceptable operation and mitigation plan could be acceptable. A specific plan of operation applied to either of these two proposed reservoir sites would produce similar effects on the Upper Souris and J. Clark Salyer Refuges in terms of days inundated and observed maximum water levels.

Based on the data you provided with your last letter, we tenatively conclude the following concerning a reservoir operation plan at either Burlington or the Confluence sites: An operation scheme that will produce the least flooding and inundation of the Upper Souris NWR pools and at the same time not overly aggravate downstream conditions at our J. Clark Salyer Refuge, cannot include a reservoir flow release cutoff date as early as May 15. An early cutoff date will severely aggravate frequency and duration of upstream flooding of Upper Souris NWR pools. In addition, an early cutoff will not materially benefit the J. Clark Salyer Refuge downstream.

The preliminary data you provided us indicates that either a constant 2,300 cfs maximum reservoir flow release or a maximum 2,500 cfs release to June 1 would be least detrimental to our purposes. You have provided us with detailed operation data only for floods of less than the 25-year magnitude so we cannot comment with assurance as to whether a 3,000 or 3,500 cfs maximum release will be more favorable for greater than 25-year floods. It may be that in years of these larger floods that we might request that you minimize adverse regulation effects on J. Clark Salyer Refuge at the expense of the Upper Souris Refuge. However, our current evaluation of available operation plans indicates this will not be likely.

Mitigation items previously requested for a Burlington Dam site and a 2,300 cfs constant flow release were outlined in our November 15, 1968, report. This report was a part of your July 13, 1969, Review Survey Document. The principal mitigation item listed in this report was an 850-acre subimpoundment located in the proposed Burlington Dam flood control pool. This subimpoundment would have been inundated only once in five years under the plan of operation we supported at that time. With our current understanding of the operation plan, this mitigation can no longer be considered adequate.

In contrast, the Baker Bridge, or third reservoir site, is in close proximity to the Upper Souris Refuge. This site obviously will produce more frequent and longer duration of flooding of all Upper Souris NWR Units for a specific plan of operation. Also, maximum water elevations will simiarly be increased on the Upper Souris pools for a specific operation plan.

The opposition we expressed to you in our August 31, 1972, letter regarding the Baker Bridge Dam site remains firm. We cannot compromise our position on this issue. The Baker Bridge site would require mitigation of such a magnitude that it would impose serious constraints on the project and the local people. It would appear prudent to pursue other solutions.

Our views on mitigation cannot be specific at this time, but we wish to point out some general concepts. Mitigation would include, but not be limited to, replacement of lands for the Upper Souris Refuge and assurance of adequate water supplies for the operation of the J. Clark Salyer Refuge. Possibly a satellite refuge or expansion of existing refuges will be needed. Also, J. Clark Salyer and Upper Souris Refuges would need riprap of dam units plus re-design of unit spillways. Channelization of the Souris Loop would necessitate mitigation similar to that required for the present channel work through Minot. Spawning areas, dikes, dams, recreational access, and other features would be needed to maintain the fishery of Lake Darling.

The Upper Souris NWR annually provides 4,545,000 days of waterfowl use through the spring and fall seasons and is important for waterfowl production. It provides 58,000 days of fisherman use and Lake Darling recruitment also contributes another 50,000 days of fisherman use in the surrounding areas. With better than a ten million dollar capital investment in the Upper Souris National Wildlife Refuge plus annual expenditures by the public of over $2,000,000 for fishing and general recreation, we have much to lose with reservior construction.

As stated in earlier letters to you, we do not favor major reservoir development on the mainstem Souris River in North Dakota. We would much rather see evacuation of the 100-year Minot flood plain for example, or flood storage upstream in Saskatchewan, if possible. Other alternatives which will provide necessary flood control, with less damage to the environment need extensive investigation.

We are sure you realize that we must conduct an "in-depth" analysis of a specific plan of operation for a specific dam site before we can give your office specific mitigation requirements and related costs. To do this, we require more time than the two weeks allowed in your September 22, 1972, letter.

We will continue to analyze all facets of the Souris Project. It would appear most improper to expend large amounts of time and manpower developing voluminous mitigation requirements for several plans which may never materialize or be changed. Further, our mitigation analysis could not be completed without evaluating the Environmental Study now being conducted by Minot State College. In addition, study of your forthcoming Environmental Impact Statement is necessary before a final plan can be discussed.

Sincerely,

Charles A. Hughlett

Charles A. Hughlett
Acting Regional Director

cc: North Dakota Game and Fish Department

United States Department of the Interior
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
EN-H-Souris River Invest.
(CE) N.D.

November 8, 1972

Colonel Rodney E. Cox
District Engineer
U.S. Army Engineer District
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Cox:

Please excuse our oversight in not replying to your September 29, 1972, letter concerning Souris River Flood Control proposals. Your letter asked for our views on two items relating to Lake Darling Dam and the Upper Souris NWR. Our comments concerning these two items are as follows:

(a) Raising Lake Darling Dam as an alternate
This proposed alternative is certainly reasonable and one which has considerable merit. This idea was even suggested by our Bureau, for consideration as early as ten years ago but did not gain support because of the flood storage requirement your office imposed at that time. We can see both advantages and disadvantages to this proposal in comparison with other suggested alternate reservoir sites. Some of the advantages to Fish and Wildlife that we can readily see are:

1. no "back-up" flooding of Upper Souris NWR units 87, 96, and mitigation units such as would occur from a downstream reservoir like Burlington
2. positive water control to refuge units 97, 86, and mitigation pools
3. less environmental losses below Lake Darling yet better opportunities for effecting mitigation
4. an improved Lake Darling physical installation
5. less damage to the existing stream fishery below Lake Darling

Some of the disadvantages are:

1. more frequent flooding of the waterfowl and wildlife area upstream from Dam 41

2. more fluctuation extremes on unit 41 which will adversely affect waterfowl production

3. more fluctuation extremes on Lake Darling which can adversely affect fishery reproduction

4. changes in the present operating plan of Lake Darling which could adversely affect present fishery recruitment to the Souris River below Lake Darling

5. adverse effect on the natural timber areas upstream from Lake Darling

We believe that opportunities to compensate for the above mentioned disadvantages are quite feasible. With a raised Lake Darling Dam the Bureau would give serious thought to asking for "side channel" construction below Lake Darling. The side channel would allow passage of flood flows alongside wildlife marshes and not through them. This channel might be necessary to protect nesting waterfowl from undue water level fluctuations caused by flood storage flow releases after normal spring runoff periods.

(b) The Safety of Lake Darling Dam

As you already know, Lake Darling Dam was built in 1935, and at that time the "feasible maximum" flow expected at Minot was 18,000 cfs. The dam apparently was constructed to pass this amount of flow with three feet of freeboard.

Using your figures for a 100 year flood at Sherwood (18,000 cfs peak and 510,000 acre-feet volume) we conclude that Lake Darling could pass this flow safely without using the emergency spillway in the right abutment of the dam. (The emergency spillway crest is at elevation 1602 and the top of dam is elevation 1606.)

In contrast, Lake Darling would be hard pressed to safely pass an authorized project standard project flood peak and flow volume (27,000 cfs and 913,000 acre-feet at Minot, respectively). This flow would leave only two feet of freeboard on Lake Darling for wave action, etc. Also, it is our understanding that your office is now working with a larger standard project flood peak and volume. No doubt major modifications of Lake Darling Dam will be necessary to comply with current design standards.

We hope that this information answers satisfactorily the two questions raised in your September29, 1972, letter. We apologize for the extended delay in your reply.

Sincerely,

Charles A. Hughlett

Charles A. Hughlett
Acting Regional Director

United States Department of the Interior
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
RB

December 15, 1972

Col. Rodney E. Cox
District Engineer
U. S. Army Engineer District
St. Paul
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Col. Cox:

This is in further response to your earlier letters dated August 18 and September 8, 22, and 29, 1972, indicating your need for our comments regarding the authorized Souris River Flood Control Project in North Dakota. Specifically, we are responding to your recent telephone request stressing the need for our review of the recently proposed Lake Darling site.

This letter provides our preliminary analysis of the four reservoir alternatives, together with our outline of the compensatory action needed to insure continuation of refuge operations and related fish and wildlife resource values in the Souris River Valley. Three primary operating plans are considered for each site. We have also considered the potential project impact on the riverine habitat of the Souris River loop and have developed the corridor concept to offset these adverse effects. Project information contained in your earlier letters, and hydrologic information presented by your staff at a series of Minot Flood Control Committee hearings in 1972 provide the basis for this preliminary evaluation.

Please keep in mind that this evaluation is not based on the detailed fish and wildlife studies required under the Fish and Wildlife Coordination Act, nor does it necessarily reflect the views of the North Dakota State Game and Fish Department. At this time, however, we wish to clarify and confirm our position concerning the proposed damsites and provide broad spectrum judgments on the relative merits of these sites.

We continue to disfavor any major dam development on the Souris River which adversely affects our Refuge operation. We firmly believe other alternatives, such as floodplain evacuation, zoning, or upstream reservoirs, to be acceptable. The Baker Bridge site, as we stated in our August 11, 1972, letter remains totally unacceptable. However, the Burlington, Confluence, and Lake Darling sites may be considered as additional alternatives if the compensatory measures described in the table are adopted.

The Bureau's pre-authorization position on the Souris River Flood Control Project was stated in our November 15, 1968, letter to your office. Therein, we outlined measures which would make the Burlington site a project we could "live with". At that time, your office had determined that the Burlington site combined with limited Minot Channel improvement, provided optimum flood protection. Since that time, new laws, policies, flood control plans, and comparable storage sites have evolved. It is evident that we can no longer be limited to the position adopted in our November 15, 1968, letter. Alternative plans, and "on the ground" physical modifications are now present that deserve our full consideration. The Lake Darling storage site proposal is, of course, only one of several relatively new flood control plan features or developments.

All of the four sites, presently proposed in your Phase I study, would have deleterious effects on our refuge operations and upon related fish and wildlife resources. Each will require varying degrees of compensation. However, we conclude that the Lake Darling site would be most desirable, Burlington and Confluence sites would be less desirable, and the Baker Bridge site the least desirable. The operation of J. Clark Salyer National Wildlife Refuge, downstream, will be affected to some degree by any reservoir and flow regimen, in combination with return flows from the 250,000-acre Garrison Diversion Project, now under construction.

The operating alternatives proposed for each damsite are as follows:

(a) Maximum reservoir release rate limited to 3,500 cfs, reduced to 500 cfs by May 15, and if necessary to accelerate reservoir evacuation, increased to 1,200 cfs in September, 1,000 cfs in October, and 700 cfs in November.

(b) Same as (a) except that maximum release rate is limited to 2,500 cfs and reduced to 500 cfs on June 1.

(c) Maximum reservoir release rate limited to 5,000 cfs with no regulation of flows under 5,000 cfs as they presently occur at Minot.

Based on our review of hydrologic charts and materials furnished this office, we tentatively conclude as follows:

Release Plan (c) would appear to have the least detrimental effect on existing resources. Plan (b) would be most similar to the release schedule contemplated in the original authorization plan and the adverse affects on the resource would be similar to those outlined in our August 2, 1965, Fish and Wildlife Report. Release Plan (a) would appear to have the most adverse effect on existing resources.

In summary, the Lake Darling site has considerable merit. From preliminary analysis, this site will result in the least environmental damage and with the most compensatory potential. This conclusion is based partly on the three tabulations attached. Please note that the advantages, disadvantages, and possible compensatory needs are not necessarily limited to those listed on the tables. Only more detailed studies can refine these preliminary views.

The Lake Darling site will not affect marsh units 87 and 96 which furnish about 60 percent of the annual waterfowl production of the Upper Souris Refuge. This site will provide good opportunities for positive water control of these units, while allowing development of an 850-acre mitigation unit. Less stream miles of the Souris River will be inundated, causing less loss of recreational access points. The timbered area below Lake Darling, a critical deer wintering range, will not be affected. Also, a minimum relocation of Bureau of Sport Fisheries and Wildlife facilities will be needed.

We trust that the information in this letter will adequately serve your immediate needs. Do not hesitate to contact us as planning continues.

Sincerely,

Travis S. Roberts

TRAVIS S. ROBERTS
Regional Director

Attachment

Lake Darling Dam

Advantages		Disadvantages
1. an improved Lake Darling Dam physical installation	8. no replacement of Upper Souris Secondary H.Q. required	1. more frequent flooding of refuge area above Dam 41 causing:
2. no "back-up" flooding of refuge units 87, 96 and mitigation units	9. minimum replacement or relocation of existing Upper Souris National Wildlife Refuge roads, trails, and recreation areas	a. adverse effect on waterfowl production
3. positive water control to units 87, 96 and mitigation units		b. possible adverse effects on fishery
4. less loss of stream fishery below Lake Darling than with Baker Bridge or Burlington		2. possible impairment of fishery recruitment from Lake Darling to Souris River
5. less timber loss below Lake Darling than with Baker Bridge or Burlington		3. more adverse effect on natural timber areas above Lake Darling than with Bake Bridge, Burlington or Confluence Dams
6. better compensatory opportunities than other sites		4. Probable replacement of Headquarters
7. less loss of recreational areas than with Baker Bridge, Burlington or Confluence Dam		

Compensatory Needs

JULY 1972 COST ESTIMATES

	Regulation Plan(a)	Regulation Plan(b)	Regulation Plan(c)
[illegible]-acre unit downstream (includes 1700 acres of land)	$ 620,000	$ 620,000	$ 620,000
Corps of Engineers protect or replace affected BSFW facilities at Upper Souris at project expense (Dam 41 repair costs)	61,000	61,000	61,000
Corps of Engineers provide O&M to BSFW for operating L.Darling site*	353,000	353,000	71,000
Fisheries development such as spawning areas and stocking	100,000	80,000	50,000
Recreational access points needed for fishery and water-based recreation	30,000	30,000	30,000
Environmental corridor the length of project area (except through Minot)	6,250,000	6,250,000	-
Corps of Engineers purchase in fee and license all project lands to Bureau for operation (project cost)	?	?	?
Replacement of lands and water areas above Lake Darling site (25,000 acres±)	3,750,000	-	-
Replacement of lands and water areas above Unit 41 site (5,500 acres±)	-	825,000	-
Periodic replacement of vegetation above Lake Darling to preserve deer habitat and esthetic values	-	-	1,250,000
Sediment pool above Lake Darling (Greene Crossing Dam) plus minor marsh development at upper end of project	-	-	520,000
Project plans provide that the water rights of the Federal Government be safeguarded	-	-	-
Estimated Cost	$11,164,000	$ 8,219,000	$ 2,602,000

*[illegible] annual for plans (a) and (b)
[illegible] annual for plan (c)

Burlington Dam	Advantages	Disadvantages
	1. less flooding of area above Lake Darling a. less adverse effects on waterfowl production above Lake Darling b. less adverse effects on timber areas above Lake Darling than a Lake Darling site	1. repeated adverse effect on NWR units 87, 96 and the 850-acre mitigation pool 2. loss of more stream fishery below Lake Darling 3. loss of timber below Lake Darling 4. loss of recreational access below Lake Darling 5. less feasible compensatory opportunities than with a Lake Darling site 6. possibly impair recrutiment of fishstock from Lake Darling to Souris River
Confluence Dam	Same as above	Same as above

JULY 1972 COST ESTIMATES

Compensatory Needs:	Regulation Plan(a)	Regulation Plan(b)	Regulation Plan(c)
1. Corps of Engineers protect or replace affected BSFW facilities at Upper Souris at project expense (83, 87, 96 repair costs)	$ 300,000	$ 300,000	$ 300,000
2. Fisheries development such as spawning areas and stocking	100,000	80,000	50,000
3. Recreational access points made for fishing and water-based recreation	30,000	30,000	30,000
4. Environmental corridor the project length (except through Minot)	6,250,000	6,250,000	-
5. Corps of Engineers license all project lands to BSFW for operation (project cost)	?	?	?
6. Development of small satellite refuge or improvement of J. Clark Salyer NWR by addition of another marsh	760,000	760,000	760,000
7. 850-acre marsh unit downstream of Unit 96 (no land costs)	-	-	365,000
8. Sediment pool above Lake Darling (Greene Crossing Dam) plus marsh development at upper end of project	520,000	520,000	520,000
9. Periodic replacement of vegetation above Lake Darling to preserve deer habitat and esthetic values	-	-	1,250,000
10. Replacement of Upper Souris NWR land and water areas above Unit 96 (31,088acres)	4,700,000	-	-
11. Replacement of Upper Souris NWR lands and water areas below Unit 83 (6,000± acres)	-	900,000	-
12. Corps of Engineers provide O&M to BSFW for operating Burlington site*	353,000	353,000	71,000
13. Project plans provide that the water rights of the Federal Government be safeguarded	-	-	-
Total Estimated Cost	$13,013,000	$ 9,193,000	$ 3,3[illegible]

*[illegible]0,000 annual for plans (a) and (b)
[illegible],000 annual for plan (c)

Baker Bridge Dam

Advantages	Disadvantages
1. less stream miles inundated than with Burlington or Confluence site	1. almost total loss of Upper Souris NWR units 87, 96
2. less timber losses than with Burlington or Confluence site	2. adverse effects to Lake Darling fishery by periodic inundation and rapid water changes
	3. more frequent wildlife loss above Dam 41, than with Burlington or Confluence sites
	4. loss of recreational areas below Dam 83 (Lake Darling)
	5. less feasible compensatory opportunities than with a Lake Darling site
	6. possible impaired recruitment of fish stock from Lake Darling to Souris River
	7. periodic loss of stream fishery between Baker Bridge and Lake Darling

JULY 1972 COST ESTIMATES

Compensatory Needs:	Regulation Plan(a)	Regulation Plan(b)	Regulation Plan(c)
1. 850-acre unit downstream of Unit 96 (plus 1700 acres of land)	$ 620,000	$ 620,000	$ 620,000
2. Corps of Engineers protect or replace affected BSFW facilities at Upper Souris at project expense (Units 83, 87, 96 repair costs)	300,000	300,000	300,000
3. Fisheries development such as spawning areas and stocking	100,000	80,000	50,000
4. Recreational access points needed for fishery and water-based recreation	30,000	30,000	30,000
5. Environmental corridor the length of project area except through Minot	6,250,000	6,250,000	-
6. Development of small satellite refuge or improvement of J. Clark Salyer NWR by addition of another marsh.	760,000	760,000	760,000
7. Corps of Engineers license all project lands to BSFW for operation (project cost)	?	?	?
8. Sediment pool above Lake Darling (Greene Crossing Dam) plus marsh development at upper end of project	520,000	520,000	520,000
9. Periodic replacement of vegetation above Lake Darling to preserve deer habitat and esthetic values.	-	-	1,250,000
10. Replacement of Upper Souris NWR lands and water areas above Baker Bridge (31,088 acres)	4,700,000		-
11. Replacement of Upper Souris NWR lands and water areas below Unit 83 (6,000± acres)	-	900,000	-
12. Corps of Engineers provide O&M to BSFW for operating Baker Bridge site*	353,000	353,000	71,000
13. Project plans provide that the water rights of the Federal Government be safeguarded	-	-	-
Total Estimated Cost	$13,633,000	$9,813,000	$3,601,000

* $20,000 annual for plans (a) and (b)
$ 4,000 annual for plan (c)

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In Reply Refer To:
FSF/RB

MAY 1973

Dear General Clarke:

A serious matter has been brought to my attention by the Bureau of Sport Fisheries and Wildlife regarding the potential adverse environmental effects of the two authorized Corps of Engineers' flood control projects on the Souris River in North Dakota. Channel modification in the vicinity of Minot and a dam and reservoir near Burlington were considered during the pre-authorization study but were authorized separately. Independent authorization was effected so that the channel modifications could provide Minot with some degree of interim flood protection during the extended period required for planning and construction of a dam upstream from the city. The channel modification was authorized by the 1965 Flood Control Act and construction of Burlington Dam was authorized by the Flood Control Act of 1970.

The St. Paul District Engineer is conducting a phase-one, post-authorization reevaluation and reformulation study for upstream control by reservoirs. We understand this study will review the authorized Burlington Reservoir under today's economic, social, and environmental conditions to determine if the recommended project still constitutes the best plan. Several alternatives, including no project, flood plain evacuation, flood plain zoning, and three other reservoir sites, are being reviewed. According to Design Memorandum number one for the channel work at Minot, the design channel capacity is subject to change depending on the results of the phase-one reservoir study. Therefore, work on the channel aspect of the project is not supposed to begin until the phase-one storage facility study is completed. The reservoir study has not been completed, yet clearing and snagging in the lowermost reach of the channel project have been completed. Bids are to be opened in early May with work to begin about mid-June on excavation of a portion of the channel downstream from Minot. It appears that there is undue haste to get the channel work well underway before information bearing on the channel capacity, as related to the ultimately selected storage plan, is available.

The principal concern of the Bureau of Sport Fisheries and Wildlife is that the piecemeal way these two projects are being handled may result in an environmentally disastrous situation even though several viable and less damaging flood protection measures may exist. Two major national wildlife refuges on the Souris River, as well as a considerable amount of unique woody habitat between these refuges, constitute extraordinarily high values that must be reckoned with in planning for flood control.

In a 1968 report, the Bureau of Sport Fisheries and Wildlife outlined measures which would make the Burlington site one it could "live with." That report also concluded that the proposed channel modifications in the vicinity of Minot would result in little damage to fish and wildlife resources. In a letter dated November 3, 1969, commenting on the reservoir storage project, the Department of the Interior stated that it was "satisfied that the recommended plan contains the necessary safeguards to protect associated fish and wildlife resources including Upper Souris National Wildlife Refuge.

During 1972, as detailed plans for the channel work became known, the Bureau expressed concern that the project would have more serious effects on wildlife habitat than previously believed and that the brief, cursory environmental impact statement on channel modifications submitted to the Council on Environmental Quality in March 1971 was inadequate. A fish and wildlife habitat loss mitigation plan involving 28 recommendations was submitted to the St. Paul District Engineer on September 13, 1972. A response to this report was received on March 22, 1973. The District Engineer agreed to most of the recommendations, but he pointed out the Corps' inability to obtain local acceptance of a greenbelt tract along the river or to acquire sufficient land in oxbows to meet mitigation requirements; these were the two major recommendations. Although the St. Paul District Engineer promised by letter dated March 14, 1972, that a revised, updated environmental impact statement would be available for review and comment in a few weeks, it still has not been released.

An environmental impact statement dealing with reservoir storage, perhaps even more inadequate than the channel modification statement, was submitted to the Council on Environmental Quality in March 1971. On October 2, 1972, the Bureau also advised District Engineer Cox that before a final plan for loss mitigation in relation to reservoir storage on the Souris River could be discussed, the Corps' revised environmental impact statement on this phase of the overall project also must be made available for study. The Bureau did not receive a copy of the revised statement until January 7, 1972, and this was only an information copy. The official revised environmental impact statement for this phase of the project has not been furnished to us as of this date.

The Bureau position regarding flood storage on the Souris River was summarized in a letter dated December 15, 1972, to Colonel Cox from the Minneapolis Regional Office of the Bureau of Sport Fisheries and Wildlife. The position expressed was essentially that due to new laws, policies, flood control plans, and potential alternative storage sites, the Bureau could no longer be limited to the position adopted in its 1968 report. The Bureau stated that if a reservoir had to be built, the Lake Darling site would have the least harmful effect on our refuge operations and related fish and wildlife resources. In addition, the least harmful of three proposed reservoir regulation plans was identified.

Due to a reorganization in the Bureau of Sport Fisheries and Wildlife, responsibility for the Souris River and Tributaries Flood Control Projects was transferred to the Denver Regional Office on January 1, 1973. Since that time, the Bureau of Sport Fisheries and Wildlife has tried without success to persuade the St. Paul District Engineer to defer construction of the channelization works until adequate impact statements thoroughly analyzing all aspects of the entire project (channelization and reservoir storage) have been made available for review and comment. Colonel Cox summarized his position in his letter of April 5, 1973, to Regional Director Marston by stating: "In view of our comprehensive review analysis and without your furnishing factual support for, and identification of, a viable less damaging alternative, I cannot in good conscience defer the continuing channel work presently programmed."

It is our view that without the benefit of an environmental impact statement assessing all the alternatives, with review comments from appropriate agencies, Colonel Cox is not in the best position to render a judgment as to what would constitute a viable alternative to channelization. Neither is he able to decide infallibly which, if any, of the reservoir alternatives should be selected. Recent court cases indicate that the National Environmental Policy Act of 1969 requires the project planning agency to look at all alternatives objectively. They further require that agency decisionmakers must have sufficient information on alternatives in an impact statement to make an intelligent decision. The conditions surrounding the Souris River and Tributaries Flood Control Projects do not appear to measure up under this test.

In view of the inadequacy of the environmental impact statements now in the record and the important fish and wildlife and other environmental values that would be sacrificed if hasty decisions are made, I am requesting a halt to further construction of the channelization works until the problems can be resolved between our two agencies.

Sincerely yours,

(Sgd) Nathaniel P. Reed

Assistant Secretary of the Interior

Lieutenant General F. J. Clarke
Chief of Engineers
Corps of Engineers
Department of the Army
Washington, D. C. 20314

DAEN-CWP-C 12 June 1973

Honorable Nathaniel P. Reed
Assistant Secretary of the Interior
Washington, D. C. 20240

Dear Mr. Reed:

This is in reply to your recent letter expressing the concern of the Bureau of Sport Fisheries and Wildlife over our construction of channel improvements for flood control on the Souris River, North Dakota, and requesting that further construction be halted at this time.

I understand that you desire a meeting in the near future to discuss the matter in detail. I believe that such a meeting will be most useful and will be pleased to discuss the background and status of the flood control planning for the Souris River with you and your staff. Colonel Raymond J. Einsigl, our Assistant Director of Civil Works for Central Divisions, telephone Oxford 3-6864, should be contacted to arrange for mutually satisfactory meeting date.

With regard to your request to halt channel construction, there is no immediate channel construction pending and it will be at least 45 days before our District Engineer in St. Paul could be in a position to award a construction contract for the next increment of channel work. The District Engineer has not yet advertised for bids on the next contract.

Sincerely,

JAMES L. KELLY
Brigadier General, USA
Deputy Director of Civil Works

CF: North Central Div
St. Paul Dist

NCSED-PB 26 July 1973

SUBJECT: Burlington Dam Operation, Souris River, North Dakota

Division Engineer, North Central

1. Inclosed are copies of the District memorandum covering the meeting with representatives of the Department of the Interior in OCE on 24 July 1973.

2. At the conclusion of the 24 July meeting, Mr. Nathaniel P. Reed, Assistant Secretary, Department of the Interior, requested information developed for tha Souris-Red Rivers International Engineering Board, International Joint Commission, covering operation of Burlington Reservoir and the computer results as they might apply to the effects of storage release on the J. Clark Salyer National Wildlife Refuge. Inclosed is a copy of a recent letter with inclosures which provided such data to the Chairman of the Canadian section of the Task Force appointed by the Engineering Board.

3. Representatives of the District will arrange to meet soon with Mr. M. A. Marston, Regional Director, Region 6, and the North Dakota Area Director, Bureau of Sport Fisheries and Wildlife, to discuss the District proposed Phase I plan, the plan of operation, the relation to the channel improvement program, alternatives, and any other matters of mutual concern, some of which may have been discussed with personnel of Region 3 and conclusions reached when the Souris River was under its jurisdiction, but not brought to the attention of Region 6 personnel.

2 Incl
1. Cy NCSED-PB Memo, 25 July 73 (dupe)
2. Cy NCSED-PB ltr to Mr. Brown, 3 July 73 (trip.)

GEORGE T. LABLONDE, JR.
Major, Corps of Engineers
Acting District Engineer

NCSED-PB 2 August 1973

Mr. M. A. Marston
Regional Director
Bureau of Sport Fisheries and Wildlife
10597 West Sixth Avenue
Denver, Colorado 80215

Dear Mr. Marston:

On 24 July 1973, representatives of our offices participated in a meeting in Washington during which the participants discussed the questions raised in a letter dated 2 May 1973 from Mr. Nathaniel P. Reed to Lieutenant General F. J. Clarke, regarding the potential adverse environmental effects of the two authorized Corps of Engineers flood control projects on the Souris River in North Dakota. The Department of the Interior and your Bureau were represented by the following:

Mr. Nathaniel P. Reed, Assistant Secretary
Mr. Ken Black, Director for Cooperative Services
Mr. Lynn A. Greenwalt, Assistant to Director, USF&WLS
Mr. James Gritman, Area Manager, BSF&WL, Bismarck, North Dakota

In his summary of the Department's position, Mr. Reed noted two primary areas of concern: first, that evacuation might be a practical, less-damaging alternative than the authorized projects and second, that the Bureau's primary waterfowl production area was the J. Clarke Salyer National Wildlife Refuge and that serious adverse effects were anticipated as a result of our operation of a flood control reservoir above Minot. Our recent reevaluation of the economics of evacuation is included in the inclosed brochure, copies of which were distributed to the conference participants. With a cost of about $178 million and the social problems which such a major dislocation of people would generate, we questioned the viability of evacuation as a solution to the flood problem. Concerning the impact of a flood control reservoir on the J. Clarke Salyer Refuge, we summarized the plan of operation developed in our several public meetings with the Citizens Advisory Committee and the results of computer runs made by the U.S. Geological Survey to simulate the effects of summer-fall runoffs from rainstorms occurring over the basin while reservoir drawdowns were in progress. These studies were made as part of a response to an International Joint Commission referral of the question to the Souris River International Engineering Board and its assignment, in turn, to an International Task Force. Since we had recently summarized the results of the studies to date in a letter with attached hydrographs to the Chairman of the Canadian Section of the Task Force, Mr. Reed suggested that we make the findings available to you. Accordingly, I am inclosing copies of our letter of 3 July 1973 to the Canadian Task Force member.

Since the Washington meeting, I have announced publicly the program I propose to recommend, based upon a review of the environmental, social, and economic effects and values involved as set forth in the revised drafts of the environmental impact statements and the Phase I project formulation design memorandum. These reports are currently being reviewed and coordinated internally and are scheduled to be distributed to concerned agencies soon for comment. I believe that better public participation and opportunity to comment meaningfully will be obtained by making known my proposed recommendation. However, I have made clear that the Phase I plan is my recommendation and as such is subject to review internally within the Corps of Engineers before a final decision is made. The comments received from the reviewing agencies and organizations could have a bearing on the final decision.

The most significant conclusion reached at the conference seemed to be that we may not have communicated sufficiently at field level. Since we had worked fairly closely with personnel of your Region 3 office throughout the review planning period in 1972, we assumed that, with the reorganization and redefinition of regional boundaries which brought North Dakota under your jurisdiction, your new personnel would be fully briefed by the Region 3 people. In my visit with you on 12 January 1973, I expressed our willingness to meet with your personnel who were concerned with the Souris River flood control projects and to answer any questions they might have.

In view of the Washington meeting, I suggest that we schedule a meeting soon whereby our planning people could meet with Jim Gritman and such other Bureau people you might desire to have participate. If a meeting in Bismarck, North Dakota, would meet your convenience, we could probably arrange to have representatives of the concerned State agencies also participate, or to hold a first meeting only with the Bureau and a second meeting with the combined group. Our men would be prepared to brief the participants on the principal project features, overall effects of construction and operation, merits of alternatives, the basis for project selection, and related matters. In addition, they would be prepared to answer any questions that might be raised.

I would appreciate receiving your views on the proposed meeting or meetings and, as appropriate, your suggestions regarding a date and times that would meet the convenience of your people.

Sincerely yours,

RODNEY E. COX
Colonel, Corps of Engineers
District Engineer

3 Incl (dupe)
1. Brochure, Dept of the Interior Conf, 24 July 73
2. Ltr w/incl, StP to Mr. Brown, 3 July 73
3. Phase I plan, 31 July 73

Copy furnished:
Mr. Nathaniel P. Reed
Washington, D.C. 20240
(w/incl 2 and 3 (dupe)

HQDA (DAEN-CWP-D (w/o incl)
NCD (w/o incl)

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D. C. 20314

DAEN-CWO-C

30 August 1973

Honorable John D. Dingell
Chairman, Subcommittee on
Fisheries and Wildlife Conservation
and the Environment
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

This is a further reply to your recent request for a report on the local flood protection project on the Souris River at Minot, North Dakota, including the status of the project and particulars as to coordination of project planning with others as required by the National Environmental Policy Act (NEPA) and the Fish and Wildlife Coordination Act (F&WCA).

This project, consisting of channel improvements, levees, and other related items, is an early feature of work in the flood control plan for the Souris River which was recommended to the Congress in our report subsequently published in House Document No. 91-321. It was approved as a separate project by resolutions of the Senate and House Public Works Committees, 25 June 1970 and 14 July 1970 respectively, under the provisions of Section 201 of the Flood Control Act of 1965 (P.L. 89-298). The remaining portion of the plan, consisting of Burlington Dam and Reservoir on the Souris River upstream of Minot, was subsequently authorized by the Flood Control Act of 1970 (P.L. 91-611). The basic data of the report was in large part prepared prior to the 1 January 1970 date of the NEPA, and included both public hearings and coordination with others as required by the F&WCA and other laws. In compliance with the new NEPA requirement, an environmental impact statement (EIS) covering the Souris River flood control plan recommended in the report was prepared and furnished in November 1970 to the Council on Environmental Quality and to the Public Works Committees of the Congress. The EIS for the Souris River report was one of several project EIS's collectively forwarded by one transmittal letter regarding projects being considered in the Omnibus Bill that later became the Flood Control Act of 1970.

Funds to begin preconstruction planning of the Minot channel improvement project were made available in late July 1970. A new EIS covering this now separate project was prepared and forwarded to the Council on Environmental Quality in late March 1971. Funds to begin project construction were made available in July 1971 and funds to continue project construction have been made available in each successive year. Two items of work have been completed, the Roosevelt Park cutoff in Minot and channel snagging and clearing along a 6.3-mile segment at the downstream end of the project. A contract is scheduled to be awarded soon for channel enlargement along a 3.4-mile segment immediately upstream of the completed snagging and clearing segment.

Since receipt of preconstruction planning funds, our field personnel have worked closely with representatives of the U.S. Bureau of Sport Fisheries and Wildlife and of the North Dakota Game and Fish Department. Our biologists, and those representing the two wildlife agencies, participated in inspections of the channel improvement reaches to identify areas where plans could be modified to minimize adverse environmental effects and to locate areas which might be acquired to compensate for environmental losses which were unavoidable. Of 28 modifications suggested by the Bureau, all but three are being adopted generally as proposed. Based upon more detailed engineering surveys and designs, field level coordination with Bureau representatives, and the results of a number of meetings with responsible local organizations and individual interests, a revised EIS is now being prepared in accordance with the more detailed requirements and format that have evolved since the earlier EIS's. Project planning is a continuing process that does not cease merely because construction begins, but often allows for the incorporation of new or modified measures found to be justified and feasible as more information becomes available.

The Burlington Dam project and the Minot local protection project are related, in that Souris River flows passing the damsite and augmented by runoff from the intervening area, later pass through the Minot area. The capacity of the channel in the Minot area to pass flows without flood damage to adjacent lands and habitations is a major consideration in planning the storage and operational flood control releases of Burlington Dam. Any increase from the natural channel capacity as a result of the Minot project will allow a larger range of flood control releases at the authorized Burlington Dam and Reservoir. The Burlington project is still in a preconstruction planning status and it, rather than the Minot project, has the potential for serious effects upon the Lake Darling and J. Clark Salyer Refuges mentioned in your letter. Lake Darling is within the flood control pool of Burlington Dam and would be completely unaffected by the Minot project. The J. Clark Salyer Refuge is more than 50 miles downstream of the Minot project, and the Minot channel project would have no effect on this refuge.

The Minot project is economically justified and feasible, with or without the Burlington project. It will significantly reduce flood damages at Minot, but will not provide the degree of protection considered appropriate for a developed area unless other additional works such as Burlington Dam are also constructed.

While your inquiry was made with reference to the Minot local protection project, further comment concerning planning and coordination efforts regarding Burlington Dam are appropriate to a full reply in view of your expressed concern for the Lake Darling and J. Clark Salyer Refuges.

Under a project studies contract, Minot State College has prepared and furnished a report on the biological and recreational impacts of nine proposed flood control alternatives. The report provides a detailed inventory of the environmental values in the Souris River floodplain, and will serve as an information base for the revised EIS's being prepared regarding both the Minot project and Burlington Dam project.

During review of project formulation for the Burlington Dam, our District Engineer at St. Paul has cooperated with a citizens advisory committee. Corps of Engineers representatives attended 17 committee meetings during which every suggested alternative to resolve the serious area flood problem was reviewed in detail. The Refuge Managers from the Upper Souris (Lake Darling) and J. Clark Salyer National Wildlife Refuges attended most of the meetings. During the series of local committee meetings, representatives of Region 3 of the Bureau made a presentation and discussed the values involved in the refuges, the current plan of operation of the Lake Darling Dam, and the possible changes in its operation should a downstream flood storage facility (Burlington Dam) be constructed. Their input at that time, together with a continuing dialogue between Corps planners and Region 3 representatives, contributed significantly to the Burlington Dam plan of operation that has now evolved.

The original plan of dam operation has been modified to take full advantage of the improved downstream channel capacity. The release rate from flood control storage was modified to assure channel capacity at downstream areas, including the J. Clark Salyer Refuge area, would not be exceeded. To aid operations at the J. Clark Salyer Refuge, the operation plan provides for a seasonally lower flow rate suggested by the Bureau. The operation plan would limit use of flood control reservoir storage to an average of once

DAEN-CWO-C 30 August 1973
Honorable John D. Dingell

in about 30 years, thereby significantly lessening the project impact on the Lake Darling Refuge.

Under a recent realignment of regional boundaries, the Bureau of Sport Fisheries and Wildlife shifted responsibility for its North Dakota facilities from the Region 3 office in Minneapolis to the Region 6 office in Denver. Some misunderstandings that appear to have arisen with this transfer of responsibility were recently discussed with Mr. Nathaniel Reed, Assistant Secretary of Interior. Technical personnel of the Department of Interior, including those of the Bureau's Region 6 office, are reviewing the proposed flood control operational plan for Burlington Dam. Similar coordination is underway through the International Joint Commission (the Souris River flows from Canada into the United States and then back into Canada). A new environmental impact statement which reviews all alternatives and is fully coordinated with all interested or affected parties, will be processed and forwarded to the Council on Environmental Quality before any construction activities are commenced regarding the Burlington Dam project. All such activities are subject to the availability of funds appropriated by the Congress, and funds to initiate construction have been neither requested of nor appropriated by the Congress.

I believe that with regard to both the Minot local protection project and the Burlington Dam project, we have complied and are continuing to comply with the National Environmental Policy Act and the Fish and Wildlife Coordination Act. We have kept the Department of Interior through the Bureau of Sport Fisheries and Wildlife fully apprised of our plans, and with their views in mind, we have done and are doing everything in our power to avoid, reduce, or compensate for losses in fish and wildlife and other environmental values. Environmental impact statements, including coordination with others, have been processed already, and revisions continue to be prepared for processing as additional project data indicate revision is appropriate. I will be pleased to provide additional information that the Committee may desire and request concerning these two projects or any other matters for which I bear responsibility.

Sincerely yours,

W. C. GRIBBLE, JR.
Lieutenant General, USA
Chief of Engineers

CF:
NORTH CENTRAL DIVISION
ST. PAUL DISTRICT

Theodore Roosevelt Chapter, IWLA
P.O. Box 1021
Minot, North Dakota 58701
January 9, 1973

THE IZAAK WALTON LEAGUE OF AMERIC
INCORPORAT

National Water Commission
Room 405
800 N. Quincy Street
Arlington, Virginia 22203

Dear Sir:

Our organization has received information concerning your draft report on water resource programs. Since the recommendations contained in your report will have a profound effect on national water resource policy in the future, we would like to comment on the following points:

1. We strongly support the recommendation that a major portion of the cost of flood control, irrigation, drainage and navigation projects be borne locally. At present, local planners think mainly in terms of benefits and tend to ignore costs that will be borne by the federal government. This works to restrict planning to those projects that can be federally financed, ruling out the possibility of innovative solutions on a local level that may be more economically and environmentally sound.

For example, the City of Minot plans to provide for its future water supply needs by receiving water through the Bureau of Reclamation Garrison Diversion Project, a plan that involves an interbasin transfer of water through over 100 miles of canal from the Snake Creek Reservoir on the Missouri River to a reservoir somewhere outside the city. At the same time the city is seeking flood protection through a Corps of Engineers project to channelize and dam the Souris River which runs through the city. One cannot help but think that if the city were not caught in the never-never land of planning imposed by jurisdictional restraints upon the federal agencies involved, that both problems could be consolidated and a single, more economical plan could be worked out. If limited local funds had to be used to solve both problems, Minot's own river would have to be regarded as a resource rather than a threat. Flood damages would have to be reduced by sound floodplain management, rather than by costly structural schemes in order to use available funds wisely to answer the problem of water supply.

aking the benefactor pay the cost of water resource development is one way of ripping way the guise of spurious cost-benefit analysis that now justifies environmentally estructive projects. More economical means of solving water problems will have to e found and coordination for better planning will become necessary to avoid duplication and use funds effectively.

owever, we should also like to caution against federal non-involvement to the extent hat will precipitate destructive, piecemeal development.

. We also support the recommendations on flood control policy that call for greater e of floodplain management and nonstructural methods of flood control instead of g dam and channelization schemes. Present flood control policies serve only to rpetuate flood damages by encouraging floodplain development.

In Minot, the avoidance of floodplain management while a structural flood control project is in the planning has resulted in some interesting benefit-cost shenanigans. In their 1969 report on the Souris River the Corps of Engineers, with respect to floodplain evacuation as a flood protection alternative, estimated annual flood damage reduction benefits at $4.4 million with annual costs of $2.3 million giving the alternative a favorable benefit-cost ratio of 1.9. However, floodplain evacuation was rejected "since other flood damage reduction alternatives were found to be much less costly and since evacuation would be socially unacceptable." At the time of the report, the Corps-recommended plan calling for reservoir storage and channel improvements was assigned annual benefits of $4.4 million and annual costs of $1.7 million for a benefit-cost ratio of 2.65.

Several changes in the Corps' original plan came under consideration as the Corps met with the Souris River Flood Control Planning Committee which was formed with the purpose of resolving public concerns. As a result, changes were made in the Corps' economic analysis. The most recent figures, related to the reservoir storage and channel improvement alternative, estimate annual benefits at $4.7 million, annual costs at $2.4 million and a benefit-cost ratio on the order of 2.0, virtually identical to the 1969 estimates for floodplain evacuation. Since the "social unacceptability" of floodplain evacuation could be greatly reduced by a phased withdrawal from the floodplain in lieu of immediate evacuation, one would assume that floodplain evacuation should now receive serious consideration. However, floodplain evacuation was again rapidly dismissed. The Corps simply re-analyzed the floodplain evacuation alternative, <u>lowering benefits</u> to $3.3 million and <u>raising costs</u> to $4.3 to $5.0 million giving the alternative an unfavorable benefit-cost ratio of 0.77 to 0.66. This change in benefit-cost ratio for floodplain evacuation points up the possibility of serious weaknesses in the Corps' benefit-cost analysis. Even the "social unacceptability" of floodplain evacuation may be more a function of the unavailability of public funds for that purpose than of genuine social concerns.

The effectiveness of present structural approaches to flood control is also questionable on technical grounds. Siltation has frequently been cited as reducing the effectiveness of storage reservoirs. Emerson's recent case study of the Blackwater River in Missouri (<u>Science</u> 173:325) suggests that channelization may set in motion natural processes of erosion that in the long run could cause destruction that outweighs any benefits of channelization. Recognition by planners that floodplain development should be restricted to agricultural and recreational uses is long overdue. Any further development of floodplains for residential and urban use must be prevented.

3. We support the recommendations that the beneficiaries of drainage and irrigation projects repay the full costs. It makes little sense to finance new federal irrigation and drainage programs designed to increase agricultural production when in 1972 approximately 60 million acres of farm lands were purposely taken out of agricultural production under federal set-aside programs at a cost to taxpayers of about $4 billion (<u>Conservation News</u>, Vol. 37, No. 22, December 1, 1972, p. 7: Build The Dams, Damn The Environment, by Ken Hampton).

We also cite those sections of the Reclamation Act of 1902, the Mineral Leasing Act of 1920 and the 1938 Hayden-O'Mahoney Amendment to the Reclamation Law that divert certain revenues into the Reclamation Fund as being outdated and suggest a review of those policies in the context of current national priorities.

4. We support the recommendation for an independent board of review to scrutinize the project plans of water development agencies. The present operating procedures of these agencies tend to bias their recommendations toward structural development and away from non-structural development. Therefore an independent board of review is needed.

We would like to see this board operated in such a manner as to permit coordination between agencies and to encourage basin-wide planning in water resource development. The interrelationships among different projects within a water basin must be recognized in order to eliminate the costly duplication and conflict inherent in haphazard development.

5. We reiterate our desire that the discount rate for water projects be set at a level of 10%, the "opportunity cost of capital." Lower discount rates permit the financing of projects that are economically unjustifiable and prevent the adoption of sound solutions such as serious land use planning, floodplain protection and non-structural approaches. We further stress that the 10% discount rate should be applied to all uncompleted water projects regardless of when they were authorized.

6. We wish to express reservations concerning the Commission's conclusions with respect to the 1972 Water Pollution Control Act Amendments. Water pollution may be responsible for roughly $12 billion in damages annually, which should certainly justify a massive effort to clean up the nation's waters and achieve no polluting discharges by 1985.

7. We would like these comments to be made part of the official record on the Draft Report.

Sincerely,

Lloyd Nygard

Lloyd Nygard, Acting President
Theodore Roosevelt Chapter, IWLA

Paula Ward

Mrs. John A. Ward
National Director-at-large
Izaak Walton League of America

CC: The Hon. Milton R. Young, U. S. Senate
The Hon. Quentin N. Burdick, U. S. Senate
The Hon. Mark Andrews, House of Representatives
The Hon. Arthur A. Link, Governor of North Dakota
Mr. Roy Ash, Director, Office of Management & Budget
Mr. Raymond C. Hubley, Jr., Executive Director, National Office, IWLA
Mr. Thomas E. Dustin, Exec. Sec., Indiana Division, IWLA

800 N.W. 15th Street
Minot, North Dakota 58701
February 1, 1973

THE IZAAK WALTON LEAGUE OF AMERICA
INCORPORATED

The Honorable Quentin N. Burdick
United States Senate
The Capitol
Washington, D.C. 20510

Dear Senator Burdick:

Please accept a very belated thank you for your time and trouble in obtaining material on the Garrison Diversion Project for us from the Bureau of Reclamation. At the Bureau's request, we will return the material to the Billings, Montana office when our study is completed.

We would also like to comment that the Missouri-Souris Projects Office of the Bureau of Reclamation in Bismarck is cooperating by loaning us additional information. All of the combined materials will assist us greatly in evaluating the Environmental Impact Statement on the Garrison Diversion Project. We understand the statement will be released some time in the near future. We will forward a copy of our comments to you as soon as possible after reviewing the statement.

As you may have realized, we are also studying the proposal for Flood Control for the City of Minot and have been receiving cooperation with the Corps of Engineers in our study. Some nationwide attention has been focused on the project through the Izaak Walton League of America in our national publication, Outdoor America. A copy of the November issue containing the story was forwarded to your office recently.

Our local chapter, the Theodore Roosevelt Chapter, will hold a public meeting soon, to be arranged with Bob Calton of the Corps of Engineers, for discussion of the Corps' Environmental Impact Statement on the Flood Control Project. Since few people are familiar with environmental impact statements, we would like to have available to hand out at the meeting an informative publication by the Environmental Protection Agency. The title of the brochure is: In Productive Harmony - Environmental Impact Statements Broaden the Nation's Perspectives. Is it possible for you to obtain 300 copies of this pamphlet for our chapter to pass out at the meeting? I believe the pamphlet is free. Any leftover copies would be passed out to the Reclamation Committee and the Environmental Affairs Committee, both of which I am a member. (These are local Chamber of Commerce Committees.)

To keep you up to date on environmental questions, we have been sending you a copy of our chapter's monthly publication, The Roughrider.

Thank you again for your assistance. I hope to hear from you soon.

Sincerely,

Paula Ward

Mrs. John A. Ward
National Director-at-large

NCSED-PB 16 February 1973

Honorable Quentin N. Burdick
United States Senate
Washington, D.C. 20510

Dear Senator Burdick:

This is in response to your letter of 12 February 1973, requesting information and a discussion of the points raised in an attached letter from Mrs. John A. Ward including a copy of her letter to the National Water Commission, particularly as they relate to flood protection on the Souris River at Minot, North Dakota.

During the past year we have cooperated with the Theodore Roosevelt Chapter of the Izaak Walton League and have developed a great respect for Mrs. Ward's statements and concern for the existing environment. The story carried in the November issue of Outdoor America was a reasonably fair analysis of some of the alternatives explored with the local flood control planning group in our efforts to develop an acceptable solution to the flood problem. At the time the article was written, Minot State College under a contract with us was preparing an environmental assessment of the areas which would be affected by the principal alternatives under consideration. More recently, we completed a preliminary draft of the environmental impact statement which is currently being reviewed within the Corps of Engineers. Also, we answered the questions raised locally regarding the hydrologic and economic effects of a reservoir development as proposed in the survey report.

A summary of our views on the points raised in the letter to the National Water Commission is inclosed.

Sincerely yours,

1 Incl
As stated

RODNEY E. COX
Colonel, Corps of Engineers
District Engineer

Copy furnished:
Honorable Quentin N. Burdick
Minot, North Dakota 58701
HQDA (DAEN-CWA-D), w/cy inc ltr and incl from Senator Burdick, 12 Feb 73
NCD, w/cy inc ltr and incl from Senator Burdick, 12 Feb 73
PA

COMMENT ON IZAAK WALTON LEAGUE LETTER
TO THE NATIONAL WATER COMMISSION
16 February 1973

Item 1 of the letter to the Water Commission speaks in general terms of the merits of local interests bearing a major portion of project costs, relates this philosophy to the Minot situation where both periodic floods and water supply shortages are serious problems, and concludes that a more economical plan could be worked out. Having spent almost a year exploring every alternative suggested and thoroughly discussing them at the public meetings of the local planning group, no panacea was found and none was within the financial capability of the community without Federal assistance. With all of the low-flow Souris River water supplies already overcommitted by prior water rights and with groundwater supplies limited, the arrangement between the city and the Bureau of Reclamation for a supplemental supply via the Garrison diversion project appears justified. At the request of the planning group, the Bureau investigated the possibility of using water stored during flood periods when available to supplement or substitute for the Garrison diversion water. The Bureau reported that the cost of the necessary pumping facilities and related works would greatly exceed possible savings in transportation costs via the Garrison diversion channel and other values obtainable. We agree that sound floodplain management is an essential and a basic element of a flood damage reduction program, but we also recognize that, once a major portion of a large city is located in the floodplain, management techniques alone rarely provide a practical solution.

Item 2 concerns floodplain management and nonstructural methods of flood damage reduction instead of dams and channels, questions the reliability of our economic analyses for protection versus evacuation at Minot, and cites general observations relating to siltation of reservoirs, canalization, and floodplain use. We spent a lot of time on the reanalyses of the economics of the many alternatives, and we doubt that any other group has considered all aspects of evacuation in depth as we have. Our estimates of costs and benefits of evacuation for the survey report were less detailed than our more recent work and the revisions are the result of our more extensive analyses. Evacuation sounds very simple to many people but they rarely realize the social problems involved; the costs of new schools, churches, and other buildings which cannot be moved; the new streets, waterlines, sewers, and other facilities which must be provided; and the problems associated with maintaining the railroad, highway, and other facilities which cannot be moved. Further, we cannot limit evacuation to Minot only. About 10 suburban developments in the valley between Minot and Burlington, parts of Sawyer, and much of Velva are presently protected by emergency levees which are wholly inadequate to cope with a major flood. These communities would also have to be moved. Both economic and social considerations make evacuation an impractical solution to the Souris River flood problem; not unavailability of public funds. The general reference to siltation of reservoirs has no bearing in this case since Lake Darling and the refuge pools already provide silt traps, and the proposed plan of operation of the flood control reservoir developed with the Planning Committee contemplates use of the storage no more often than about once in 30 years. Floodplain regulations to control development in vulnerable areas are in effect in both Minot and Ward County, and the flood plan provides for their continuance except in those areas which will receive a high degree of flood protection. Thus, we are in complete agreement that every effort must be made to prevent unwise floodplain development which would lead to further requests for public assistance.

Items 3, 4, 5, and 6 are not specifically oriented toward the flood problems on the Souris River and the advantages and disadvantages of their acceptance as public policy have already been discussed at length at public hearings, in the press, and by many concerned organizations and individuals. The Corps of Engineers views on these policy matters are a matter of record and are promulgated at the Washington level.

In conclusion, the development of an acceptable solution to the Souris River flood problems has been extremely complex involving existing wildlife refuges, differing urban and rural landowners concerns, and international interests. Although we are accused of being biased toward structural measures, this is definitely not the case. We believe our review work with the local planning committee has been fair and impartial. Quite possibly some of the members of the local chapter of the Izaak Walton League may have personal interests which preclude their unbiased approach to the solution of the Souris River flood problems. The local planning committee has elected to remain functional beyond this initial planning stage. Thus, we look forward to continuing this valuable local participation in the area.

800 Northwest 15th Street
Minot, North Dakota 58701
May 14, 1973

THE IZAAK WALTON LEAGUE OF AMERICA
INCORPORATED

Col. Rodney E. Cox, District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

ar Col. Cox:

onsidering the St. Paul District's recent efforts to minimize environmental impact of rojects, as noted in our letter of 13 April 1973, we are distressed with the apparent ntent of the Corps to go ahead with the channelization of the Souris River without ully complying with NEPA. We are more concerned with compliance with the "spirit" of he law than with the "letter" of the law.

t the 19 September 1972 meeting of the Souris River Flood Control Planning Committee e indicated that a concerted effort would be necessary to convincingly demonstrate that he impact statement would be more than just an overlay upon agency decision making. he intent of NEPA is not to fill the archives with futile impact statements, but to hape project planning.

ince some progress toward mitigating the adverse environmental impact of the channel hase of the project is underway, we have waited patiently for convincing evidence that eservoir planning has been influenced by the impact study. Such evidence has not been orthcoming. Since channelization irrevocably commits the Corps to a structural solu- ion to flood control on the Souris River, we cannot allow construction to proceed uncon- ested until several important questions have been answered:

. Where will the flood control reservoir be located and what will be its storage capacity?

e feel that channelization as a part of the plan cannot be divorced from the question of eservoir storage. If a reservoir location and design is proposed that has an unaccept- ble environmental impact, then the whole project is unacceptable and no part of it should e constructed.

e Souris River Flood Control Planning Committee took the position that economic and vironmental factors would preclude planning for protection from floods greater than ose which occur once in 150 years. The environmental impact study by Lunan and Glor- gen indicated that the least damaging structural alternative involved construction of dam at Lake Darling. As yet, the Corps has not given any significant indication that ese recommendations are being integrated with planning or that the final proposed servoir will be significantly different from that originally proposed in 1969, before tizen input and an environmental impact study were available to the Corps. We would ke to see compelling evidence that these factors have influenced planning of the servoir.

In the 1969 report on the Souris River the Corps, with respect to the floodplain evacuation alternative, estimated annual flood damage reduction benefits at $4.4 million with annual costs of $2.3 million giving the alternative a favorable benefit-cost ratio of 1.9. In more recent figures the Corps lowered benefits to $3.3 million and raised costs to $4.3 to $5.0 million giving the alternative an unfavorable benefit-cost ratio of 0.77 to 0.66. What accounts for this discrepancy?

It is extremely important that this question be resolved, both because the floodplain evacuation alternative has received only a cursory examination and been rejected on unsubstantiated grounds and because this change in benefit-cost ratio points up the possibility of serious weaknesses in the benefit-cost analysis. It is difficult to see how, within a three-year period, benefits could fall so much while costs approximately doubled. One would think that benefits and costs would be closely linked to the economy such that a rise in one would be accompanied by a rise in the other. Are these differences the result of error or some inscrutable mathematical legerdemain?

3. How were costs and benefits both upstream and downstream from proposed reservoirs calculated and what are those costs and benefits?

In spite of repeated requests at Flood Control Planning Committee meetings by Mr. Nygard and Mr. Southam that this information be made available so that its accuracy could be investigated, the Corps' representatives failed to comply.

It was brought out in questioning of Mr. Calton by Mr. Southam that land values only are calculated in the analysis of costs due to land losses upstream and that annual production losses are ignored. On the other hand, it was indicated that potential benefits from possible future development of the floodplain downstream are calculated as benefits. Is this an accurate impression? If so, could you explain the rationale behind such an approach; to us, it is a riddle wrapped up in a mystery inside an enigma. If not, will you please provide information on the criteria used to calculate benefits and costs? We would also appreciate an itemized benefit-cost analysis for the proposed project.

4. What steps are being taken to insure that Souris River communities comply with floodplain zoning requirements?

In March of this year alone, permits were issued for the construction of three structures in the 100-year floodplain in Minot. One of these structures is a three-plex. Total value of the three structures comes to $48,000. And yet, little or no flood protection has been provided. We are concerned that after protection has been provided, acceleratio of floodplain development may rapidly nullify any benefits from flood control.

We hope that the Corps can provide meaningful answers to these questions. Your letter of 19 April 1973 was encouraging in affirming our belief that much can be accomplished through an attitude of mutual cooperation. Like our namesake, the Theodore Roosevelt Chapter prefers to "speak softly and carry a big stick."

Sincerely,

Paula Ward

Mrs. John A. Ward
National Director-at-large, IWLA

CC: Hon. Milton R. Young
Hon. Quentin N. Burdick
Hon. Mark Andrews
Hon. Arthur A. Link
Raymond C. Hubley, Jr., Exec. Dir., IWLA

NCSED-PB 11 June 1973

Mrs. John A. Ward
National Director-at-large
The Izaak Walton League of America
800 Northwest 15th Street
Minot, North Dakota 58701

Dear Mrs. Ward:

This responds to your letter of 14 May 1973 in which you raised several questions concerning the alternative solutions to the flood problem on the Souris River, North Dakota.

I appreciate the amount of work you have done in developing your questions, and as a result, we have gone into considerable detail in documenting our inclosed response. Your third question was answered, at least in part, in our letter of 10 January 1973 to Mr. Ralph Christensen, Chairman of the Souris River Flood Control Committee, a copy of which is also inclosed.

Since copies of your letter were furnished to your congressional representatives, the Governor, and the Executive Director of the Izaak Walton League, I am furnishing copies of my response to them and to the Chairman of the Citizens Flood Control Committee.

Sincerely yours,

2 Incl
As stated

RODNEY E. COX
Colonel, Corps of Engineers
District Engineer

Copy furnished:
Hon. Milton R. Young, w/incl 1
Hon. Quentin N. Burdick, w/incl 1
Hon. Mark Andrews, w/incl 1
Hon. Arthur A. Link, W/incl 1
Mr. Raymond C. Hubley, Jr., Exec.Dir., IWLA, w/incl 1
HQDA (DAEN-CWA-D), w/cy ltr fr Mrs. Ward 14 May 73, & Incls
NCD, w/cy ltr fr Mrs. Ward 14 May 73, & Incls
Mr. Ralph Christensen, w/incl 1

Response to Questions in Letter Dated
14 May 1973 from Mrs. John A. Ward
Representing Izaak Walton League of America
May 1973

1. Question: Where will the flood control reservoir be located and what will be its storage capacity?

Answer: We agree that the channel size and reservoir storage are interrelated, and they have been considered as such in our review of alternatives with the Citizens Committee. However, the channel improvements completed to date, and those proposed for the next stage of construction, do not commit us to any specific program since the channel work is economically feasible without further work. The channel improvements produce lower stages for the more frequent floods and damage reduction benefits commensurate with the costs. After a year of public discussion and searching review of every possible alternative, to propose further delays while we repeat the analyses of some of the alternatives appears questionable, particularly in view of the risk of a major disaster every spring.

We question the validity of your statement that, if a part of the only practical solution to the flood problem has, in your opinion, " -- an unacceptable environmental impact, then the whole project is unacceptable ---." This philosophy could be applied to every alternative since all have opponents who consider some feature unacceptable from their viewpoint. The net result would be "do nothing", a decision you may be fully prepared to justify in this case, until the next major flood occurrence with its accompanying human suffering, disasterous economic losses, and possible deaths. The entire point of the citizens committee review of alternative choices was to approach each possible solution fairly and openly and, when appropriate, to seek modifications to minimize adverse effects but which might involve some additional social, environmental, or economic costs in order to obtain the greatest public good.

To date, the Corps of Engineers has not made a final decision on the damsite location or the storage capacity, but we, in our preliminary draft, have presented all aspects bearing on the decision. In order to minimize delays, the draft environmental impact statement has been developed based on the District's suggested best plan. If the final Corps decision does not agree with this plan, the formulation report and the impact statement will be revised prior to its distribution to concerned interests and agencies for comment.

The Citizens Committee recommended in item 1, "Resolution of the flood problem through the basic concepts of an upstream storage reservoir and increasing the channel capacities," and in item 7, "---a flood control plan which would provide for a flood of the magnitude that occurs once in 100 years", while expressing the opinion that " ---economic and environmental factors would preclude planning for protection of floods greater than those which occur once in 150 years". Also, in item 6, the Committee concluded that on the matter of the damsite, " --- the Corps must be left in a flexible position ---". The latter was a wise decision because the amount of storage capacity required for protection of a large metropolitan area is an engineering decision which must be based on years of hydrologic experience and training.

Flood frequency is a statistical procedure, based upon the available period of record, used in determining the relative merits of alternative flood reduction plans. At best, we have only 70 years of record. The indicated flood having a 1 percent chance of recurrence in any year (often called a 100-year flood) may be a satisfactory basis for identifying the upper limit of floodplain management controls, evacuation, or channel improvement design since a less-frequent larger flood would cause a relatively small fringe of inundation. However, in the case of flood proofing and levees, a less-frequent event exceeding the design flood could cause a failure and total losses in protected buildings or areas. Major reservoirs are designed to pass the probable maximum flood without failure, but may pass a major part of flood peak flows which exceed design capacity with the accompanying severe flooding in downstream areas. Where these measures are existing or proposed, we must give consideration to the regional flood potential as well as the indicated flood frequency. In the case of Minot and the suburban areas, we now have several miles of fairly high levees warranting our careful consideration of the need for a greater degree of protection than the 150-year plan proposed in the survey report.

The Board of Engineers for Rivers and Harbors, in commenting on the 1969 survey report, noted a number of areas which should be given further consideration in post-authorization studies including the possibility of rare floods of substantially greater magnitude and larger residual damages than shown in that report. The survey report plan, because of the relatively low maximum release rate of 2300 cfs, required storage of 637,000 acre-feet to obtain about 150-year protection. In the survey-report plan, we were limited by the international boundary from developing more storage and obtaining a greater degree of protection. As a result of our review with the Citizens Committee, we were able to increase the reservoir release rate to the 5000 cfs channel capacity thereby assuring less frequent use of the reservoir and permitting us to obtain a desirable higher degree of protection with less storage. The less frequent use of the reservoir, about once in 30 years on the average, and with potential storage to a level of about 3 feet lower than proposed in the survey report, we would reduce adverse environmental effects in the reservoir area while increasing the degree of protection to a more secure level.

2. Question: In the 1969 report on the Souris River, the Corps, with respect to the floodplain evacuation alternative, estimated annual flood damage reduction benefits at $4.4 million with annual costs of $2.3 million giving the alternative a favorable benefit-cost ratio of 1.9. In more recent figures, the Corps lowered benefits to $3.3 million and raised costs to $4.3 to $5.0 million, giving the alternative an unfavorable benefit-cost ratio of 0.77 to 0.66. What accounts for this discrepancy?

Answer: In the survey report we estimated the first cost of evacuation at $50 million based on June 1969 prices, representing an average annual cost of about $2.3 million at the interest rate then in effect of 4-5/8 percent. In October 1972, we reported to the Committee a first cost of about $74 to $86 million and average annual charges of $4.3 to $5.0 million, as noted. During the period from June 1969 to October 1972, building prices increased about 33 percent. In addition, the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 materially increased both moving costs and property acquisition costs by the Federal Government. These factors which entered into the increased cost included reconsideration of allowances for extension of public service facilities to resettlement areas such as sewers, water supply lines, streets, walks, lighting and related services. We consider the increase in the estimated cost of evacuation, as presented to the Committee, to be extremely conservative.

Our estimate of average annual benefits was affected by a number of factors, some of which tended to increase and others to decrease the benefits. However, the principal factor appears to have been our handling for the Committee reports of future growth expected in the absence of any structural or nonstructural measures. Because of the infrequency of major floods and the aesthetic nature of the valley as compared to the upland areas, if nothing were done to resolve the flood problem, we could expect the zoning regulations to lapse and continued growth to take place in the floodplain. With the authorized channel-reservoir plan, such growth would not be restricted. The growth properties in the present floodplain would be protected and would receive the benefits of the project works. However, with public ownership of presently-occupied floodplain lands, growth would be limited to private lands above the 100-year level adjacent to the evacuated public lands or on lands in the floodplain not acquired under the evacuation plan. Since the channel-reservoir plan as presently contemplated would provide a very high degree of protection as compared to the 100-year evacuation plan, the residual damages under the former would be less than for the latter. These differences in the location of probable future growth led us to reduce such benefits from those recognized in the survey report. However, this conclusion will be reviewed.

Neither the survey nor the Committee reports included recognition of local employment benefits. Since such benefits are now recognized as applicable to the channel-reservoir plan, they will be added to benefit analyses for all alternative plans including evacuation as appropriate.

The detail in which we analyze benefits and costs of alternative is a value judgment based on the economic, social, environmental and engineering elements involved. In this case, we were inclined to conclude that the social problems involved in such a major undertaking would be insurmountable. Consequently, the procedure followed in obtaining costs primarily by increasing survey cost estimates based on published cost indices and generalized estimates of benefits were convenient tools to obtain approximate answers. Since your letter suggests that a substantial segment of the public may favor evacuation, we propose to make a more detailed study of both the costs and benefits of evacuation. Our findings will be made available at a public meeting at which we propose to review all aspects of our formulation studies.

3. Question: How were costs and benefits both upstream and downstream from proposed reservoirs calculated and what are those costs and benefits?

Answer: This question was answered each time it was brought up by Mr. Nygard and Mr. Southam, but they seemed to remain unconvinced. Mr. H. E. Kendall, Chief of our Rock Island District Real Estate Division, reviewed this subject in detail at the 19 July 1972 Committee meeting at Mohall. He discussed the procedure followed and the factors involved in determining the fair market value of lands or rights-of-way required for a project. The appraisal seeks to establish the price the owner could expect to receive if he sold the property on the open market, taking into account the earning power of the property, buildings, water supply and other pertinent factors. Having received payment for his property either for fee taking or flowage easement, he may purchase new land with the payment received and, if a market exists for the commodity he produced on his former holding, he can raise the same crop or produce the same product on his new land.

Should he elect to invest in land in another state or in a new venture, some local loss might occur, but on a national basis, such an effect would be offset by a gain in the new area. This leads to the question of the validity of recognizing secondary effects on the merchants with whom the property owner did business. Since we do not use secondary effects in determining average annual flood damages and benefits, recognition of secondary costs would be inappropriate. This entire subject was also discussed in detail in our letter of 10 January 1973 to Mr. Ralph Christensen, Chairman of the Flood Control Committee, and in the attachment which accompanied that letter. Copies of the letter and inclosure were reproduced for distribution to Committee members and for Dr. John Ward.

The basis for estimating flood damages and benefits obtainable downstream was discussed in great detail at the 16 August Committee meeting. Damages to developments expected to take place in the floodplain in the absence of protection works are valid effects which should be taken into account. Your next question indicates that some growth is taking place in spite of existing city and county regulations. If no project were undertaken, we can foresee continued expansion in the floodplain. Further, a substantial part of the future-growth damages is based on improvements to existing developments, betterment in home furnishings, and expansion of business stocks.

We cannot provide an itemized benefit-cost analysis until a final decision has been made on the nature and scope of the overall plan. As soon as this decision is made, the plan formulation design memorandum and environmental impact statement will be completed and distributed for comment. The design memorandum will include a summary of all benefits and costs.

4. Question: What steps are being taken to insure that Souris River communities comply with floodplain zoning requirements?

Answer: The administration of floodplain land-use regulations is primarily an exercise of the police power and is a non-Federal responsibility. Such regulations seek to control and guide land use and development to reduce future susceptibility to flood hazards and damages consistent with the exposure involved. Normally, floodplain regulations do not preclude all use of floodplain lands. Complete prohibition of occupation could be interpreted as of such a restrictive nature as to constitute a taking and would probably require the regulatory agency to acquire the affected properties. Most regulations set up certain controls which, in the public interest, must be met if development is to be permitted including flood proofing, elevation of facilities subject to damage above the prescribed flood level, or other actions to minimize potential flood losses. We do not know if the structures mentioned were permitted prior to adoption of the current regulations or if the buildings meet prescribed regulations. Although all regulations are susceptible to violation or may be circumvented, public understanding of the purpose and value of floodplain regulations has increased so that, with protection of most of the presently occupied areas of the floodplain and continuance of regulations as appropriate in unprotected areas, violations would not be of major concern and would certainly not nullify the benefits of the protection measures.

Mr. Calton/yz/7571

NCSED-PB

10 January 1973

Mr. Ralph Christensen
Chairman, Souris River Flood
Control Committee
Culligan Water Conditioning
24-2nd Street NE
Minot, North Dakota 58701

Dear Mr. Christensen:

You will recall that Messrs. Duane Dokken, Clair Southam, and Lloyd Nygaard have raised the question of economic loss and the impact on the service area should private lands be taken out of production as a result of reservoir development and operation on the Souris River above Minot, North Dakota.

Apparently, two questions are involved; first, do the annual charges on estimated land payments fully represent the primary economic costs involved and, second, what would be the amount and effect of the production loss on the local economy? We have discussed these questions with other economists and with local agricultural production authorities and, with their assistance, have reached the conclusions outlined in the attached statement. If and when we move into the phase II planning studies, this matter will be given further in-depth consideration.

Briefly, at this time we believe that the prices paid for reservoir lands, as recognized in the average annual charges, will fully cover the economic effects which we are required to identify under Federal policy for assessment of benefits and costs. We agree with Mr. Southam that the valley ranch lands between the boundary and Burlington may have an annual gross earning power of about $500,000, a substantial part of which might be expended in the area each year. However, with the proposed plan of operation involving storage on an average of about once in 25 or 30 years, the loss of production would be infrequent and would be offset by the payments made for the right to flood.

We recognize that some reduction in income to merchants servicing area ranchers would result the year that reservoir use precluded production. Offsetting these losses would be the gains realized from the use of the moneys paid for the right to flood. Possibly some overall reduction in farm income would result from resettlement of residences now in the pool area, increased operating costs, and changed farm management plans. However, these reductions would be more than offset by economic gains associated with higher use of the flood-prone areas now inadequately protected in Minot and adjacent urban developments.

I trust that our review of this matter will adequately meet the needs of the advisory committee at this time. Additional copies of this letter and the inclosure are attached should you wish to make them available to all members of the advisory committee. In addition, I suggest that copies be furnished to Mr. Duane Dokken, Dr. John Ward at Minot State College, and any others who may have expressed an interest in this subject.

Sincerely yours,

1 Incl (15 copies)
As stated (w/15 cys ltr, 1/10/73)

J. R. CANTON
Chief, Planning Branch
Engineering Division

Discussion of Possible Economic Loss
Due to Federal Acquisition of Productive
Lands in the Proposed Burlington Reservoir Area
5 January 1972

Estimated average annual charges developed for the survey report included an item of $30,200 representing the adjustment for the estimated annual loss due to lands withdrawn from production in the reservoir area. This value was obtained by multiplying the market value of the productive lands ($2,197,000) by the difference between the assumed annual interest rate of return on these lands (6.00 percent) and the Federal discount rate used at that time (4.625 percent). The basis for this determination was that the annual economic return from the use of the land was assumed to average 6 percent as compared to the interest rate of 4 5/8 percent used in developing annual charges.

The survey determination of the economic loss not accounted for in the estimated annual charges on the fair market price of the land was based on fee taking and, because of the frequency of inundation, did not recognize possible production through leases to offset some of the lost production. Further, since the recipients of the fair market value of the land could elect to buy an equivalent farm in another area or open a new area to the same operation, the economic loss might be considered local or regional but not a national loss.

With the reservoir operated so that storage would not inundate the farmlands more often than once in 25 or 30 years, continued operation by the owner after receiving an appropriate payment for the right to flood and any increased operating costs would appear practical. If the owner elected to sell his property, the Government could lease the farm and 75 percent of the income returned through the State to the local governing body.

Local interests have presented an estimate for the Burlington pool area indicating gross annual earnings on 5,900 acres in 18 ranch units in Ward County and on about 5,000 acres involving 18 ranch units in Renville County of about $303,000 and $221,000, respectively. Agricultural production records for Renville and Ward Counties show that farm production expenses constitute about 65 percent of the market value of all agricultural products sold, including livestock. On this basis average annual net income would total about $184,000 on the 10,900 acres or $16.90 per acre. Frequency-area flooded data for the reservoirs are available indicating that the average area flooded annually would approximate 1,950 acres above a dam at Burlington, representing a net annual loss by ranch operators of about $33,000. If this loss were distributed equally, the loss for 36 operators would be about $920 per ranch operator or, capitalized at 6 percent, would approximate $15,300. This amount when combined with the costs of moving buildings, adjusted to reflect the requirements of the 1970 Uniform Relocations Assistance and Real Property Acquisition Policies Act, and with any increased operating costs, would represent a basis for flowage easement costs. If the fair payment negotiated with the owner fully covers these losses and other added costs, no additional economic losses would need to be taken into account.

Use by local interests of gross income in evaluating effects of lost production is based on the assumption that all income flows to the merchants of the region and not just the net income. Also, some mention has been made of the multiplier effect of money expended for goods and services. However, these are secondary effects which have not been taken into account in estimating monetary benefits attributable to flood losses prevented. Thus, if we were to recognize lost gross income and the multiplier effect of reservoir land earning power as an added cost, we should include secondary effects on the benefit side of the equation. Federal policy precludes use of secondary benefits, but if they were used, they would greatly exceed the income foregone secondary effects.

This reanalysis of the question of loss of local income as an additional cost item leads to the conclusion that, in this case, use of gross loss of earning power of the land would be inappropriate and that the net loss of income is fully recognized in the negotiated payment for fee taking or flowage easement.

800 Northwest 15th Street
Minot, North Dakota 58701
July 17, 1973

THE IZAAK WALTON LEAGUE OF AMERIC.
INCORPORAT

Col. Rodney E. Cox, District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Col. Cox:

Thank you for your prompt reply of 11 June 1973. We are grateful for the detail contained in your response as well as for the thoughtfulness which was apparently applied. However, we find that some rather direct questions have been answered only indirectly.

The question "Where will the flood control reservoir be located and what will be the storage capacity?" probably comes closest to being answered on p. 3 by the phrase "with potential storage to a level of about 3 feet lower than proposed in the survey report." Since a design flood pool elevation of 1622.2 feet was proposed in the survey report we assume that a level of approximately 1619 feet is now proposed. Note that this does not directly specify either "location" or "storage capacity" of the reservoir. Since three alternate sites have been proposed, we have taken the liberty of approximating the storage capacity, protection and elevation above the 100-year protection level for the three different sites. Data distributed at committee meetings were used in these approximations; the results are presented in Table 1 below. Storage capacities were taken from elevation storage graphs; protection was approximated by plotting protection vs. storage data distributed at meetings on log-probability paper and interpolating.

Table 1. Approximate storage capacity, protection and elevation above the 100-year protection level for three alternate damsite locations.

Site	Storage	Protection	Elevation above 100-year protection level
Burlington	570,000 acre-feet	850-year	20 ft.
Baker Bridge	440,000 acre-feet	410-year	15 ft.
Lake Darling	320,000 acre-feet	180-year	9 ft.

At the elevation cited, we note that all three locations will provide greater than 150-year flood protection; thus, the statement on p. 3 which indicates the proposed reservoir will "increase the degree of protection" above that proposed in 1969 is of no help in distinguishing the location.

The 3rd Annual Report of the Council on Environmental Quality on pp. 237-238 states, "Agencies and private groups whose interests and expertise put them frequently in a commenting role on draft 102 statements have complained at times of the difficulty of preparing helpful comments in only 30 to 45 days...in most cases improvement of the comment process will require that agencies develop means of giving ample advance notice and encourage consultation before the draft statement is finished. By making other agencies and groups aware that a draft is being developed, an agency can give them time to prepare for the upcoming opportunity to comment. Such a warning may also bring in a faster feedback that permits earlier modification of the proposal and thereby avoids later confrontation."

Your answer to our first question was helpful in giving us an insight as to why the District's "suggested best plan" was selected but has left us in the dark as to what that plan is.

We reserve judgment on your contention on p. 1 of your response that a structural solution is "the only practical solution to the flood problem" until the results of your "more detailed study of both the costs and benefits of evacuation" are available.

We note with interest the statement on p. 1 that "...the channel improvements completed to date, and those proposed for the next stage of construction, do not commit us to any specific program since the channel work is economically feasible without further work." We should like to point out that this opens up the possibility of yet another alternative which would make reservoir storage unnecessary, that of channelization to protect against floods up to 30-year frequency along with a reduced flood plain evacuation plan to protect against floods of 30 to 100 year frequency with the channel in operation. This alternative should also be evaluated.

The reply to our second question still does not explain the reduction of benefits from $4.4 million to $3.3 million over a three-year period. The relationship between future growth and a reduction in benefits is not clear. We agree that the conclusion should be reviewed.

Apparently, you intend to calculate local employment benefits in the channel-reservoir plan. Local employment benefits are also applicable to the flood plain evacuation plan since both demolition in the flood plain area and construction outside of that area would produce local employment. Some of the costs of evacuation would also be balanced by local employment benefits as a result of extension of public service facilities.

We were not questioning your judgment as to the detail in which you analyzed the benefits and costs of evacuation, rather we were questioning your methods, which seemed to have changed significantly between 1969 and 1972.

Thank you for including a copy of the 10 January 1973 letter to Mr. Ralph Christensen. We had not received a copy of this analysis previously. It contains several points that we will have to study further before commenting.

Reference is made to using the reservoir for storage about once in 30 years, but the discharge-frequency curve, plate B-2 in the survey report, appears to indicate that use of the reservoir would be closer to once in 20 years. Discharges of greater than 5000 cfs are indicated as having a frequency of annual occurrence of about 4½% under existing conditions with Lake Darling, which would amount to about once in 22.5 years.

We understand your inability to provide an itemized benefit-cost analysis until a final decision has been made. We would appreciate being placed on your mailing list for copies of both the draft environmental impact statement and the design memorandum when they become available.

Since you indicated that the administration of flood plain land use regulations is a non-Federal responsibility, we have taken the question to local officials. A copy of our letter to Mr. Ralph Christensen on the subject is enclosed.

Sincerely,

Pamela Ward

Mrs. John A. Ward
Regional Governor, IWLA

Enclosure

CC: The Hon. Quentin N. Burdick
The Hon. Milton R. Young
John Arnold, City Manager, City of Minot
Ralph Christensen, Chairman, Flood Control Planning Committee

Raymond C. Hubley, Jr., Executive Director
The Izaak Walton League of America
1800 N. Kent Street, Suite 806
Arlington, Virginia 22209

800 Northwest 15th Street
Minot, North Dakota 58701
July 20, 1973

THE IZAAK WALTON LEAGUE OF AMERIC
INCORPORAT

The Honorable Milton R. Young
U.S. Senate
The Capitol
Washington, D.C. 20510

Dear Senator Young:

We were shocked to read in the Minot Daily News, July 19, 1973, that you had approved the appropriation of funds that would advance pre-construction planning of the Burlington Dam. We have asked the Corps of Engineers for information on the location and storage capacity of the reservoir and were told that a final decision had not yet been made. However, we were given enough information to determine that if the reservoir were built at Burlington it would be of the magnitude that would provide on the order of 850-year flood protection.

The citizens' Souris River Flood Control Planning Committee met for nearly 12 months to resolve public concerns relative to the issue. One of the most significant positions taken by the Committee was that economic and environmental factors would preclude providing any more than 150-year flood protection.

We feel that you could not have been fully apprised of the situation by the Corps of Engineers if you approved of a Burlington location for the dam.

We will be contacting residents of the Souris River Basin within the next few weeks to decide on a course of action. We would appreciate receiving your comments prior to that meeting.

Sincerely,

Paula Ward

Mrs. John A. Ward
Regional Governor, IWLA

CC: Col. Rodney E. Cox, District Engineer
Department of the Army
St. Paul District, Corps of Engineers
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

800 Northwest 15th Street
Minot, North Dakota 58701
July 22, 1973

THE IZAAK WALTON LEAGUE OF AMERICA
INCORPORATED

Ralph Christensen, Chairman
Ward County Water Management District
Box 1667
Minot, North Dakota 58701

Dear Mr. Christensen:

The Theodore Roosevelt Chapter of the Izaak Walton League of America has visited the sites of several recently constructed buildings in the 100-year flood plain. As a result of our observations we feel that there is sufficient evidence of non-compliance with the flood plain zoning ordinance in Minot to warrant an investigation of the matter by the Ward County Water Management District.

We note that section 4c (Permitted Uses) of the flood plain zoning regulation provides that:

"(7)(aa) No basements shall be constructed for new residences.
(bb) Where practicable first floor elevation shall be raised above the flood profile."

We have found two recently constructed houses on the flood plain that have basements. One, located at 1203 - 5th Ave., N.W. is a split-level and thus has living space below ground level. The other is an unnumbered house east of 2515 Belview Drive.

We contacted the City Engineer's office to determine if the first floors of residences at 419 - 2nd Ave., N.W. (a three-plex) and 307 - 5th St., N.W. were above the flood profile. We were informed that the elevation provisions of the ordinance are not being enforced.

We note that section 3g. of the ordinance disclaims liability on the part of the City of Minot for flood damages resulting from reliance on the ordinance. We wonder if flood damages resulting from the City's failure to enforce the ordinance creates a liability on the part of or a cause of action against the City of Minot.

We would appreciate hearing of your findings on these matters.

Sincerely,

Paula Ward

Mrs. John A. Ward
Regional Governor, IWLA

CC: Col. Rodney E. Cox, District Engineer
St. Paul District Corps of Engineers

City of Minot: John Arnold, City Manager
Robert Olson, City Planner
Burt J. Peckham, City Engineer

Raymond C. Hubley, Jr., Executive Director
Izaak Walton League of America
1800 N. Kent St., Suite 806
Arlington, Virginia 22209

DEPARTMENT OF THE ARMY
St. Paul District, Corps of Engineers
1210 U. S. Post Office and Custom House
St. Paul, Minnesota 55101

PUBLIC AFFAIRS OFFICE
JOHN W. LARSON
612-725-7505

FOR RELEASE
PA-12-73
31 July 1973

CORPS RELEASES RECOMMENDED
FLOOD DAMAGE REDUCTION PLAN

The St. Paul District, U.S. Army Corps of Engineers, today released copies of its overall recommended plan for flood damage reduction on the Souris River. The recommended plan was developed as a result of District engineering studies, public participation of residents of the Souris River valley, and environmental impact studies, and is subject to review and approval in Washington.

The recommended plan calls for:

A 5,000-cubic-feet-per-second (cfs) channel through Minot;

Construction of the Burlington Dam at the authorized site with a reservoir with a design storage to elevation 1620

(595,000 acre-feet of usable storage), operated to reduce flood peak flows which would otherwise exceed 5,000 cfs (about 1 year in 33);

Structures on the Des Lacs River to divert flood flows in excess of downstream channel capacity into Burlington Reservoir via a 7,500-foot tunnel through the divide between the Des Lacs and Souris River valleys;

About 4.9 miles of channel improvement;

Improvement of the existing levees, with construction of appropriate interior drainage works, at Sawyer and Velva to accommodate passage of flows up to 7,500 cfs.

Maintenance of the Souris River channel downstream from the Burlington Dam.

The plan rejects evacuation of the flood plain because of its high cost, now estimated at $178 million, and its unacceptability to local residents, and also recommends against constructing a dam at a site near the existing Lake Darling structure.

Colonel Rodney E. Cox, St. Paul District Engineer, stated in connection with the recommended plan, "In view of the potential for a major disaster in ~~a~~ the growing metropolitan area of Minot where 12,000 to 15,000 people may be displaced in a major flood, and 4,000 to 5,000 homes flooded as well as several schools, churches, and business places, we are recommending the maximum degree of protection obtainable within the limits of economic feasibility and available floodwater storage capacity in the United States."

The average annual benefits for the recommended project are estimated to be $5,662,000, the costs $4,747,000. The benefit-cost ratio for the entire project, which establishes its economic feasibility within the standards established by Federal law, is 1.2.

Revised environmental impact statement drafts on the recommended plan are nearing completion, and will be distributed for comments soon.

Copy furnished:
Senator Burdick
Senator Young
Congressman Andrews

NCSED-PB 31 July 1973

Mrs. John A. Ward
Regional Governor
The Izaak Walton League of America
800 Northwest 15th Street
Minot, North Dakota 58701

Dear Mrs. Ward:

This responds to your most recent letter of 17 July 1973, concerning our planning for flood damage reduction on the Souris River at and in the vicinity of Minot, North Dakota. We recognize that you have put much time and thought into your analyses, comments, and searching questions, and we want to be as candid as possible.

Recently our officials in Washington advised that, although we had not yet been able to submit for review our phase I report or the revised environmental impact statement, they had no objection to our making public the principal features of the plan I propose to recommend, provided we establish that it is the District recommended plan and is subject to review and approval. Accordingly, earlier this week I furnished to the press and to the chairman of the Citizens Advisory Committee a copy of the inclosed summary of the plan I propose to recommend. This action should meet your concern regarding identification of the damsite, storage capacity, and associated project elements.

Information in response to your further comments is included in the inclosed statement.

We will furnish you copies of the revised environmental impact statement drafts for both the Minot Channel and the Burlington Reservoir plus related work together with a copy of our Phase I Design Memorandum covering the latter program as recommended. An itemized summary of costs and benefits will be included in our design memorandum.

Sincerely yours,

RODNEY E. COX
Colonel, Corps of Engineers
District Engineer

2 Incl
1. Phase I Plan
2. Comments on ltr
Mrs. Ward to StP Dist,
17 July 73

Copy furnished: (w/incl)

Honorable Quentin N. Burdick
Washington, D.C. 20510

Honorable Milton R. Young
Washington, D.C. 20510

Mr. John Arnold
Minot, North Dakota 58701

Mr. Ralph Christensen
Minot, North Dakota 58701

Mr. Raymond C. Hubley, Jr
Arlington, Virginia 22209

PHASE I PLAN

The phase 1 plan of improvement (see plate 5) covering the authorized reservoir provides for the following:

a. Construction of the dam at the authorized site with design storage to elevation 1620 (595,000 acre-feet of usable storage), operated to reduce flood peak flows which would otherwise exceed 5,000 cfs (about 1 year in 33), with reservoir releases following the inflow recession until flows at Minot fall below 500 cfs when this flow may be maintained by storage drawdown and increased after the growing and harvesting season with appropriate allowances for ice cover during the winter.

b. A dam on the Des Lacs River to divert flood flows in excess of downstream channel capacity into Burlington Reservoir via a 7,500-foot tunnel through the divide between the Des Lacs and Souris River valleys. The diversion plan was found to be no more costly than the increased cost of locating the main stem dam below the confluence of the two streams and was less damaging to the environment and more acceptable socially since construction of the dam below the confluence would require acquisition of a cemetery, a historical park, and about 30 residences.

c. About 4.9 miles of channel improvement, upgrading existing levees, and providing for interior drainage and leveed areas to accommodate passage of flows up to 5,000 cfs in the reach from the Burlington damsite to the upper end of the Minot channel.

d. Improvement of the existing levees, with construction of appropriate interior drainage works, at Sawyer and Velva to accommodate passage of flows up to about 7,500 cfs.

e. Maintenance of the Souris River channel downstream from the Burlington Dam.

The economic factors developed for the phase 1 design memorandum, based on July 1972 prices, are summarized in tables 4, 5, 6, and 7.

Table 4 - Estimated first costs in $1,000

Item	Federal	Non-Federal	Total
Burlington Dam and Reservoir	$40,000	-	$40,000
Des Lacs diversion	14,100	-	14,100
Channel, Burlington to Minot	4,750	$750	5,500
Sawyer	440	80	520
Velva	1,700	150	1,850
Total reservoir and related work	60,990	980	61,970
Channel, Minot	13,600	2,390	15,990
Total, Souris River project	74,590	3,370	77,960

Table 5 - Estimated average annual charges in $1,000

Item	Federal	Non-Federal	Total
Interest and amortization			
Reservoir and related work	$3,699 (1)	$54	$3,753
Minot channel	702 (2)	123	825
Maintenance and operation			
Reservoir and related work	129	15	144
Minot channel	-	25	25
Total			
Reservoir and related work	3,828	69	3,897
Minot channel	702	148	850
Total, Souris River project	4,530	217	4,747

(1) Interest rate 5½ percent and 100-year economic life.
(2) Interest rate 5 1/8 percent (fixed when first construction funds made available) and 100-year life.

Item	Reservoir and related work	Minot channel	Total Souris River project
Flood damage prevention			
Current conditions	$1,162	$1,039	$2,201
Future growth	2,223	-	2,223
Lake Darling Dam, rehabilitation foregone	553	-	553
Local employment	556 (1)	129 (1)	685 (1)
Total average annual benefits	4,494	1,168	5,662

Table 6 - Estimated average annual benefits in $1,000

(1) Creditable, provided the county qualifies as an area of unemployment eligible for Federal assistance under Title IV of the Public Works and Economic Development Act of 1965.

Table 7 - Comparison of average annual benefits and costs in $1,000

Item	Average annual benefits	Average annual costs	Benefit-cost ratio (1)
Reservoir and related work	$4,494	$3,897	1.15
Minot channel	1,168	850	1.4
Total Souris River project	5,662	4,747	1.2

(1) If local employment benefits are excluded, the benefit-cost ratio would be 1.01 for the reservoir and related work, 1.2 for the Minot channel, and 1.05 for the total Souris River project.

Principal questions which have been considered in arriving at the definite project plan include:

a. What degree of protection is considered adequate for a growing metropolitan area where 12,000 to 15,000 people may be displaced by a major flood and 4,000 to 5,000 homes flooded together with several large schools, churches, and business places? The District has recommended complete protection up to about 80 percent of the standard project flood.

b. Should standard project flood protection be provided for the Des Lacs River at a cost of about $14 million for the recommended diversion works and tunnel to the Burlington Reservoir? The District recommends the diversion works as the most practical means of obtaining protection from possible high intensity storms and the resulting flash flood disaster potential.

c. Since sufficient storage cannot be developed to contain a standard project flood on the Souris River without inundating lands in Canada, should the maximum storage within the United States be developed giving protection for about 80 percent of the standard project flood at a cost of approximately $6 million over that for 150-year protection? The District recommends the added protection.

d. How much weight should be given to the social and environmental considerations since the maximization of net benefits is not a controlling factor? In view of the potential for a major flood disaster, the District recommends the maximum degree of protection obtainable within the limits of economic feasibility.

e. Since the Bureau of Sport Fisheries and Wildlife and the environmental organizations would probably not oppose constructing the dam near Lake Darling structure, could we accept this site which has only sufficient storage to provide 150-year protection and could not accommodate the Des Lacs diversion without excessive cost? The District recommends against the Lake Darling damsite.

f. Since the Bureau of Sport Fisheries and Wildlife and the environmental organizations claim evacuation of the floodplain to be the best solution from an environmental viewpoint to the Souris River flood problem, could this be proposed? The District recommends against evacuation because of the high cost, lack of economic feasibility, and local unacceptability, the latter based on both social considerations and the limits of local financial capability.

RESPONSE TO COMMENTS
in Letter dated 17 July 1973 from
Mrs. John A. Ward, Izaak Walton League of America
31 July 1973

1. Evacuation:

a. Revised economic analysis. - We recently completed our detailed review of the work items involved in evacuation, the first costs, average annual charges, and estimated average annual benefits. This study was much more comprehensive than that made for the survey report and provides us with a realistic cost estimate which we could defend should evacuation be selected.

The costs of evacuation take into account all costs for a relocation site, site preparation, utility relocations, and necessary compliance with the Uniform Relocations Assistance and Real Property Acquisitions Policies Act of 1970. Tables 1, 2, and 3 summarize the results of this review. The total estimated cost of evacuation of the 100-year floodplains in Minot, Sawyer, Velva, the urbanized portions of the reach from Burlington to Minot, and the urbanized area between Minot and Logan, based on July 1973 prices, is currently estimated at $179,675,000, including $31,042,000 in social betterments and enhancement of private building values. Average annual costs assignable to flood control at 5½ percent (100-year project life) are estimated at $8,208,000. Average annual benefits realized through elimination of flood damages to buildings and other improvements from the floodplain approximate $2,150,000 with an additional amount of $2,147,000 for future growth losses precluded by enforcement of floodplain management regulations. If the area qualifies for Federal assistance under Title IV of the Public Works and Economic Development Act of 1965, local employment benefits of about $1,657,000 would be realized, bringing total average annual benefits to $5,954,000. The benefit-cost ratios for evacuation and floodplain management would be 0.7 and 0.5 with and without local employment benefits, respectively.

Table 1 - First costs in $1,000 for floodplain evacuation

Item	Minot to Burlington				Minot				Minot to Logan				Sawyer				Velva			
	Overall Cost		Costs of Social Betterments		Overall Cost		Costs of Social Betterments		Overall Cost		Costs of Social Betterments		Overall Cost		Costs of Social Betterments		Overall Cost		Costs of Social Betterments	
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal
Lands	-	$22(1)	-	-	-	$2,400(1)	-	-	-	$6(1)	-	-	-	-	-	-	-	$110(1)	-	-
Site Development	-	256(2)	-	-	-	14,031(2)	-	-	-	75(2)	-	-	-	-	-	-	-	857(2)	-	-
Move Structures:																				
Residences	$2,740	-	$108(3)	-	$41,137	-	$4,197(3)	-	$458	-	$33(3)	-	$188	-	$14(3)	-	$3,544	-	$369(3)	-
Commercial	-	-	-	-	1,658	-	-	-	132	-	-	-	-	-	-	-	-	-	-	-
Public Buildings	-	-	-	-	336	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purchase Structures:																				
Residences	-	-	-	-	20,020	-	12,513(4)	-	100	-	63(4)	-	100	-	63(4)	-	1,720	-	1,075(4)	-
Commercial	-	-	-	-	14,122	4,498(5)	928(4)	$4,498(5)	918	288(5)	24(4)	$288(5)	192	$60(5)	8(4)	60(5)	1,673	354(5)	180(4)	$354(5)
Public Buildings	-	-	-	-	13,825	1,922(5)	119(4)	1,922(5)	-	-	-	-	-	-	-	-	1,100	63(5)	35(4)	63(5)
Moving Expenses	141	-	-	-	6,061	-	-	-	99	-	-	-	31	-	-	-	644	-	-	-
Acquisition costs	150	5	-	-	4,113	30	-	-	44	3	-	-	19	-	-	-	377	12	-	-
Roads & Bridges	-	-	-	-	-	4,050	-	-	-	-	-	-	-	-	-	-	-	282	-	-
Floodplain Restoration	89	-	-	-	4,878	-	-	-	26	-	-	-	11	-	-	-	298	-	-	-
Contingencies	468	42	16	-	15,923	4,040	2,664	963	267	55	18	43	82	9	13	9	1,404	252	249	63
E&D and S&A	101	13	-	-	3,400	1,200	-	-	58	17	-	-	18	-	-	-	300	75	-	-
TOTAL	3,689	338	124	-	125,473	32,171	20,421	7,383	2,102	444	138	331	641	69	98	69	11,060	2,005	1,908	480
TOTAL FEDERAL AND NON-FEDERAL COST	4,027		124		157,644		27,804		2,546		469		710		167		13,065		2,388	

(1) Relocation site of 600 acres.
(2) Clearing, earthwork, roads, utilities, etc.
(3) Added value of new foundations, basement utilities, and improvements required by building code.
(4) Added costs to comply with Uniform Relocation Assistance and Real Property Acquisitions Policies Act of 1970.
(5) Added costs to private business and owners of schools and tax exempt properties to obtain new buildings.

Table 2 - Summary of first costs in $1,000, floodplain evacuation, Souris River, North Dakota

Item	Overall Costs		Costs of Social Betterments		Costs Chargeable to Flood Damage Prevention(6)	
	Federal	Non-Federal	Federal	Non-Federal	Federal	Non-Federal
Lands	-	$2,538(1)	-	-		$2,538
Site Development	-	15,219(2)	-	-		15,219
Move Structures:						
Residences	$48,067	-	$4,721(3)	-	$43,346	-
Commercial	1,790	-	-	-	1,790	-
Public Buildings	336	-	-	-	336	-
Purchase Structures:						
Residences	21,940	-	13,714(4)		8,226	-
Commercial	16,905	5,200(5)	1,140(4)	$5,200(5)	15,765	0
Public Buildings	14,925	1,985(5)	154(4)	1,985(5)	14,771	0
Moving Expenses	6,976	-	-	-	6,976	-
Acquisition Costs	4,703	50	-	-	4,703	50
Roads & Bridges	-	4,332	-	-	-	4,332
Floodplain Restoration	5,302	-	-	-	5,302	-
Contingencies	18,144	4,398	3,050	1,078	15,094	3,320
E&D and S&A	3,877	1,305	-	-	3,877	1,305
TOTAL	142,965	35,027	22,779	8,263	120,186	26,764
TOTAL FEDERAL AND NON-FEDERAL COSTS	177,992		31,042		146,950	

(1) Relocation site of 600 acres.
(2) Clearing, earthwork, roads, utilities, etc.
(3) Added value of new foundations, basement utilities, and improvements required by building code.
(4) Added costs to comply with Uniform Relocation Assistance and Real Property Acquisitions Policies Act of 1970.
(5) Added costs to private business and owners of schools and tax exempt properties to obtain new buildings.
(6) Overall costs less costs of social betterments.

TABLE 3 - SUMMARY OF ECONOMIC COSTS AND BENEFITS IN $1,000
FOR FLOODPLAIN EVACUATION, SOURIS RIVER, NORTH DAKOTA

Economic Investment:

Reach	First Costs	Interest During Construction(1)	Total
Burlington to Minot	$4,027	18	$4,045
Minot	157,644	1,041	158,685
Minot to Logan	2,546	5	2,551
Sawyer	710	0	710
Velva	13,065	619	13,684
Total	177,992	1,683	179,675
Less costs of social betterments(2)	31,042	-	31,042
Flood damage prevention	146,950	1,683	148,633

Average annual costs:

Interest and amortization (3)		8,208
Operation, Maintenance and Replacements (4)		0
Total average annual costs		8,208

Average annual benefits:

Flood damage prevention		
Existing conditions, year 1980	2,150	
Future growth, 1980 to 2030 constant last 50 yrs.(5)	2,147	
Total flood damage prevention		4,297
Local employment (5)		1,657
Total average annual benefits		5,954

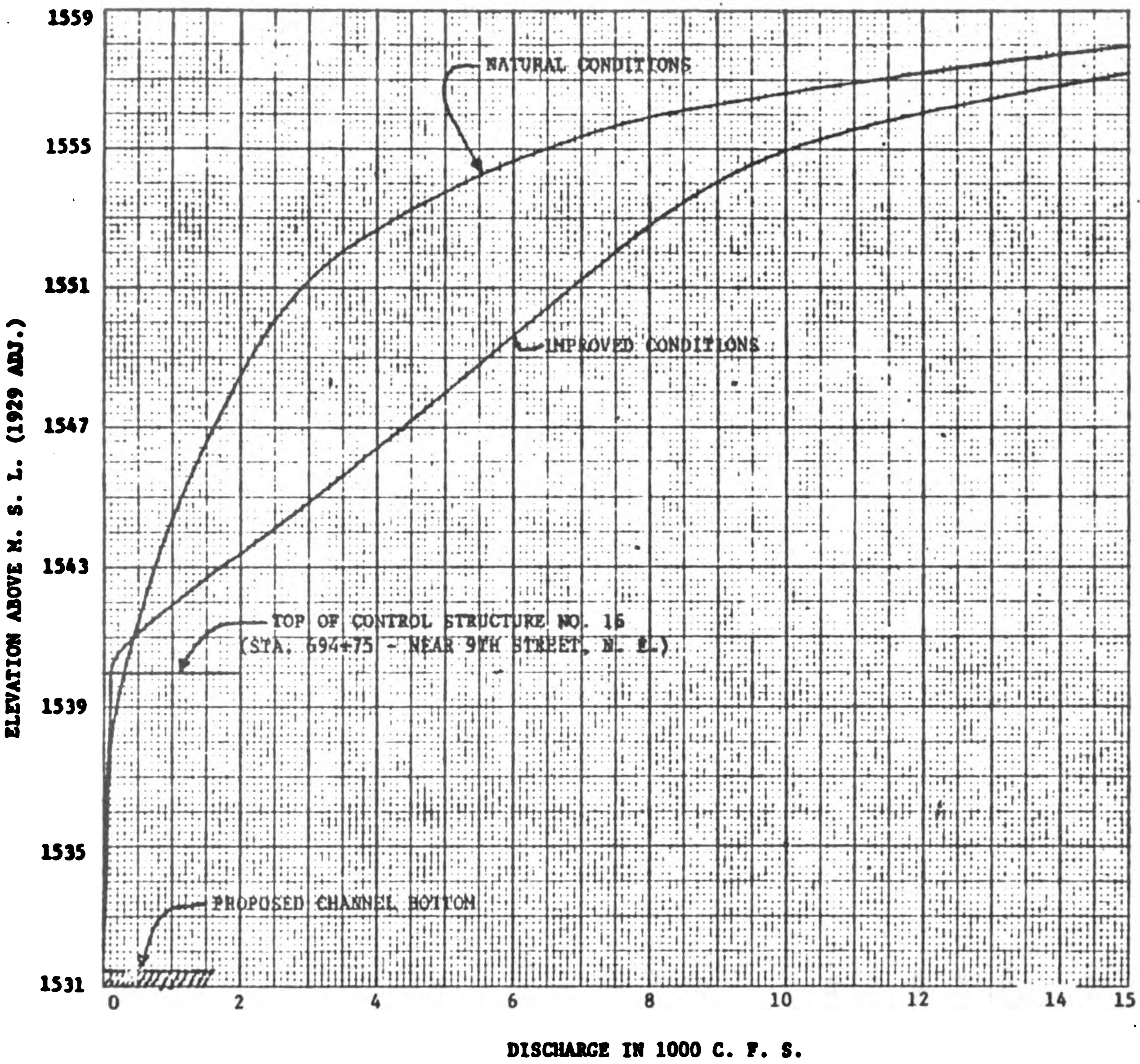
Benefit-Cost Ratio:

With local employment benefits	0.72
Without local employment benefits	0.52

(1) Based on an interest rate of 5½ percent and estimated 2-year site development period.
(2) Includes betterments to residences, businesses and public buildings in accordance with provisions of Public Law 91-646 and through private expenditures.
(3) Investment X 0.05526 over 100-year economic life.
(4) Increases and decreases in operation, maintenance and replacements of public and private improvements are not evaluated since such costs are recognized as mutually offsetting.
(5) Obtainable through continued enforcement of floodplain regulations.
(6) Creditable, provided the county qualifies as an area of unemployment eligible for Federal assistance under Title IV of the Public Works and Economic Development Act of 1965.

The foreseeable social and political problems associated with such a major dislocation of people are of such magnitude as to preclude its consideration as a viable alternative. The relocation of churches, schools, and other public service institutions would divide the groups served by the institutions and adversely affect not only those moved but also those remaining on the margins of the vacated areas. Some small businesses could not continue to operate and others would suffer substantial losses. The conclusion appears inevitable that a decision to evacuate the floodplain in this case could only lead to no action and continuance of the flood risk.

b. Reduced area evacuation in combination with a 5,000-cfs channel. - Evacuation to supplement the channel improvement program would not produce sufficient cost savings to make it practical. Plate B-6 from the Channel Improvement Design Memorandum shows the rating curves (elevation-discharge relations) for existing and improved channel conditions on the Souris River at the Main Street Bridge. You will note that, at the channel design discharge of 5,000 cfs, we obtain a reduction in water-surface elevation of about 5½ feet, or at elevation 1548 the improved channel would carry 5,000 cfs as compared to about 1,800 cfs under existing conditions. For flows greater than the channel design discharge the rating curves tend to draw together or to become asymptotic as the added channel capacity becomes a less significant part of the total flow area. Thus, at the 100-year flow of 14,000 cfs, the channel work produces a reduction in elevation of only 1 foot, or at elevation 1556.8 the gain in flow passed would be from 10,700 cfs to 14,000 cfs. We doubt that the difference in area flooded with a 1-foot reduction due to the channel work would result in sufficient overall cost reductions to make the combined undertaking any more feasible economically than the evacuation of the entire floodplain up to the 100-year elevation without channel work. Further, since the channel work benefits Minot primarily, the outlying residential area evacuation would be substantially the same either with or without the Minot channel work.



NOTE: Revised on 13 February 1973.

Design Memorandum No. 1
Flood Control
Souris River at Minot, N. D.
DISCHARGE RATING CURVES
SOURIS RIVER AT UPSTREAM
SIDE OF MAIN STREET BRIDGE
STA. 736+65
St. Paul, Minn. District
FILE NO. 81-B-5/67

PLATE B-6

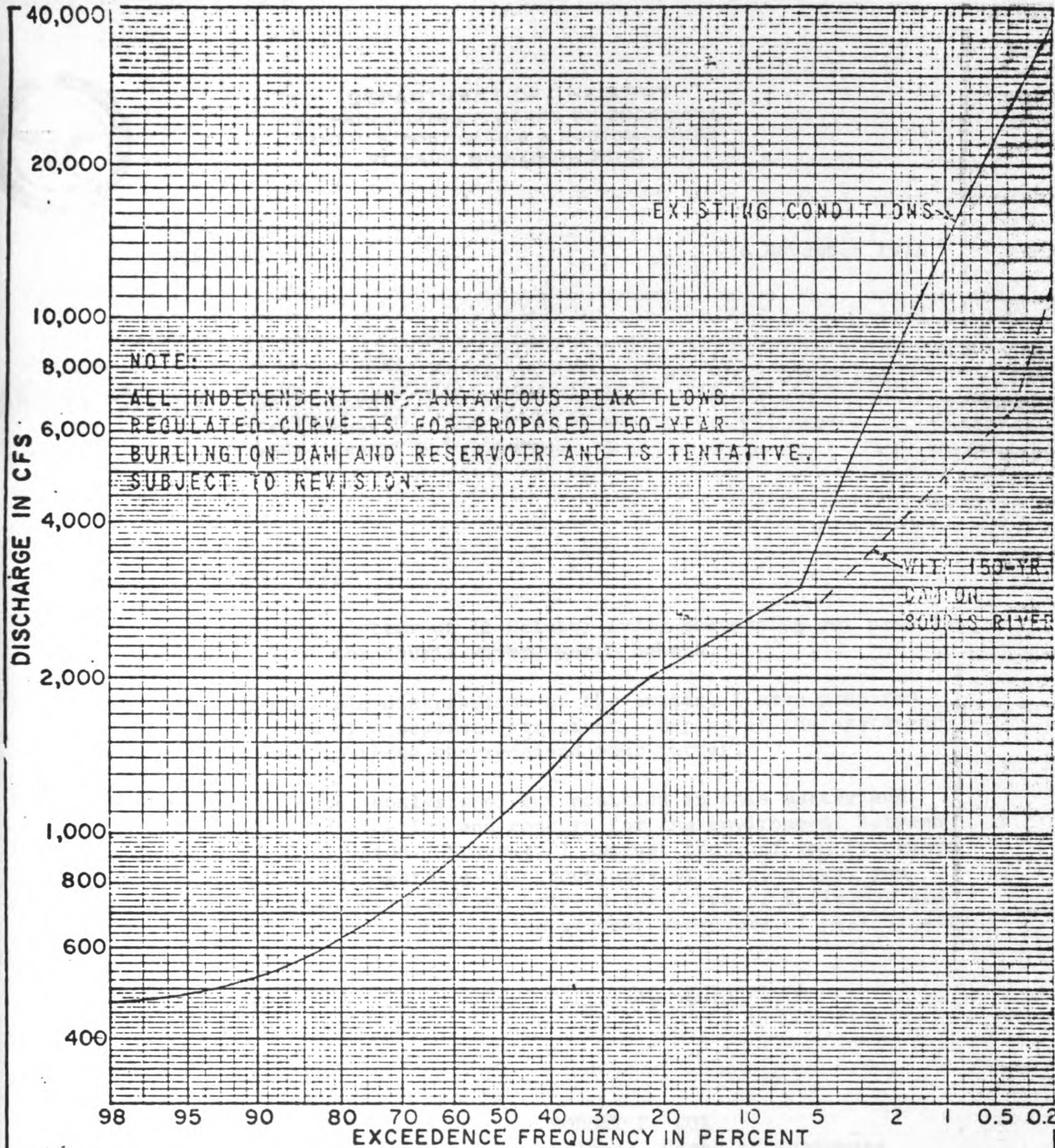
c. Benefits assigned to evacuation. - Our estimates of average annual flood damages for conditions existing in 1980 total $2,253,000 with an estimated additional amount of $2,277,000 for the present worth of the losses attributable to unregulated future growth. Evacuation would eliminate flood damages to all but the fringe area affected by the infrequent floods of a magnitude greater than the 100-year flood. Thus, the flood damage benefits attributable to evacuation have been estimated at $2,150,000 annually. Assuming that evacuation would be accompanied by strict enforcement of floodplain regulations, average annual benefits attributable to such action would be $2,147,000, making a total of $4,297,000 out of a possible $4,530,000. This determination is comparable to that used for the proposed reservoir and related works for which the channel benefits total $1,039,000 and the benefits realized by operation of the reservoir and related work total $3,386,000 for a total of $4,425,000 annually. The residual losses with the channel-reservoir plan are less than for the evacuation-floodplain regulation plan because of the near complete protection provided by the former.

d. Applicability of local employment benefits to evacuation. - Local employment benefits realized through use of local labor in evacuation have been determined in the same manner as for the structural measures.

e. Difference in methods used between 1969 and 1972. - We agree that we may have had some inconsistencies in the methods or assumptions made in the original survey and subsequently used in the updating process. However, the procedures and data now used in our evacuation review analyses are consistent with those used for the channel and reservoir economic analyses.

2. In regard to the frequency of the 5,000-cfs flow at Minot, plate B-2 of the 1969 survey report does show a chance of occurrence of about 4.5 percent for the 5,000-cfs flow. However, the frequency-discharge relation was later revised, taking into account the added period of record and other factors, when the hydrology was reviewed for the channel improvement

design memorandum. The revised frequency curve, Plate A-7, was furnished to the Advisory Committee at the 4 April 1972 meeting and was discussed by Mr. H. O. Johnson of our office at that time. The frequency of the 5,000-cfs flow approximates 3.3 percent which is equivalent to a probability of occurrence of once in about every 30-year period on the long-term average. As we pointed out in our response to your 14 May 1973 letter, flood frequency determination is a statistical procedure based upon the available period of record, about 70 years for the Souris River at Minot. If the 70-year period of record represents an average of several such 70-year periods, we could say with reasonable assurance that a particular flow might recur so many times in a 100-year period. At the present time the best available data indicate that a 5,000-cfs flow can be expected once in about 30 years.



NOTE:

AT LOWER STAGES GAGE IS AFFECTED BY BACKWATER FROM HIGH GASSMAN COULEE FLOW. THEREFORE, DASHED CURVE WAS DRAWN TO INCLUDE RUNOFF FROM GASSMAN COULEE AND REPRESENTS THE DISCHARGE AT CONFLUENCE WITH GASSMAN COULEE.

DESIGN MEMORANDUM NO. I
FLOOD CONTROL
SOURIS RIVER AT MINOT, N.D.
DISCHARGE-FREQUENCY CURVE
SOURIS RIVER AT MINOT, N. D.
REGULATED BY PROPOSED BURLINGTON DAM
ST. PAUL, MINN. DISTRICT
FILE NO. RI-R5/56

PLATE A-7

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT. CORPS OF ENGINEERS
1210 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL MINNESOTA 55101

IN REPLY REFER TO
NCSED-PB

16 November 1973

Dr. and Mrs. John A. Ward
800 Northwest 15th Street
Minot, North Dakota 58701

Dear Dr. and Mrs. Ward:

This responds to your letter of 15 October 1973, concerning our proposal for flood control on the Souris River, North Dakota.

In view of your multiple distribution of the letter, I have prepared my reply in the form of a separate statement. Copies of the statement are being furnished to those who received your letter.

I appreciate your frank analysis of our position in this matter and your uncompromising dedication and concern for the environment between Lake Darling and Burlington. However, I suggest that, if you or others have further questions regarding our procedures or conclusions, you might wish to arrange for a meeting between the Corps of Engineers and your group rather than to continue the present procedure of periodically exchanging letters.

Sincerely yours,

RODNEY E. COX
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

NCSED-PB
Dr. and Mrs. John A. Ward

16 November 1973

Copy furnished: (w/incl)

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RESPONSE TO COMMENTS
in letter dated 15 October 1973 from
Dr. and Mrs. John A. Ward, Izaak Walton League of America
16 November 1973

1. The Advisory Committee:

The local citizens committee was not formed because of objections raised by local citizens but was established at the suggestion of the Corps of Engineers as a basis for the exchange of pertinent information and to facilitate a better public understanding of the complex nature of the flood problem and alternative solutions. The committee was composed of representatives of the major areas of concern, including those who could speak for residents of the area above Lake Darling, between Lake Darling and Burlington, the Des Lacs area, the suburban areas near Minot, the Minot area, the middle Souris area, and the ranch lands in the Towner area farther downstream. As a result of the public attendance at the meetings and the factual reporting of the proceedings, the public became much more aware of the nature of the flood threat and the values and effects of the many considerations discussed in the 16 meetings of the committee. Some of the suggestions by committee members were not practical, but all were reviewed and weighed on their merits. Other suggestions, such as the proposal to pass all flood flows up to about 5,000 cfs (cubic feet per second) at Minot, the proposed channel capacity through the city, were considered meritorious and operation plans were revised accordingly.

In its final position paper the committee listed 17 points. Since most of the recommendations were meritorius and were developed during the committee meetings, the Corps of Engineers was able to agree with all but one or two of the recommendations. The committee could not agree on a specific damsite and, in item 6, left this question open to the Corps of Engineers. In item 7, the Committee recommended 100-year protection and doubted the feasibility of protection from a flood larger than one having a frequency of once in about 150 years. The latter recommendation was apparently a committee compromise. Since the degree of flood protection to be provided involves many engineering, economic, environmental and social considerations, of which the risk of loss of human life is of significant importance, such a decision cannot be based on a compromise but must rest upon the best judgment of experienced water resource planners. The committee was advised on several occasions that the question of degree of protection was a matter on which the committee should present its views but that the final decision would be made by the Corps of Engineers.

During one of the Advisory Committee meetings Councilman Duane Dokken raised several questions and presented his analysis of the 1882 flood volume and related personal views. Later, when the question of a possible flood disaster if a storm similar to that experienced at Rapid City, South Dakota, should center just above Minot was raised, Mr. Lloyd Nygaard expressed his view that a dam across the valley at the Burlington site would reduce the available valley storage thus worsening the flood threat in Minot. Both of these items were discussed at length before the Committee and were apparently resolved, at least to the satisfaction of Councilman Dokken. Also, the Committee was advised that flood routing analyses indicated that the 5,000 cfs channel would be adequate to handle the expected runoff from a Rapid City-type flood. In addition, the low-level culverts through the dam at Burlington, necessary to pass a Souris River flood up to 5,000 cfs without storage, would permit backflow during a Rapid City-type flood so that the valley storage above the dam would be available.

2. Project costs:

Inasmuch as construction costs have been increasing at a rate varying from 8 to 15 percent per year since June 1969, project costs would have increased from $34.5 to $51.0 million by July 1973 with no change in the work anticipated in the project document (1969 survey report plan). The net effect of modifications of the dam and reservoir design amounts to a cost increase of only 2 percent of the original estimated project cost after recognizing price increases.

A significant part of the increase in channel improvement cost is attributable to the change in capacity, from 3,800 to 5,000 cfs and the addition of features to minimize possible adverse environmental effects. The change in channel capacity was necessary to obtain 100-year protection from floods which occur more frequently on the Des Lacs River, recognizing adjustments in flood-frequency relations considered advisable as a result of the 1970 flood. Also, the larger channel capacity provides the city with protection from floods which could be generated on the small coulees below Burlington should a storm, such as that which occurred in the Rapid City, South Dakota area, center over the drainage area of the coulees.

The addition of local protection improvements at the suburban areas upstream of Minot and at Sawyer and Velva was made necessary when the recommendation of the advisory committee was adopted to allow flows up to the Minot channel capacity (5,000 cfs) to pass through the reservoir without storage reduction. This decision permits more effective use of the storage for the infrequent major floods and less frequent inundation of the ranch and wildlife refuge lands between Burlington and Lake Darling.

The Des Lacs diversion is a desirable alternative to increase the degree of protection from the less-frequent major floods which could originate on that stream. On page 8, paragraph 13, of its report, which is included in the project document, the Board of Engineers for Rivers and Harbors recommended further consideration of an alternative damsite below the confluence of the Des Lacs River because of the possibility of a rare major flood originating on the uncontrolled Des Lacs River. The cost of the Des Lacs diversion tunnel and associated works plus Burlington dam and reservoir proved to be no more than the cost of a dam and reservoir located below the confluence. However, the tunnel and associated works had none of the adverse effects of the confluence reservoir which would require major highway and railroad relocations, relocating about 30 additional residences and a public park, moving a cemetery, and periodic inundation of additional valley lands. The need for the diversion works and its size will be thoroughly considered by reviewing authorities.

The following table summarizes changes in project cost estimates:

Estimated project costs, Souris River, North Dakota

	Survey plan June 1969 prices	Survey plan July 1973 prices	Current plan July 1973 prices	Reason for increase over survey report plan at July 1973 prices
Burlington Dam and associated works	29.2	43.2	44.0	a
Minot Channel	5.3	7.8	17.0	b
Suburban area improvements	-	-	8.6	c
Des Lacs Diversion			12.5	d
Total	34.5	51.0	82.1	

a. Redesign based on data currently available.

b. Increase in channel capacity from 3,800 to 5,000 cfs, inclusion of environmental protection and mitigation measures, and modification of interior drainage works to meet current standards.

c. Modification of existing emergency levees and associated channel works to accommodate passage of flood flows up to 5,000 cfs.

d. Alternative to reservoir below junction of the Des Lacs and Souris Rivers to protect against major flood potential on the Des Lacs River as suggested by the Board of Engineers for Rivers and Harbors, p. 8 of H.D. 91-321.

3. <u>Economic analysis</u>:

The Izaak Walton League representatives question the Corps of Engineers economic analyses, noting that benefits for future growth reportedly exist "only in the Corps' mind", Lake Darling Dam rehabilitation costs foregone are considered "absurd", and recognition of the benefits realized through local employment "defies logic".

The matter of continuing new construction in the floodplain was brought to the attention of the Corps of Engineers during the public meetings of the Advisory Committee, and in a letter of 14 May 1973, the Izaak Walton League representative stated that "...In March of this year alone, permits were issued for the construction of three structures in the 100-year floodplain in Minot." Others have reported that about 40 or more new buildings have been undertaken or permitted in the Minot floodplain since local regulations to control such growth were adopted. Thus, the growth of future flood damages must not be entirely in the minds of the Corps since growth has been observed even with the existing regulations. Accordingly, the area of concern would seem to be not whether future flood damages are going to be greater than present flood damages but rather how much of the growth should be recognized and evaluated in economic considerations.

Very competent Corps economists have analyzed Minot growth rates, and have taken into account the social and environmental advantages offered by the valley lands versus the upland areas, the city and county long-range land-use plans, and other factors. Both the city and county regulations are so worded that they would not be continued in force should the project plan not be constructed. On this basis the future-growth in flood losses has been projected through the assumed project life and discounted to present worth. Such benefits are not secondary and are a realistic picture of the future.

The Lake Darling dam was constructed in the 1930's under standards which are now considered obsolete and inadequate when the downstream urban developments are taken into account. If no downstream flood control dam were to be constructed, replacement of the Lake Darling spillway with a modern structure and modification of the dam would be required. The cost of modernization of the Lake Darling dam would be justified by the need to continue providing water supplies to the downstream refuges during the frequent periods of low flow. If a much larger downstream dam were constructed for flood control, overtopping of the Lake Darling dam would not affect the downstream urban development since the resulting flows could be absorbed in the new reservoir without exceeding design outflows. In the case of construction at or near the Lake Darling dam, part or all of the existing dam would be replaced, whereas if the flood control structure were constructed farther downstream, modification of Lake Darling dam would not be necessary. The elimination of the need to rebuild Lake Darling dam would be a definite savings to the Federal Government and, as such, is a benefit creditable to the project regardless of which damsite is selected.

The employment benefits to be obtained locally are evaluated for water resource projects in counties designated by the Economic Development Administration as areas with chronic and persistent unemployment and underemployment. Such benefits are considered to be the value of local labor within reasonable commuting distance that will be used in project construction and operation and which, in the absence of the project, would otherwise be unemployed. Both Ward and Renville Counties have been designated as areas of high unemployment eligible for assistance under title IV of the Economic Development Act of 1965 and for recognition of employment benefits in planning water resource projects. Local employment gains are considered incidental benefits and, as such, are added to the primary project benefits. However, projects are usually formulated and sized without consideration of such incidental employment benefits. Thus, the Corps of Engineers shows two benefit-cost ratios; one with and one without employment benefits. In this manner all concerned interests may be aware of the opportunity for such local benefits to be realized, and their overall significance may be taken into account together with other benefits in considering the contribution the project would make to the attainment of our national objectives.

4. Floodplain evacuation:

The benefits and costs of evacuation and its limitations as a solution to the Souris River flood problem were discussed at length in the reply of 31 July 1973 to a letter dated 17 July 1973 from the Isaak Walton League representative. Evacuation has merit in relatively undeveloped floodplain areas, but it is impractical and uneconomic in this case. The variance in estimated benefits was due to differences in the handling of future growth. If the schools, churches, businesses, and residences remain in the floodplain, continued improvements and new developments are inevitable, and damages prevented by structural measures to such improvements are clearly direct benefits to be recognized in justification of such structural measures. In contrast, evacuation, as an independent action, could only eliminate flood damages to the properties removed from the floodplain. However, with public ownership of the floodplain and its dedication to parks and open space, regulations precluding future occupation of the floodplain could be readily enforced. Thus, in our July 1973 detailed review of the merits of evacuation, average annual benefits totalling $2,150,000 were credited to evacuation. Whether future growth benefits would be properly creditable to evacuation as reported in the project document, is debatable. However, for comparison with the structural measures, future growth losses precluded through enforcement of floodplain management regulations were combined with the evacuation benefits. A total average annual benefit of $4,297,000 was obtained in this manner for the two actions, evacuation and regulations to preclude future reoccupation of the floodplain.

In retrospect, the evacuation alternative probably should have been given more detailed study and analyzed more completely as part of the project document study. When we learned that the Izaak Walton League representatives seriously considered that evacuation of about 4,000 residential structures together with public buildings and businesses, now in the floodplain, we undertook to produce a realistic estimate which, when all factors were taken into account, proved to be several times greater than the survey-scope estimate.

The survey report displays several alternatives and discusses their advantages and disadvantages leading toward the recommended plan. The purpose of the current phase I, project formulation study, is to review the alternatives and, in light of possible changed conditions and policy, to confirm the project document plan or to identify the scope and nature of any proposed alternatives or revisions to the 1969 survey report plan. Changes in estimates of benefits and costs are inevitable when new data and new policies are taken into account and more detailed investigations are made. The credibility of the Corps of Engineers is high because of its willingness to consider fairly and impartially all suggested alternatives.

5. Opposition to the Corps' plan:

The Izaak Walton League representatives note that "opposition to the Corps' plan is growing among residents along the stretch of the Souris Valley from Burlington to Lake Darling." With the exception of recent changes in ownerships in the vicinity of the damsite where a residential subdivision has been started, only 13 property owners are involved between the damsite and Lake Darling. Records indicate that several of these owners opposed the reservoir proposed in the project document and have remained unalterably opposed during the past 2 years planning review period. In contrast, more than 4,000 downstream property owners from Burlington to Towner remain in favor of the plan.

6. Degree of protection:

The use of the terms 100-year, 200-year, or 1,000-year protection is unfortunate since they imply a reliability which exceeds the limits of the available data. Thus, on the Souris River we have only 70 years of streamflow records. For economic analyses this limited record is extrapolated to several hundred years since the total flood damage caused by a rare infrequent flood is a significant part of the total loss potential in large urban areas. Average annual flood control benefits are represented by the difference between average annual flood damages with and without the corrective measures under consideration. Thus a change in flood frequency generally is not of major concern since the benefits or difference between damages with and without a project may only change a small amount.

The theory of flood probability is based generally on the assumption that the period of record, 70 years at Minot, is an average of all such periods expected in say 1,000 years. However, the hydrologist has no assurance that the record is representative of future 70-year periods. The 70-year period from 1903 to 1973 may have been unusually devoid of flood occurrence due to a prolonged drought or may have included an unrepresentative number of major floods. If a flood considerably larger than any in the period of record were to occur next spring, the frequency curves would be adjusted to reflect the impact of the new data, and a flood peak or flood volume which was considered to have a recurrence frequency of several hundred years might become a 100-year event. Thus, although flood frequency provided a point of reference for project formulation and degree of protection determination, it is not the only or necessarily the best criterion for project design for large urban areas where the risk of loss of human life is a primary consideration.

If structural measures are to be provided to protect a large metropolitan area, a high degree of protection must be assured to prevent a disaster which might occur if the project design flood were to be substantially exceeded. As a guide, and possibly as an upper limit of protection, a standard project flood is developed for the principal flood sources. Such a flood is defined as the flow that may be expected from the most severe combination of meteorological and hydrologic conditions considered reasonably characteristic of the region involved, exclusive of extremely rare combinations.

The first step in project formulation involves establishment of the most economic size improvement or combination of improvements based on discharge-frequency and discharge-damage analyses. In the case of the Minot area, such a project might well be a reservoir at or above Burlington having a 200-year storage plus some channel improvement through Minot. The next step in the project formulation is to weigh the merits of providing protection from the standard project floods which, in this case, could originate on the Souris River above Burlington, on the Des Lacs River, or on Gassman Coulee, the latter a small uncontrolled stream tributary to the Souris River below its junction with the Des Lacs River. In this step the planner must identify in meaningful terms the environmental, social, and economic impacts, both favorable and unfavorable, caused by or obtainable through provision of the increased degree of protection. When standard project flood protection is not possible within economic limitations, prudent planning dictates that consideration be given to the highest degree of protection obtainable within economic limits, particularly when the risk of loss of human life and other considerations, social and environmental, permit such action.

The project document plan developed in 1969 provided for a dam at the Burlington site with a 637,000 acre-foot reservoir. The present plan provides for a smaller dam at the same site with a storage capacity of 595,000 acre-feet. The increase in channel capacity through Minot from 3,800 to 5,000 cfs, together with improvement of protection works at suburban residential areas and downstream communities, made possible the operating plan which could use the available storage more effectively. The current plan provides protection from floods up to about 75 percent of the standard project flood potential from the three principal sources. Thus, the plan materially reduces the risk of a rare but possible flood exceeding the project design.

7. <u>Environmental inventory</u>:

During July 1972 the Corps of Engineers entered into a contract with Minot State College to identify the plant, wildlife, and stream resources in alternative project areas being considered in connection with flood control plans on the Souris River; to summarize the ecological, visual, and human-cultural values of local, State and national importance; and to describe the probable impacts of alternatives on such resources. The report, completed in January 1973, provides an excellent summary of the flora and fauna in the study area and presents a discussion of alternative plans and their probable impacts primarily on the open water, marsh, grassland, and floodplain forest resources. The recommendations extend to those alternatives which would be least damaging from an environmental viewpoint, primarily because this was the main thrust of the study, and the principal area of expertise of the investigators.

The report recommends evacuation of the floodplain, about 12,000 people, with no discussion of the economic cost and social impacts of such a venture. Similarly, the report proposes, as a second-best alternative, channel improvement through populated areas and evacuation of at least the 50-year floodplain, again without reference to cost or social impacts or recognition that the 50-year and 100-year floodplains are almost identical. Finally, the report recommends, as the third best alternative, a 5,000 cfs channel capacity through populated areas plus reconstruction of Lake Darling dam, based primarily on environmental considerations without concern for the extent or nature of the remaining flood risk.

The State college report provides us with needed information on only one aspect (environmental impact) of several parameters which must be taken into account in reaching a decision on the type, location, and size of improvements which will best meet the public need on the Souris River. Information presented by the Minot College study staff at one of the Advisory Committee meetings was, in part, instrumental in bringing about the revised plan of operation which would materially reduce the frequency of reservoir storage and associated adverse effects on the environmental values and farm operations in the reservoir area. Because the Corps does not accept the recommendations of the study group, the conclusion does not follow that the findings have been ignored.

The Corps of Engineers has the responsibility to provide an engineeringly sound solution to the flood problem. We would betray the public trust if we were to construct an inadequate project which, although it minimized environmental effects, was unable to protect the life and property of the valley residents.

During July 1973, after thorough consideration of the views expressed by the advisory committee, the Minot State College study group, and the Bureau of Sport Fisheries and Wildlife, the District Engineer announced for public discussion his tentative decision to recommend construction of the dam at the authorized Burlington site, with design storage to elevation 1620, together with the Des Lacs diversion and downstream channel and levee improvements. He based his decision on a thorough review of all practical alternatives capable of meeting the flood control need, recognizing that some adverse effects cannot be avoided and that, insofar as possible, the adverse effects will be either mitigated or outweighed by the public need. His recommended action is in agreement with national policy and administrative directives existing at that time, and he is convinced that the overall public interest would best be served by construction of the recommended plan. All of the alternatives to the Burlington Dam, including a new or higher dam at the Lake Darling damsite, will be described and their advantages and disadvantages will be summarized in a general design memorandum. This design memorandum, the Minot State College environmental report, the minutes of the advisory committee, the environmental impact statement, and other related papers will be available to reviewing authorities. In addition, the record of a final-stage public meeting to be held early next year in Minot, will be available to reviewers. Thus, decision makers at all levels will have a frame of reference and the necessary data to understand the values involved and the basis for selection and size of each project feature.

8. Compliance with the law:

The Corps of Engineers is complying and will continue to comply with the requirements of the Uniform Relocation Assistance and Real Property Acquisitions Policies Act of 1970 contrary to the opinion of the representatives of the Izaak Walton League. Records show that a final environmental impact statement was transmitted to the Council on Environmental Quality on 25 March 1971 well before any contract was awarded for construction of the channel improvement. The Corps is in complete compliance with the requirements of the National Policy Act of 1970. More recently we have prepared a draft statement which covers more completely the environmental concerns and changed conditions encountered since the original statement was prepared. It will be submitted to the Council soon.

9. The final decision:

Water resource policy is not fixed but changes from time to time. Most recently new Principles and Standards for Planning Water and Related Land Resources have been established by the Water Resources Council and approved by the President to be effective 25 October 1973. Although guidelines have not been made available for their uniform application, some changes in the project as presently formulated may result.

)0 Northwest 15th Street
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ecember 19, 1973

Northern
Plains

AMERIC

Region III

l. Rodney E. Cox, District Engineer
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. Paul, Minnesota 55101

ear Colonel Cox:

iank you for your reply to our letter of 15 October 1973. Your suggestion that we rrange a meeting with the Corps of Engineers in lieu of exchanging letters is ppreciated, but we feel we must reject it for several reasons:

1. The cost to the Izaak Walton League, should we arrange to journey to St. Paul for the meeting would be excessive in comparison with the cost of postage. For the same reason, we feel the cost to the taxpayer precludes sending Corps representatives to Minot.

2. The exchange of letters provides for a documentation of remarks for which a meeting could not provide. It is less likely that one's remarks will be misinterpreted if they are in writing. The nature of written communication as opposed to oral communication also requires greater clarity of expression.

3. Since letters can be disseminated widely at only a fraction of the cost of travel, a far wider segment of the interested public can be informed of our concerns and your replies than would be possible in a meeting.

4. We have had the experience in previous meetings with Corps representatives of asking a question only to be informed that the answer to that question fell outside of the area of expertise of those present. Such questions are then answered by mail, or at subsequent meetings, or ignored. We feel it more efficient to direct our questions to the district office where you can answer them with the full support of your technical staff.

e feel that labeling our dedication and concern for the environment as "uncompromising" s not entirely correct. Rather we have sought those compromises that would reduce verall environmental impact while still providing for flood protection. An increase n channel capacity from 3600 cfs to 5000 cfs represents a significant compromise. It ill probably result in greater disruption of floodplain forest along the channelized eaches. The effect of channelization on degradation regime and ground water recharge as not been evaluated to our satisfaction. Nevertheless, we have accepted the increase n channel capacity because, as stated in the biological impact study:

1. It allows maximum flow at any given time, emulating natural river function while still providing flood protection.

2. It limits the amount of storage required upstream, reducing environmental impacts from storage and prólonged releases.

3. It decreases duration of storage.

4. It reduces the probability of local downstream flooding late in the growing season due to local storms and full channels.

5. The use of land near Towner for hay meadows could be continued with little change in management.

6. There would be minimal disturbance of waterfowl nesting on the J. Clark Salyer National Wildlife Refuge.

You will note that the above points reflect concern for the entire Souris Loop and not merely "the environment between Burlington and Lake Darling."

In conclusion, we are in sympathy with your apparent feeling that the present procedure of periodically exchanging letters is losing much of its charm. As such, you should agree that an adequate environmental impact statement on this project is long past due.

We would also appreciate receiving a copy of the Phase I Design Memorandum as noted in your letter of 31 July 1973. Since preparation of the Design Memo usually precedes construction we assume it is in readiness.

Sincerely,

Paula Ward

Mrs. John A. Ward, Regional Governor

John A. Ward

John A. Ward, President
Theodore Roosevelt Chapter, IWLA

CC: Raymond C. Hubley, Jr., Executive Director, IWLA
Raymond A. Haik, Chairman, Executive Board, IWLA
Dr. Alfred J. Kreft, National President, IWLA