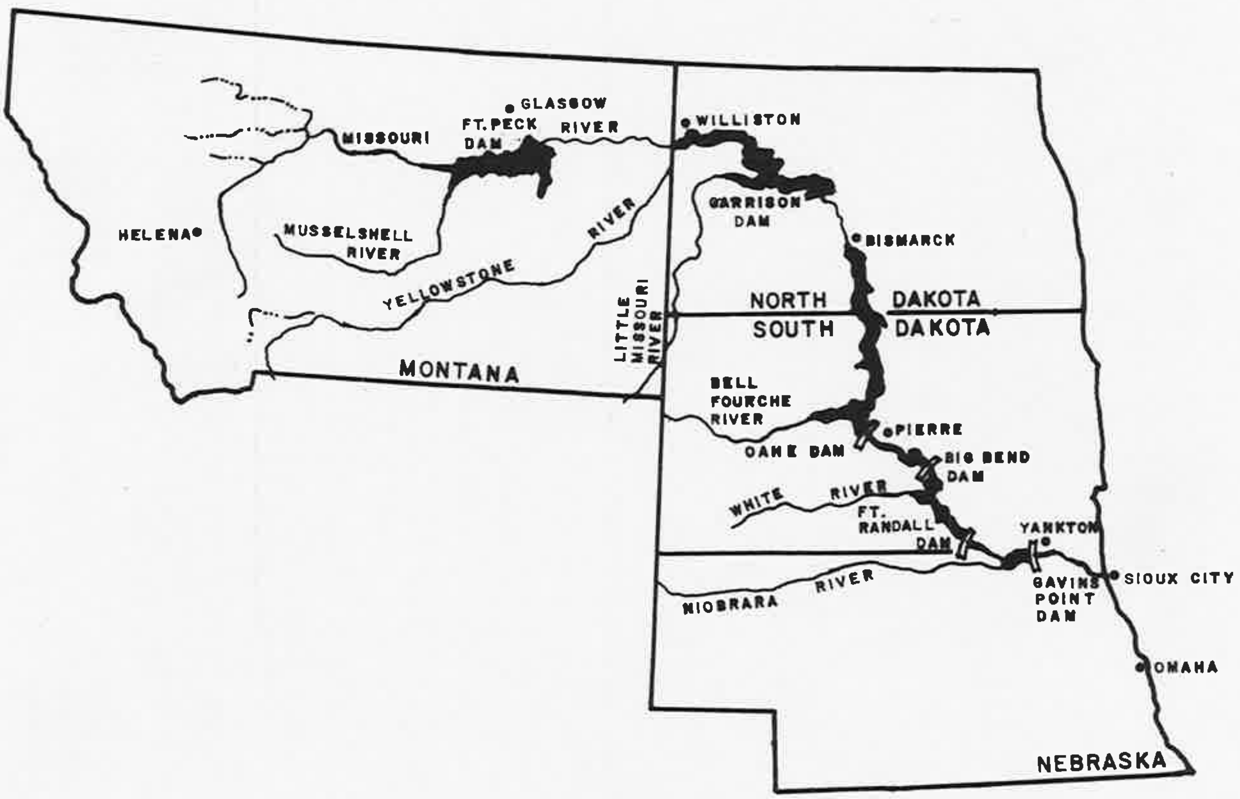
Upper Missouri River Bank Erosion



Montana and North Dakota

April 1991

UPPER MISSOURI RIVER

BANK EROSION

MONTANA AND NORTH DAKOTA

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I. INTRODUCTION

Problem Statement

Since the completion of the Missouri River main stem reservoirs, the net loss of highly valued lands along the river in the upper basin states has increased substantially. The loss of these lands has adversely impacted landowners, local and state governments, Indian Reservations, recreation, wildlife, and the environment. The Corps of Engineers, who operate the main stem dams, are responsible for the bank erosion. However, the Corps has refused to correct the damage being done. The Congress of the United States has directed the Secretary of the Army to undertake such measures, including maintenance and rehabilitation of existing structures, which the Secretary determines are needed to alleviate bank erosion and related problems. By this action the Congress acknowledges that the federal government, through the Corps of Engineers, is responsible for the bank erosion. However, no money has been appropriated to allow the Corps to meet their responsibility.

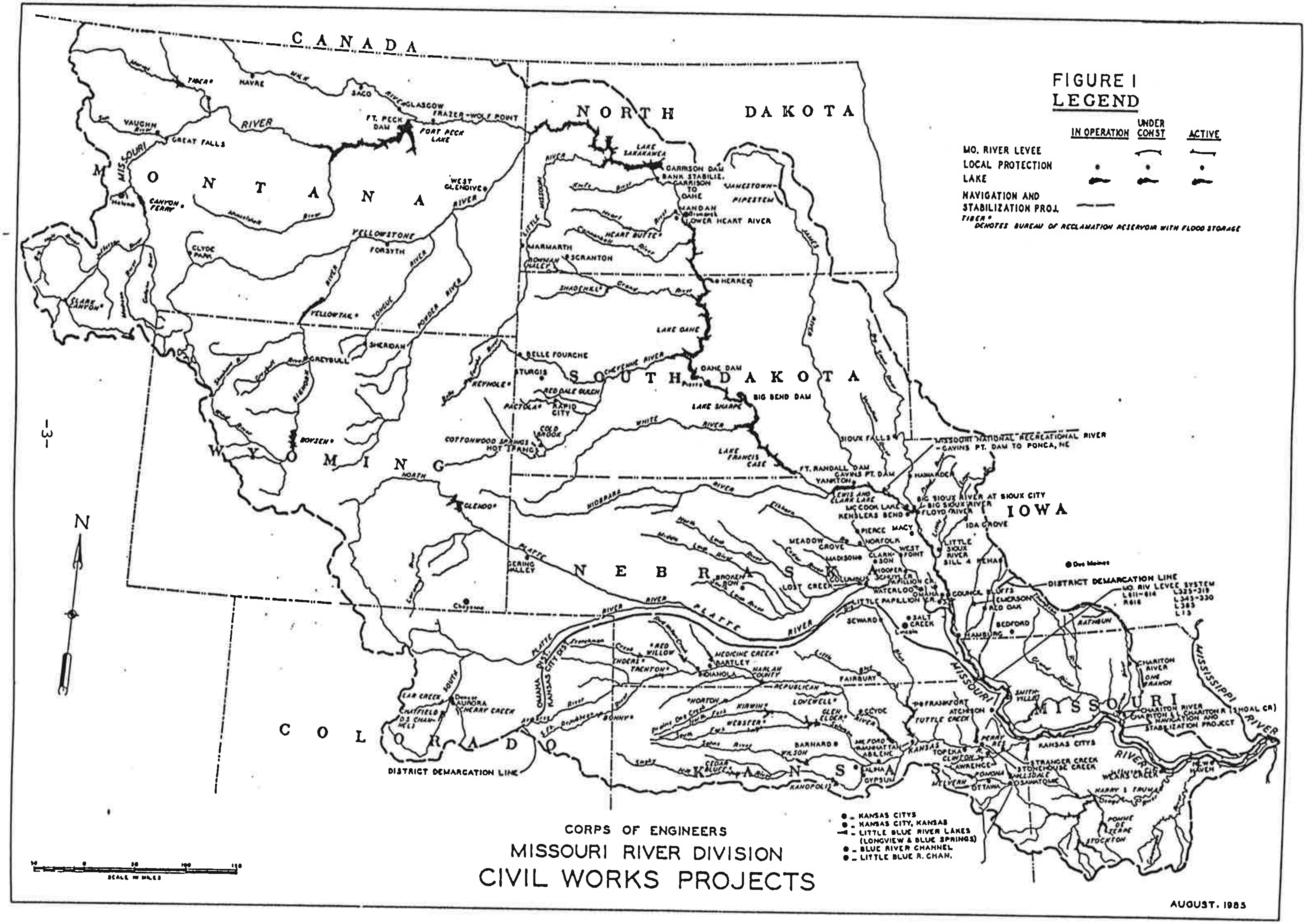
Purpose and Scope

This report reviews the history of the development of the Missouri River system, presents justifications for bank protection measures, and itemizes erosion sites. Although this report emphasizes the problems in Montana and North Dakota, information from Nebraska and South Dakota is included as these two states are also losing land to bank erosion.

The organizations supporting this report hope the information provided will persuade the United States Congress to appropriate sufficient funds to alleviate the damage occurring in the upper basin states. The organizations also hope the Congress will direct the Corps of Engineers to repair the damage caused by the dams they control.

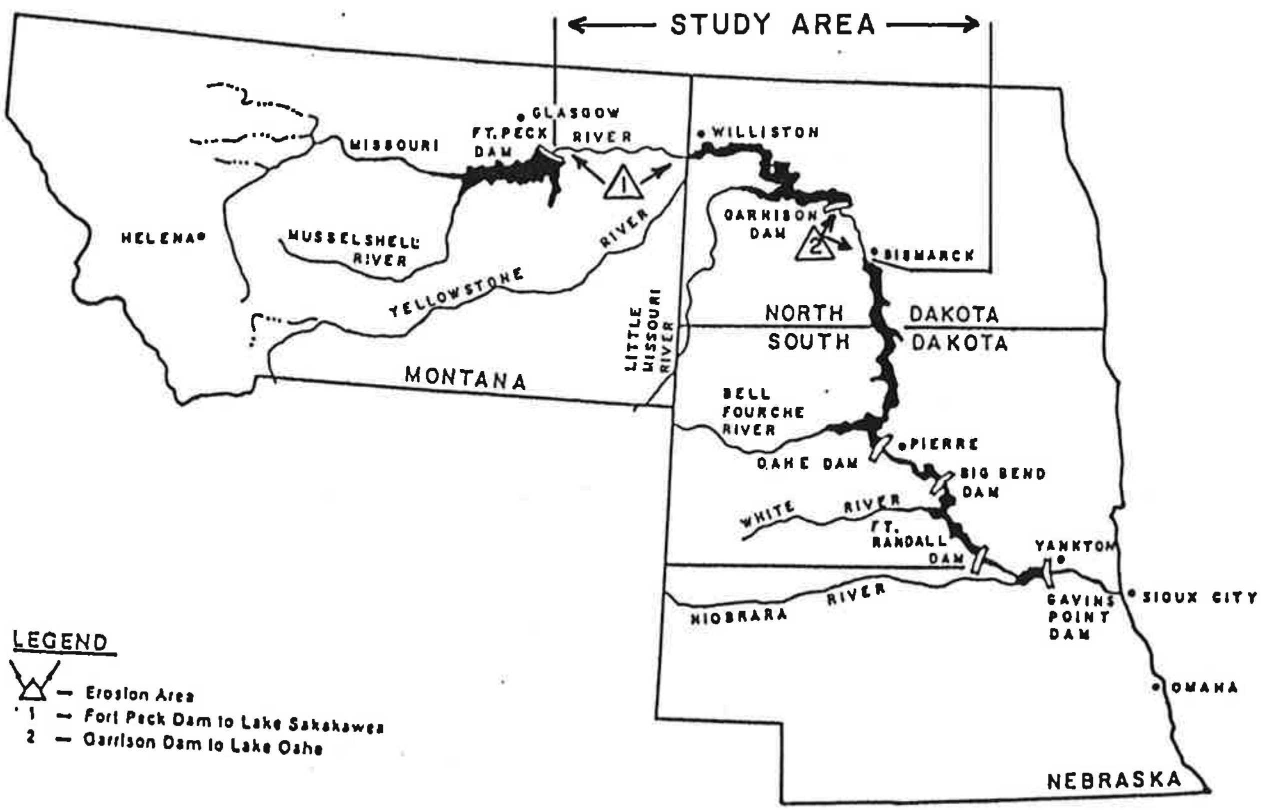
Description of the Study Area

The Missouri River drainage basin consists of 529,000 square miles and includes all or parts of ten states, Figure 1. There are six main stem dams located along the thousand mile reach of the Missouri River extending from Yankton, South Dakota to Glasgow, Montana. Open reaches of river exist between Fort Peck and Lake Sakakawea (204 miles), Garrison and Lake Oahe (87 miles), Oahe and Lake Sharpe (5 miles), Fort Randall and Lewis and Clark Lake (44 miles), and downstream of Gavins Point Dam (58 miles). The area upstream of the point 58 miles downstream of Gavins Point is referred to as the upper basin, Figure 2. The five open reaches are the focus of this report with emphasis given to the reaches between Fort Peck and Lake Sakakawea and between Garrison and Lake Oahe.



CORPS OF ENGINEERS
MISSOURI RIVER DIVISION
CIVIL WORKS PROJECTS

FIGURE 2



STUDY AREA
GLASGOW
FT. PECK DAM
MISSOURI
RIVER
WILLISTON
HELENA
MUSSELSHELL RIVER
YELLOWSTONE
RIVER
GARRISON DAM
BISMARCK
LITTLE MISSOURI RIVER
NORTH DAKOTA
SOUTH DAKOTA
MONTANA
BELL FOURCHE RIVER
PIERRE
OAHE DAM
BIG BEND DAM
WHITE RIVER
FT. RANDALL DAM
YANKTON
GAVINS POINT DAM
SIOUX CITY
NIOBRARA RIVER
OMAHA
NEBRASKA
LEGEND
— Erosion Area
1 — Fort Peck Dam to Lake Sakakawea
2 — Garrison Dam to Lake Oahe

II. HISTORICAL BACKGROUND

Before the Dams

The Missouri River, before the construction of the main stem reservoirs, was a typical alluvial river that gradually meandered in its broad flood plain. There was a balance over the years between the destruction of valley lands by erosion of the high banks and the building of new valley lands by sediment deposited during floods. This process resulted in a continual migration of the river channel within the Missouri River Valley, but no long-term net loss of valley lands.

The natural flows of the Missouri River varied greatly from year to year and during the year. The winter flows of the upper Missouri River were normally very low since the cold temperatures precluded rainfall and snowmelt. Ground water flows into the river and its tributaries were the only sources of flow. The cold temperatures also caused thick ice formation on the river. At Bismarck, the ice was so stable that railroad tracks were laid on the ice to allow trains to cross before the present bridge was constructed.

Spring temperatures caused the snow cover on the plains to melt causing a sudden surge of high water. Normally the melt occurred in Montana earlier than in the Dakotas. The spring runoff sometimes arrived in the Dakotas before the ice on the river had melted causing ice jams and flooding. The severity of these ice jam floods depended on the amount of water and the amount and hardness of the ice. During these ice jam floods, large amounts of sediments were deposited, building up the valley lands. The spring runoff was very sudden, the riverbed and banks were still frozen so amazingly little bank erosion occurred during the spring despite the high flows.

After the spring runoff the river returned to low flows. The snow in the mountains of Montana and Wyoming usually began melting in late May, reached a peak in late June, and was completed in July. This caused what was known as the June rise. The river channel was normally large enough to accommodate the June rise without flooding the normal bottom land. The lower sandbars, especially those that had a growth of willows, slowed the silt laden water, causing the deposition of silt and thus the beginning of new land formation. Normally, low precipitation in the upper basin during the late summer and fall caused the river to return to moderate and low flows that continued through the winter.

The bottom lands of the Missouri River superbly complemented the adjacent lands. The hills adjacent to the bottom lands were ideally suited to grazing cattle and the bottom lands provided hay and ideal wintering quarters for the ranchers' herds. The occasional flooding or near flooding kept the water table high enough to sub-irrigate the land and the silt deposits of the floods, high in phosphate and potash, created an ideal environment for many crops including forage crops for winter feed. The wooded land provided all the shelter needed to protect cattle through the winter and they were moved to higher ground before the spring flood. Although many permanent buildings were erected on the flood plains, the occasional ice jam flooding was very damaging. If the dams had not been built, most of the bottoms lands would probably have reverted to principally agricultural and recreational usages. Only moderate improvements, such as fences were necessary to produce income from these highly productive bottoms lands. All of this changed with the installation of the Pick-Sloan dams.

The Dams

Fort Peck Dam and Lake were authorized by Congress under provisions of the Public Works Administration Act of 1933, and completed under the Rivers and Harbors Act of 1935. The Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point projects were authorized by the Flood Control Act of 1944. The authorized purposes of these dams and lakes include flood control, hydropower, irrigation, navigation, municipal and industrial water supply, recreation, sanitation, and fish and wildlife conservation.

The construction of the six dams and lakes on the upper Missouri River began in 1933 with the Fort Peck project, and ended in 1965 with the completion of the Big Bend project. The six dams and lakes were designated the Pick-Sloan Missouri Basin program in 1970. The Corps of Engineers' district office in

Omaha, Nebraska, under the Missouri River Division, is responsible for operating and maintaining the dams and lakes on the upper Missouri River.

The upper basin states relinquished over 2,500 square miles to allow construction of the six Pick-Sloan dams, more area than the state of Delaware. Montana lost approximately 588,000 acres; North Dakota 550,000 acres; South Dakota 520,000 acres; and Nebraska 10,000 acres. Choice bottom lands, coal, oil and forestry resources, and small towns were lost forever to these states. The loss of the highly productive bottom lands had a tremendous effect on farmers and ranchers. Although landowners were compensated for the land taken, they were not compensated for the cost of relocation or for improvements necessary at new locations.

After the Dams

With the closure of the dams the sediment load of the river was drastically altered. Sediment once carried by the river is now deposited in the upper reaches of the reservoirs. Clear water released from the reservoirs has a massive silt bearing capacity and immediately begins to pick up sediments from the river banks and bed. For example, the measured sediment load immediately below Fort Peck Dam is zero. At Culbertson, Montana, 150 miles downstream, the average annual measured load is 5,000,000 tons per year. With the exception of tributary inflow, this sediment load is derived from the riverbed and erosion of river banks in the 150-mile reach.[1]

The building process of high floodwaters of the past are now non-existent, halting the rebuilding of bottom lands. Only low sandbars reaching to the upper levels of the currently fluctuating river are formed. Therefore, the present bank erosion results in the permanent destruction of bottom lands, widening of the riverbed, and a continuing net loss of land to the upper basin states.

The continued wet and dry cycles of the river banks, due to river fluctuations caused by releases for power generation, increased erosion rates. The unprotected river banks will continue to erode as long as there are variations in flow. Winter fluctuations are the most damaging. High winter flows are needed to evacuate water for flood control storage and hydropower, and due to ice conditions, higher stages are required to provide the necessary flow capacity beneath the ice. High winter stages were not common prior to the construction of the dams, and, as stated above, the lowest flow generally occurred during the winter. Power generation causes large changes in the flow rate during the day, variations ranging from 8,000 to 10,000 up to 36,000 to 37,000 cubic feet per second occur in a matter of hours. These fluctuations cause the bank to undergo freeze thaw cycles, unlike before the dams when the banks froze to a low level. The fluctuations also cause the ice to move up and down along the bank and may cause the ice to break up and move with the current. The freeze thaw cycles, ice movement, and the increased flow confined by the ice cause great damage to the banks. The effects of these processes are often unknown until spring when large portions of the banks which have been undercut, begin to fail.

III. EXISTING AUTHORITIES

After the dams were constructed and the bank erosion became a problem, the Congress authorized stream bank erosion projects in 1963, 1968, 1974, and 1976. The federal government paid all of the construction costs under these authorities. The protection works under these authorities have been completed and the authorities have expired.

Under Public Law 88-253, dated December 30, 1963, as amended by the Flood Control Act of 1968, the Corps completed 23 projects costing approximately $8 million on the river reach between Garrison Dam and Lake Oahe. A national stream bank erosion prevention and control demonstration program was authorized by the Stream Bank Erosion Control Evaluation and Demonstration Act of 1974, as amended by the Water Resources Development Act of 1976. Under these acts, the Corps completed 28 demonstration projects on the upper Missouri River.

The Water Resource Development Act of 1988, amended Section 9 of the Flood Control Act of 1944. The amendment (Appendix A) directed the Secretary of the Army to undertake such measures, including maintenance and rehabilitation of existing structures, which the Secretary determines are needed to alleviate bank erosion and related problems associated with reservoir releases along the Missouri River between Fort Peck Dam, Montana, and a point 58 miles downstream of Gavins Point Dam, South Dakota, and Nebraska. By this act Congress acknowledged the fact that the dams are causing the loss of lands and assigned the Corps of Engineers the responsibility of correcting the damage. In this act, the Congress authorized the expenditure of $3 million per year to be apportioned as a joint-use operation and maintenance expense. However, there has not been any appropriation of funds for this purpose, and the Corps maintains that bank stabilization is a low priority item not appropriate for funding in view of current budgetary constraints.

IV. JUSTIFICATIONS

Upper Basin Sacrifices

Reservoirs:

The upper basin states made many sacrifices for the Pick-Sloan Missouri Basin program. Table 1 lists the acquisitions by the United States for the reservoirs as of September, 1977.

Table 1 - Land Acquired for Reservoirs
Data From Master Manual

		Acres
Fort Peck	Montana	588,468
Lake Sakakawea	North Dakota	457,909
Lake Oahe	North Dakota & South Dakota	420,735
Lake Sharpe	South Dakota	45,139
Lake Francis Case	South Dakota	114,373
Lewis and Clark Lake	South Dakota and Nebraska	34,476
		1,661,000

Most of the land acquired has been inundated by the pools behind the dams, the remaining land is flooded only rarely during unusually high pool levels caused by high runoffs.

The economic impact of the loss of land in the upper basin states has been tremendous. Leitch and Schaffner estimated that in 1984, the area taken for the Garrison Reservoir would have generated $37 million of personal income to North Dakotans and $109 million of gross business volume. The North Dakota portion of Lake Oahe caused North Dakota to forgo an additional $7.8 million in personal income and $22 million in gross business volume in 1984.[3] In Montana, the current value of total benefits lost as a result of Pick-Sloan project inundation, direct and indirect, is estimated at over $550 million since project completion. The other upper basin states would have suffered similar economic losses depending on the area and value of land inundated. Local government entities also suffered a reduction in tax receipts. The Corps does make a payment in-lieu of taxes, but the payment is usually less than the county average while the river bottoms taken by the Corps was some of the best agricultural land in the area.

Bank Erosion:

The upper basin states continue to lose land to the Missouri River. The Corps of Engineers stated the dams have caused a change in the flow regime of the Missouri River. The Corps admits these changes resulted in a lowering of the stream bed, widening of the channel, and a net loss of high bank lands.[5] While bank erosion did occur before the dams were built, due to accretion there was no net loss of valley lands. Table 2 shows the post dam construction erosion rates in the four remaining reaches of the Missouri River.

Table 2 - Comparison of Post Dam Stream Bank Erosion Rates From Summary Report of Feasibility Studies

River Reach 1/	Erosion Rate Following Closure (ac/yr)	Period Covered	Most Recent Erosion Rate (ac/yr)	Period Covered 2/
Fort Peck	95 3/	1938-75	90 4/	1975-83
Garrison	98	1954-60	48	1978-82
Fort Randall	67	1953-61	15	1976-84
Gavins Point	161	1956-69	80	1979-85

1/ Identified by the dam located at the upstream end of the reach.
2/ The most recent data analysis by the Corps.
3/ Based on a 91.5-mile reach (erosion rate/mile = 1.04 acre/year/mile).
4/ Based on a 180.5-mile reach (erosion rate/mile = 0.53 acres/year/mile).

Table 2 shows the erosion rates are decreasing. This decrease could be an indication that a new equilibrium is developing. However, short-time periods over which most of the rates are calculated, the varying flows due to changes in runoff and operations of the dams from year to year, and the construction of some bank protection measures, thus reducing erosion in some areas, make it impossible to state that such an equilibrium is developing. Table 2 does show that the upper basin states are losing a considerable amount of land. Future losses are impossible to predict, but it is apparent that lands will continue to erode unless bank protection measures are constructed.

The majority of the land being lost is agricultural land causing a continuing economic loss to the states. In North Dakota, an estimated $614,514 in gross business volume and

$196,333 in personal income, were foregone in 1984 due to the loss of 2,447 acres to bank erosion through 1983 in the Garrison to Lake Oahe reach of the Missouri River.[3] In 1991, it is probable that over $125,000 in net farm income was foregone in Montana due to the loss of over 5000 acres to bank erosion in the period 1938 to 1991. These losses generally increase each year and have accumulated since Fort Peck Dam was completed in 1938. The other reaches between dams also have large economic losses. Another economic cost to the upper basin states is the reduction in property tax revenues as land erodes away. These economic losses will continue to increase as more land is lost.

Irrigation development along the Missouri River has been restricted because of the lack of good pump sites. The river bank adjacent to the farmers' land is subject to active bank erosion, which discourages or prevents irrigation. Unfortunately, only a few farmers along the open reaches of the Missouri River are fortunate enough to have pump sites located on naturally hard banks or where a bank stabilization project has been constructed. If the land was protected from erosion loss, more bottom lands would be irrigated since the soil and water is compatible. Prior to the dams most of the valley lands were naturally flood irrigated in the spring. The economic losses caused by the difficulties to irrigation were not considered by Leitch and Schaffner, but the value of irrigation in the dry upper basin states cannot be disputed.

Bank erosion has caused other losses that are impossible to quantify. The river is attacking the few areas of natural woodlands remaining along the Missouri River. These woodlands are very rare in the prairie states of the upper basin, occurring only along the rivers, and already over 750 miles of the river have been inundated by the pools of the six main stem dams. Bank erosion has also caused reduction in development along the river. Developers and home owners are naturally reluctant to risk building houses in unprotected areas.

Future Problems:

Bank erosion along the Missouri River will continue to cause problems if no action is taken. The Corps of Engineers has stated that bank erosion, unless halted, will gradually transform the present river into a wide area of sandbars, channels, and islands occupying most of the valley floor between bluffs.[6] Continued erosion will cause the economic impacts to not only continue but to increase. Also the future condition of the river described by the Corps would make boating, fishing, and withdrawal of water for off-river uses almost impossible.

Delta Formation

The soil eroded from the river banks settles out of the water in the upstream reaches of the reservoirs, resulting in the formation of deltas. These deltas reduce storage areas in the reservoirs, raise the water table under adjacent land, and can trigger ice jams and flooding both during freeze-up in the fall and break-up in the spring. Decreasing erosion rates in the open reaches between reservoirs would slow the delta formation.

Benefits

The Corps of Engineers maintains that the benefits of the Pick-Sloan dams more than offset the residual losses from stream bank erosion. There is no question that this is true on a basin-wide basis. However, the downstream states have received most of the benefits while the upstream states have made most of the sacrifices. The Flood Control Act of 1944, as amended, assured all ten states of equal benefits. The overall plan was designed to provide flood control, navigation, irrigation, power, water supply, water quality control, recreation, and fish and wildlife. Navigation is confined to the lower Missouri and flood control is a much larger benefit to the lower basin. Irrigation has not been developed in the upper basin to the degree expected. Less than half the power generated by the Missouri River system is used in the states in which it is generated. Water supply and water quality control have been spread throughout the basin. During the current drought, operation of the dams has supported navigation at the expense of recreation, fish, and wildlife. Table 3, taken from The Montana Pick-Sloan Initiative summarizes the distribution benefits and costs of the Pick-Sloan plan.

Table 3 - Distribution of Benefits and Cost of Pick-Sloan Plan

State	Acres Lost to Reservoirs (ac)	Irrigation Promised (ac)	Irrigation Developed (ac)	PS Hydro Consumed (%)	Benefits Navigation	Benefits Flood
CO	0	102,999	0	18.1	No	No
IA	0	0	0	15.6	NA	Yes
KS	0	193,490	32,500	0.0	Yes	Yes
MN	0	0	0	18.9	No	No
MO	0	0	0	0.0	Yes	Yes
MT	590,000	1,313,930	76,200	6.5	No	Yes
NE	15,162	1,009,375	164,100	15.2	Yes	Yes
ND	584,060	1,266,400	9,000	10.7	No	No
SD	520,390	972,510	24,100	14.1	No	No
WY	0	158,100	88,200	0.8	No	No
Multi-State Projects			107,500			
Total	1,709,709	5,307,704	501,600	100	NA	NA

Flood Control:

The main stem reservoirs have prevented over $2.7 billion in flood damages through 1988.[5] The flood control benefits continue to accrue, mostly to the downstream states. There are approximately 1018 river miles between Fort Peck Dam and the point 58 miles below Gavins Point Dam. Approximately 620 miles of the 1018 miles are inundated by reservoirs, obviously the inundated areas receive no flood control benefits. The remaining 398 miles have experienced a reduction in flooding, however, the benefit of the flood reduction is questionable.

The majority of the remaining river miles are in Montana and North Dakota, between Fort Peck Dam and Lake Sakakawea (204 miles), and between Garrison Dam and Lake Oahe (87 miles). The flood control benefits to these reaches is uncertain. The river bottoms were not extensively developed prior to construction of the dams. Bismarck-Mandan and Williston are the only cities in North Dakota that have substantially developed the flood plains since the construction of the dams. In both cases, much of the development is now threatened by flooding caused by the formation of deltas in the upper reaches of Lake Sakakawea and Lake Oahe.

Eleven major flood events occurred in the Garrison Oahe reach between 1881 and 1952. Ice jams were the principal cause of flooding in each incident.[7] These spring floods would not have damaged agricultural lands, Leitch and Schaffner wrote, "Floods that did occur were as much a benefit to farmland as they were a detriment, in that they provided valuable soil moisture and deposited rich sediment upon the land."[3] The same would have been true of the Fort Peck to Lake Sakakawea reach.

While the main stem reservoirs have reduced flooding in the upper basin, they are operated primarily to reduce flooding in the lower basin. The Corps of Engineers objectives for flood control regulation are: "The Missouri River main stem reservoirs are regulated, insofar as is practical, to prevent flows originating above or within the system from contributing to damaging flows through downstream reaches of the Missouri River. Regulation of individual reservoirs which comprise the system is integrated to successfully meet this objective. In addition, each individual reservoir is regulated to prevent, insofar as practicable, reservoir releases from contributing to damaging flows through the downstream reaches in which the particular reservoir affords a significant degree of control."[2] Notice that this does not address flooding that may be caused by reservoirs immediately downstream of areas being flooded. Reservoirs cause flooding upstream due to ice jams in the upper reaches where deltas have formed or by being held at very high stages causing backwater effects upstream.

Navigation:

Operations of the six main stem reservoirs during 1987 made possible the movement of an estimated 2.4 million tons of commerce on the Missouri River in the reach from Sioux City to the mouth.[5] The benefit of this navigation is limited to the lower basin states. However, in low water years such as the last three, the priority given to navigation by the Corps of Engineers has had a significant impact on upstream uses such as recreation. Navigation has been given this high priority even though the Missouri Basin Survey Commission stated, "Navigation should be given the lowest priority in preference for use of water and the lowest priority in investment of public funds. A system of water transportation is not essential to full development of the other resources of the basin. Alternative means of transportation are now readily available."[8] The drawdown of the reservoirs to support navigation has had a severe effect on recreation. The Corps has extended a number of boat ramps but this has done little to decrease the negative impacts.

The Corps of Engineers maintains the entire navigation channel eliminating bank erosion below Sioux City. However, the Corps insists that stream bank protection in the upper basin is a low priority item and not appropriate in view of current budgetary constraints.[5] This is inconsistent with the Corps' justification in the lower reach where 75 percent of the benefits of channelization were attributed to bank stabilization. The Missouri Basin Survey Commission noted, "Obviously the Corps now considers erosion control and related benefits from the project as a more important justification than the navigation aspects. Of the total estimated annual benefits attributable to channel stabilization, about 25 percent is credited to navigation and about 75 percent to bank erosion control and land enhancement."[8]

Irrigation:

The upper basin states expected to increase irrigated acreage using water stored in the main stem reservoirs. The states were promised irrigation development to offset the loss of prime agricultural land to the reservoirs. As initially authorized in the Flood Control Act of 1944, over 1.3 million acres of irrigated agriculture was planned for Montana, but only 76,200 acres have been developed.[9] In North Dakota, the Garrison Diversion Project would have supplied water to irrigate over one million acres, stabilize Devils Lake, and provide water for municipal and industrial purposes in the eastern part of the state. The current authorization for Garrison Diversion limits irrigation to 130,940 acres. South Dakota was promised the Oahe project to offset the loss to the four reservoirs in the state. The Oahe Unit, as planned, would have provided water to irrigate 482,000 acres of land, municipal and industrial use in 22 towns and cities, fish and wildlife developments at 28 locations, and recreation uses. Due to opposition from environmentalists, lack of support, and the unwillingness of Congress to keep their promises, these projects have not been built.

Hydropower:

The reservoirs of the upper Missouri River provide water for large amount of power generation. The power is marketed to wholesale power customers by the Western Area Power Administration (WAPA). The three upper basin states with generating facilities received less than half the power generated (Table 4), The remaining power is marketed in other states.

Table 4 - Electric Power
From WAPA 1990 Annual Report

State	Power Generated (kWH)	Power Sold Within State (kWH)
Montana	1,902,270,457	803,766,000
North Dakota	1,793,573,000	1,060,710,000
South Dakota	4,642,160,000	1,876,010,000
Total	8,338,003,457	3,740,486,000

The values shown are for FY '90, the third year of drought. The drought caused abnormally low reservoir levels resulting in a reduction of power generation. Even with the reduced generating levels, the states in which the power was generated received only 45 percent of the power.

Recreation:

The upper basin states traded one form of recreation for another. The recreation provided by the free flowing river and several hundred thousand acres of choice river bottom habitat was traded away for the slack water in the reservoirs. While there is no doubt that development of the reservoirs provided substantial recreation benefits and increased the fishing waters of the upper basin, these gains caused the loss of other types of recreation opportunities.

The current drought, in combination with the releases for navigation, has reduced recreation benefits on the main stem reservoirs. The lower water levels have eliminated many of the shallower areas of the reservoirs, made boat access difficult even with the extension of boat ramps, and caused several private recreation areas to close. The drought has also caused Devils Lake to fall to a level where massive fish kills are imminent. If the Garrison Diversion Unit had been completed, recreation on Devils Lake would be in no danger, adding to the recreational benefits.

Dam Operations

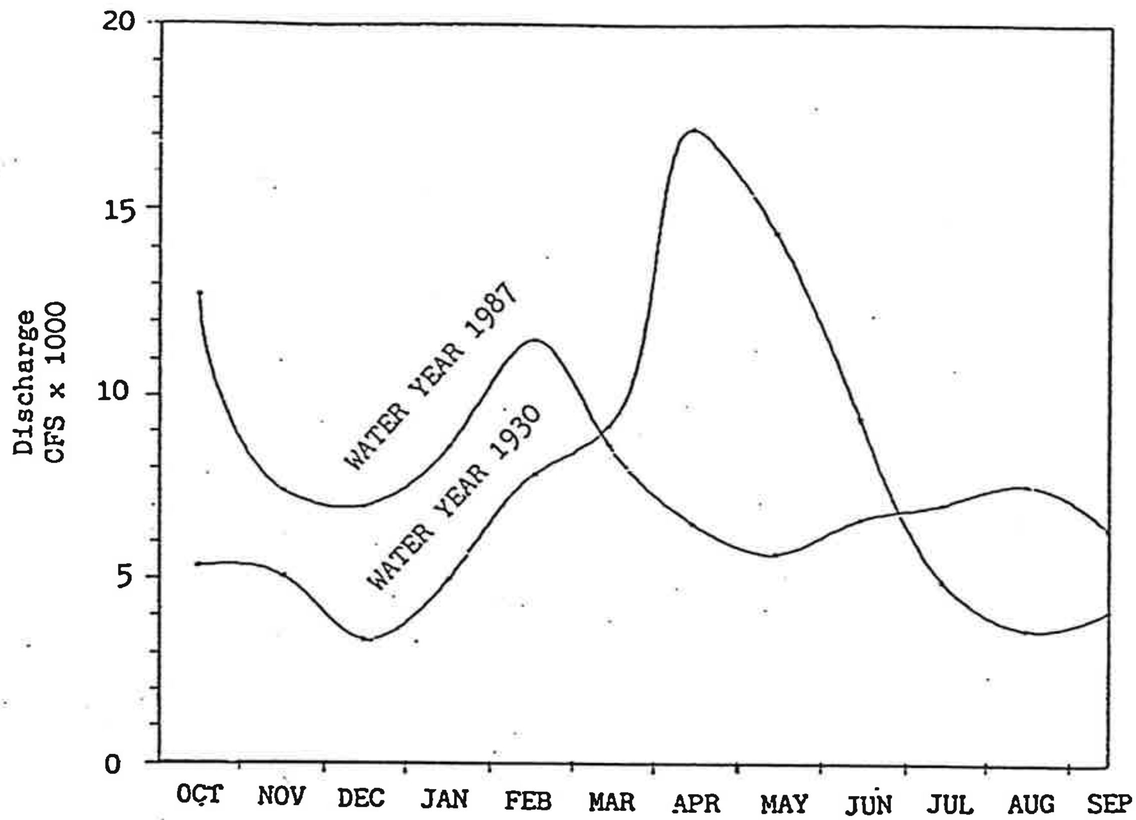
Operation of the main stem dams along the Missouri River has caused an increase in the net loss of land along the river. The increase is the result of the clear water being discharged from the dams, the increased winter flows, and the rapid fluctuations in discharge. The dams cause virtually all the incoming sediment to be trapped within the reservoirs, resulting in releases of sediment free water. This clear water has a silt carrying capacity of approximately 2.2 percent of the weight of the water itself. The water attempts to obtain this capacity and in doing so removes silt from the riverbed and banks, eventually carrying it into the next reservoir downstream.

The Corps of Engineers has increased winter flows in the Missouri River considerably, especially downstream of Fort Peck Dam and Garrison Dam. Natural winter flows before the construction of the dams (e.g. water year 1930) were generally less than 7,000 cfs at Wolf Point, Montana, and less than 19,000 cfs at Bismarck, North Dakota. Prior to 1960, the Corps' Annual Operating Plan for the main stem reservoirs set tentative limitations for safe average protracted winter flows at 10,000 cfs at Fort Peck and 15,000 cfs at Garrison. In early 1960, the Corps began to experiment with higher releases during the winter months. Each year after 1960, the winter discharges were increased. By 1971, the limits for winter discharge had been increased to 14,000 cfs at Fort Peck and 35,000 cfs at Garrison. As a result, during recent winters (e.g. 1987), flows have ranged from about 7,000 cfs to 11,000 cfs at Wolf Point, and from 20,000 cfs to 35,000 cfs at Bismarck. The flow at Wolf Point and Bismarck for water years 1930 and 1987 are shown in Figures 3 and 4.

Rapid variations in discharges from the dams due to power peaking operations also contribute to bank erosion downstream of the dams. The continual wetting and drying of the banks cause the soil to lose cohesiveness and erode. Typical power peaking operations cause dramatic changes in discharge immediately downstream of the dams, Figure 5. The fluctuations in flow are reduced downstream, but are still quite large. Figures 6 and 7 illustrate the influence of fluctuations at Wolf Point, 62 miles downstream of Fort Peck Dam.

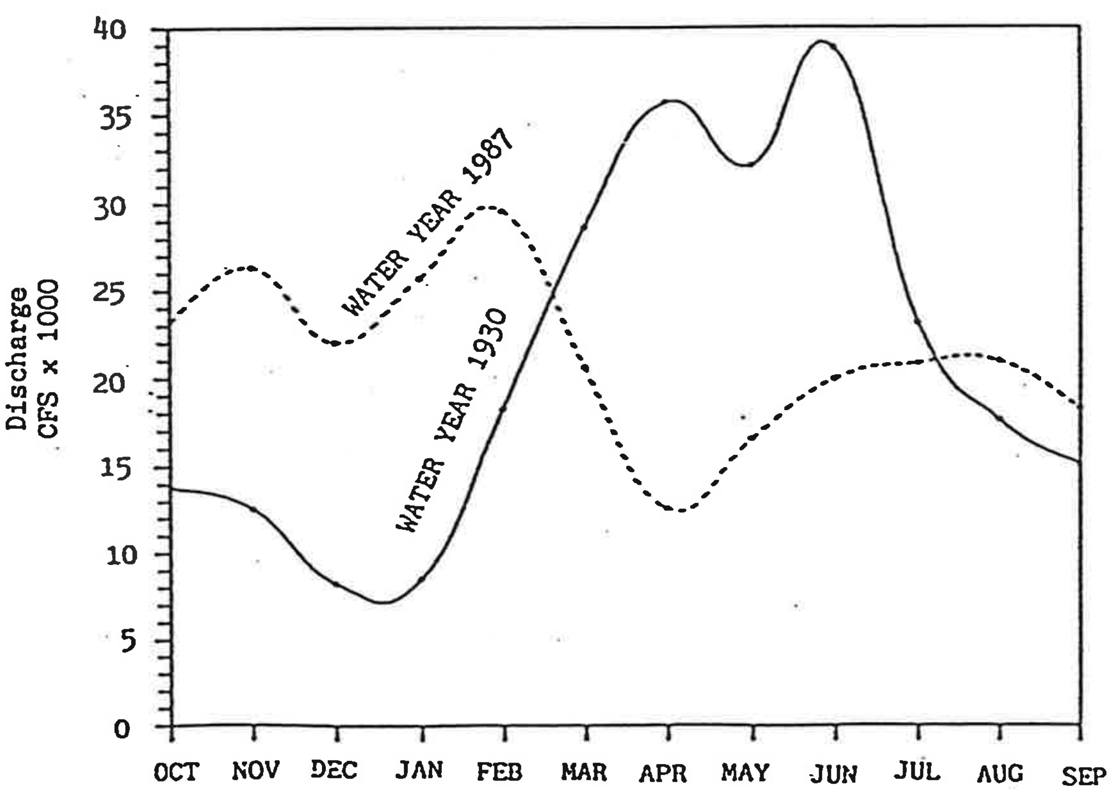
There is no doubt the variations in flow caused by the operations of the dams has caused bank erosion along the Missouri River. The Corps of Engineers recognizes varied stream flow as a predominant factor influencing erosion conditions on the Missouri River[1]. However, the Corps has not yet taken responsibility for the damage being caused by implementing a program of bank protection in the upper Missouri River basin.

Figure 3
Missouri River Mean Monthly Flow
Wolf Point, Montana



Period of Measurement October 1,1989-October 7,1989

Figure 4
Missouri River Mean Monthly Flow
Bismarck, North Dakota



Period of Measurement October 1,1989-October 7,1989

Figure 5
Typical Power Peaking Operations
Fort Peck Dam, Montana

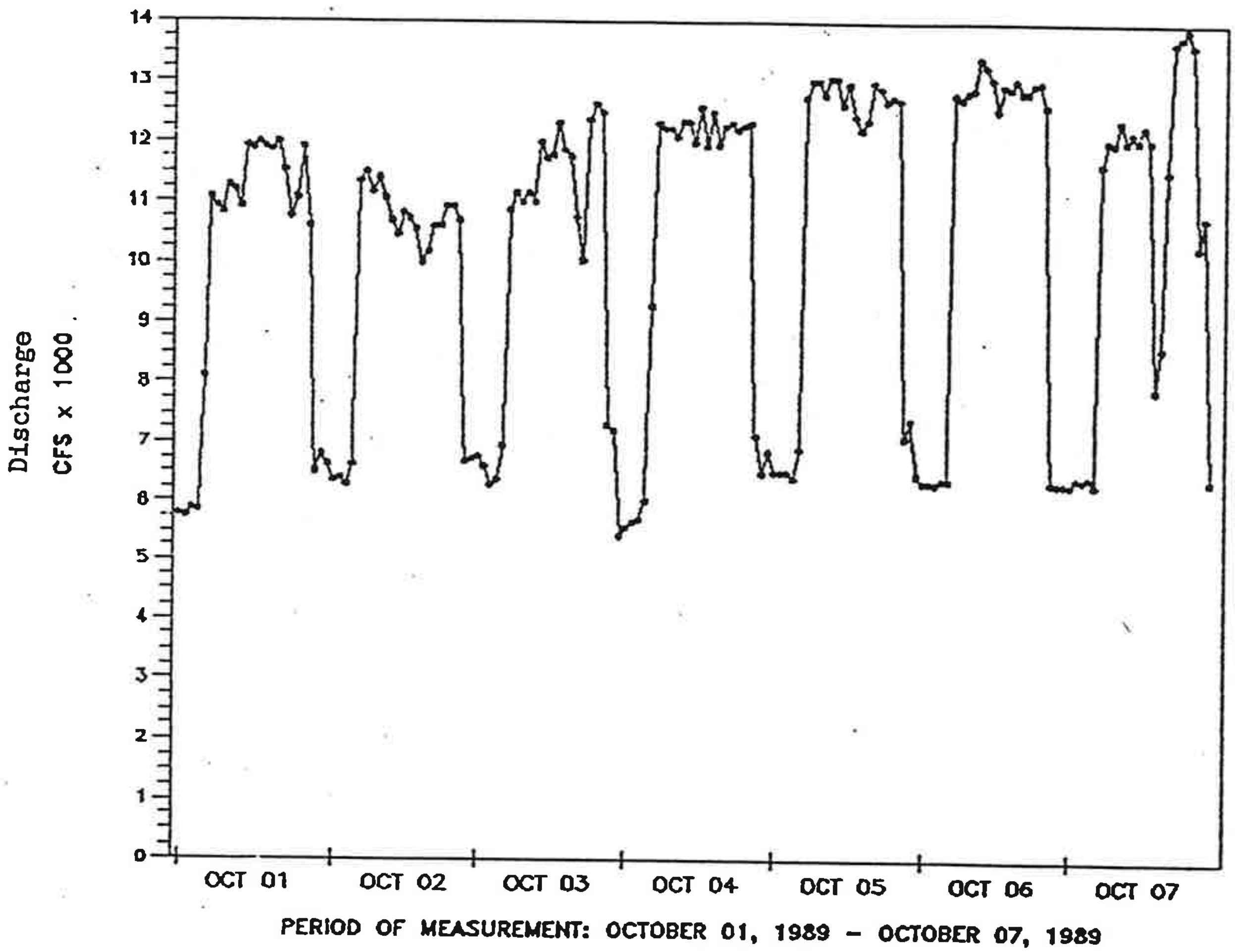
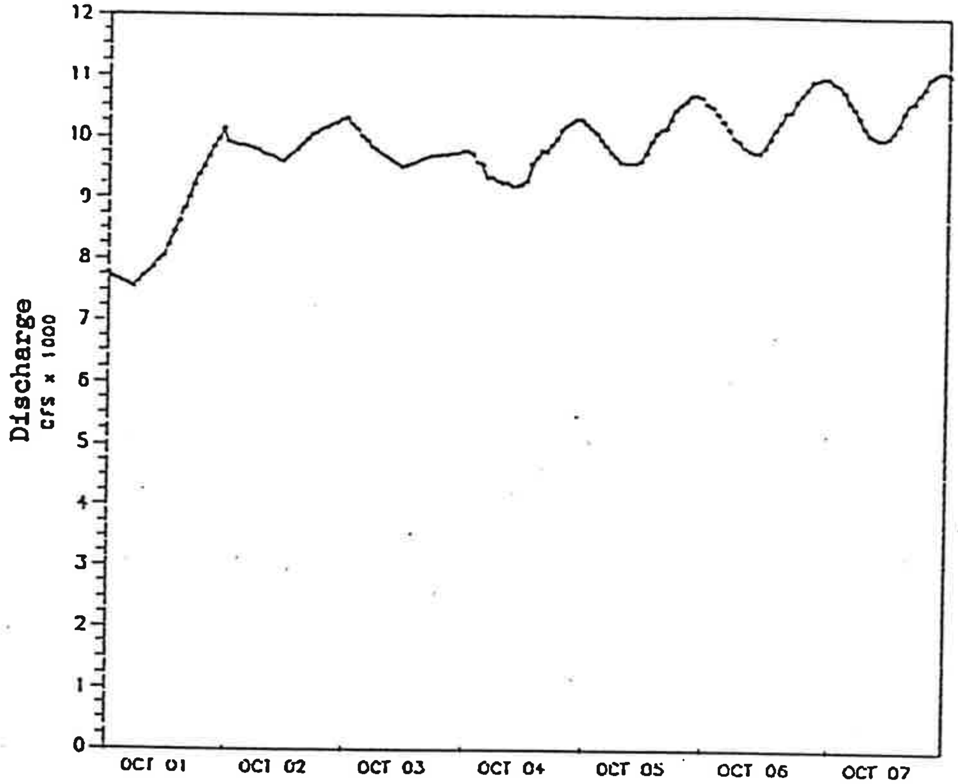
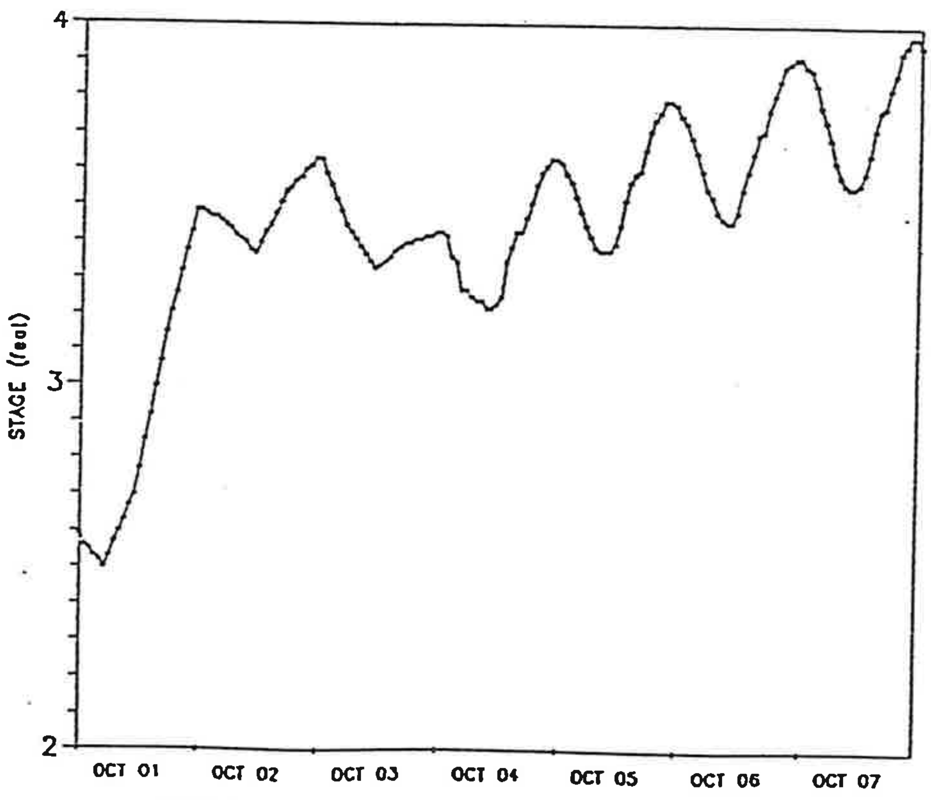


Figure 6
Missouri River Discharge
Wolf Point, Montana



PERIOD OF MEASUREMENT: OCTOBER 01, 1989 - OCTOBER 07, 1989

Figure 7
Missouri River Stage
Wolf Point, Montana



PERIOD OF MEASUREMENT: OCTOBER 01, 1989 - OCTOBER 07, 1989

Responsibility

Operation of the Missouri River main stem dams by the Corps of Engineers have caused net losses of land in the reaches between the dams. The Corps should take action to alleviate the damages. The Corps has agreed that the dams have caused a net loss of lands, "Because erosion continues to remove sediment from the channel banks without buildup of new high bank lands through accretion, channel widths have increased approximately 16 percent since construction of the dams. It is impossible to accurately predict the ultimate characteristics of the river channels downstream from the dams. Erosion could continue at the current rate until the river becomes a wide area of sandbars and channels, occupying an ever-increasing proportion of the valley width between the bluffs."[5]

The Corps maintains that bank stabilization projects in the upper basin must be incrementally justified on their own. However, the General Accounting Office in a March, 1988 report, proposed the following two options for Congress to consider in dealing with stream bank erosion involving federal projects, both options call for funding whether the projects are economically justified or not.

1. Legislation could be enacted to fully or partially fund the cost of erosion control structures whether they are economically justified or not. Under this option the federal taxpayers, and/or the nonfederal entity, would pay for the cost of erosion protection.

2. Legislation could be enacted to charge the cost of erosion control structures, whether they are economically justified or not, to (1) hydropower or (2) all the project purposes on the basis of the cost allocation for the project. Under this option the hydroelectric consumers, other beneficiaries, and federal taxpayers would pay varying portions of the cost of the erosion control structures for the benefit of individual landowners."[10]

The GAO report noted that the options involve new legislation and require commitment of large amounts of federal funds. The Congress, in response to the GAO report, includes a section in the Water Resources Development Act of 1988, enacting the second option of the GAO report. The legislation directed the Secretary of the Army to undertake measures necessary to alleviate bank erosion and related problems along the Missouri River between Fort Peck, Montana, and a point 58 miles downstream of Gavins Point Dam, South Dakota, and Nebraska. The legislation makes no reference to economic justification but does allow the Secretary to acquire interests from willing sellers in the affected areas. There would be no reason to acquire land being eroded if it was economically justified to protect it, therefore, the Congress implied that no economical justification is required.

The Congress has directed the Corps of Engineers, through the Secretary of the Army, to construct bank protection structures. The Corps still maintains that funds should not be budgeted for this purpose. However, a large share of the costs would be reimbursed from Pick-Sloan Project revenues. Local cost-sharing and normal benefit/cost studies are not necessary or appropriate since the corrective structures are elements of the entire Pick Sloan project.

The reimbursement would raise the cost of electricity. It is interesting to note that the Midwest Electric Consumers Association, an organization of all the Rural Electric Cooperatives, and the municipals who receive electric power from the Pick-Sloan dams, have consistently passed resolutions at their annual meetings requesting the Corps of Engineers to construct bank stabilization measures at project expense. The North Dakota Association of Rural Electric Cooperative has also consistently adopted similar resolutions. They understand this will cause a small increase in power costs, but realize it is not proper that they receive power at the expense of the river banks. These resolutions and others are contained in Appendix B.

Historical Sites

There are many archeological sites in the Missouri River Valley. Many of these sites have been identified, however, very few systematic archeological surveys of the private lands along the river have been conducted. There are undoubtedly many other significant sites that have not been recorded due to the lack of surveys.

Section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended, clearly applies to the management of the Missouri River by the Corps of Engineers. NHPA covers any project, activity, or program that can result in changes in the character or use of historic properties, if any such historic properties are located in the area of potential effects. The project activity or program must be under the direct or indirect jurisdiction of a federal agency or licensed or assisted by a federal agency. Undertakings include new and continuing projects, activities, or programs, and any of their elements not previously considered under Section 106. The bank erosion caused by the operation of the main stem dams is resulting in the loss of historic properties that the Corps should protect.

The effects of erosion on historical sites in North Dakota are best documented at the Double Ditch Historic Site. Any change in the river bank results in destruction of significant features and artifacts exposed in the river bank. Prehistoric human graves located around the edge of the Mandan village have been disinterred by erosion within recent years. Such erosion has clearly had adverse effects upon this and other significant prehistoric sites which are not protected.

Repair of Existing Structures

Many of the bank protection measures constructed in the 1960s and 1970s are in need of repair. Before these structures were built, the Corps of Engineers required the local sponsor to sign so-called a, b, c assurances. These assurances require local cooperation in bank protection and stabilization projects along the Missouri River. These assurances, require that the sponsoring agency shall:

(a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and operation of the project;

(b) hold and save the United States free from damages due to the construction works;

(c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army.

The local entities knew this was wrong, especially compared to the downstream projects where all maintenance was federally provided, but they signed the required a, b, c agreements because the need was so critical and with the belief that this obvious injustice could be corrected. The Congress in the Water Resources Development Act of 1988 began to correct this injustice by authorizing maintenance and rehabilitation of existing structures.

The projects built under Section 32, Demonstration Act of 1975, were an effort to determine how economically protection could be achieved. Many of these have failed or will soon fail and considerable work is necessary immediately or they will be lost. The repair work needed has been authorized, however, no appropriation has been made and the Corps has not acted to repair these structures. The upper basin states urge the Congress to appropriate the necessary funds and direct the Corps to include the maintenance and rehabilitation of these structures in an ongoing bank stabilization program.

Along the 183-mile reach of the Missouri River below Fort Peck Dam that is in Montana, the Corps of Engineers has completed one stream bank protection project. This structure is currently in need of repair or modification. All other bank protection measures have been undertaken by local landowners' state and county road departments, irrigation districts, and the Burlington Northern Railroad.[1] Clearly, in Montana, local individuals and groups are bearing the cost of bank stabilization.

V. DAMAGED AREAS

Existing Structures

Many bank protection structures constructed by the Corps of Engineers under previous authorizations are in need of repair. These repairs should be given the highest priority for funding to prevent the loss of the investment already made. The Corps of Engineers conducts an inspection of the structures between Garrison Dam and Lake Oahe every summer and prepares a damage report. The report from the July 1990 inspection, with some additions, follows as a summary of the repairs needed and the estimated cost of the work. As Table 5 shows, approximately $327,000 will be needed to repair the damaged structures.

Site Selection

Staff members of the Montana Department of Natural Resources and Conservation and the North Dakota State Water Commission identified eroding areas in their respective states. Based on erosion rates, land use, erosion activity and cost, the eroding areas were classified into three groups: sites needing protection immediately, sites needing protection soon, and noncritical sites. The ranking of the sites and the sites themselves will change over time due to the dynamic nature of the Missouri River. Changes in flow due to nature and operations of the dams cause the river to attack different bank locations each year. The sandbars also shift causing changes in flow patterns and bank erosion. Therefore, it is impossible to predict which sites may need protection in the future.

Table 5 - Structures Needing Repair

Structure No.	Bank	Length (feet)	Description	Stone* (tons)	Excav* (CY)	Estimated Cost ($)
Ref 1380.28	R	25	Windrow Refusal Extension	130	145	3,975
Rev 1374.05	L	300	Windrow Revetment Rehab.	1200	0	30,000
Ref 1370.42	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1370.08	R	25	Windrow Refusal Extension	130	145	3,975
Rev 1368.6	L	200	Reinforced Revet. Rehab.	400	0	10,000
Rev 1368.6	L	100	Reinforced Revet. Rehab.	200	0	5,000
Ref 1367.5	L	25	Windrow Refusal Extension	130	145	3,975
Ref 1367.31	L	25	Windrow Refusal Extension	130	145	3,975
Ref 1367.2	L	25	Windrow Refusal Extension	130	145	3,975
HP 1367.02	L	25	Hardpoint Root Extension	130	145	3,975
HP 1366.8	L		Hardpoint Root Rehab.	100	0	2,500
HP 1366.8	L	25	Hardpoint Root Extension	130	145	3,975
HP 1366.4	L		Hardpoint Root Rehab.	100	0	2,500
HP 1366.4	L	25	Hardpoint Root Extension	130	145	3,975
HP 1366.3	L		Hardpoint Root Rehab.	100	0	2,500
HP 1366.3	L	25	Hardpoint Root Extension	130	145	3,975
Rev 1365.3	R	100	Bankline Revet. Rehab.	200	0	5,000
DK 1360.36	R	40	Earth Core Dike Rehab.	80	0	2,000
Ref 1359.32	L	25	Windrow Refusal Extension	130	145	3,975
Ref 1359.14	L	25	Windrow Refusal Extension	130	145	3,975
Rev 1359.13	L	50	Windrow Revetment Rehab.	100	0	2,500
Rev 1358.97	L	25	Reinforced Revet. Rehab.	50	0	1,250
HP 1356.89	L	25	Hardpoint Root Extension	135	145	4,100
HP 1356.89	L	30	Hardpoint Root Rehab.	30	0	750
HP 1356.84	L	30	Hardpoint Root Rehab.	30	0	750
DK 1351.30	R	20	Earth Core Dike Rehab.	40	0	1,000
Rev 1350.5	L	600	Toe Trench Revet. Rehab.	600	0	15,000
DK 1349.6	R	40	Earth Core Dike Rehab.	80	0	2,000
DK 1349.4	R	40	Earth Core Dike Rehab.	80	0	2,000
Ref 1344.83	L	25	Windrow Refusal Rehab.	50	0	1,250
Ref 1344.51	L	25	Windrow Refusal Rehab.	50	0	1,250
Ref 1343.46	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1343.34	R	25	Windrow Refusal Rehab.	50	0	1,250
Ref 1343.34	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1343.26	R	25	Windrow Refusal Rehab.	50	0	1,250
Ref 1343.26	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1342.38	R	30	Windrow Refusal Extension	130	145	3,975
Ref 1342.17	R	40	Windrow Refusal Extension	130	145	3,975
Ref 1342.04	R	40	Windrow Refusal Extension	130	145	3,975
Ref 1341.84	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1341.68	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1341.47	R	50	Windrow Refusal Rehab.	100	0	2,500
Ref 1341.46	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1341.14	R	25	Windrow Refusal Extension	130	145	3,975
Rev 1340.88	R	25	Reinforced Revet. Rehab.	50	0	1,250

Table 5 - Structures Needing Repair (Cont.)

Structure No.	Bank	Length (feet)	Description	Stone* (tons)	Excav* (CY)	Estimated Cost ($)
Ref 1340.78	R	25	Windrow Refusal Extension	130	145	3,975
Rev 1338.7	L	50	Composite Revetment Rehab	50	0	1,250
Ref 1335.60	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1335.47	R	30	Windrow Refusal Extension	155	175	4,750
Ref 1335.34	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1335.22	R	25	Windrow Refusal Extension	130	145	3,975
Ref 1335.10	R	25	Windrow Refusal Extension	130	145	3,975
Rev 1332.3	L	1600	Trench Revetment Rehab.	2400	0	60,000
Ref 1332.0	L	30	Windrow Refusal Extension	155	175	4,750
Rev 1328.8	R	100	Stone-Fill Revet. Rehab.	200	0	5,000
Rev 1328.65	L	100	Bankline Revetment Rehab.	200	0	5,000
CB 1327.45	L	75	Channel Block Rehab.	150	0	3,750
Ref 1323.9	L	30	Windrow Refusal Rehab.	150	0	3,750
Ref 1323.85	L	30	Windrow Refusal Rehab.	150	0	3,750
Rev 1323.8	L	50	Windrow Revetment Rehab.	100	0	2,500
Rev 1323.8	L	50	Windrow Revetment Rehab.	100	0	2,500
Rev 1323.8	L	50	Windrow Revetment Rehab.	100	0	2,500
Ref 1323.55	L	25	Windrow Refusal Extension	130	145	3,975
HP 1322.4	L	25	Hardpoint Root Rehab.	100	0	2,500
Rev 1318.2	R	125	Composite Revetment Rehab	250	0	6,250
Ref 1317.79	R	30	Windrow Refusal Extension	155	175	4,750
Ref 1316.66	R	50	Windrow Refusal Rehab.	50	0	1,250
Ref 1316.46	R	50	Windrow Refusal Rehab.	50	0	1,250
Rev 1314.6	L	50	Earth Core Dike Rehab.	100	0	2,500
			Totals	12,130	4,750	$336,900

*Unit price for stone is $25/ton and the unit price for excavation is $5/CY.

Montana:

The Montana Department of Natural Resources and Conservation relied upon the Corps of Engineers' report Missouri River Stream Bank Erosion Study Fort Peck Dam, Montana to the Yellowstone River, North Dakota to develop the inventory of bank erosion sites. The information from the report was modified where necessary, based on information supplied by local groups and the Fort Peck Assiniboine and Sioux Tribes. Photographs were taken of erosion sites in Montana, some of these photos along with photos of sites in North Dakota, are displayed in Appendix C.

North Dakota:

The North Dakota State Water Commission staff used several sources of information to develop the inventory of bank erosion sites. These sources included: The Corps of Engineers' reports Missouri River Stream Bank Erosion Study Garrison Dam to Lake Oahe North Dakota and Missouri River Stream Bank Erosion Study Fort Peck Dam, Montana to the Yellowstone River, North Dakota. The Water Commission also used maps generated from aerial photographs showing the 1950, 1975, and 1984, 1985, or 1986 Missouri River bank alignment from Garrison Dam to Bismarck. Additional information was gathered by inspection trips, the Garrison to Oahe reach was inspected in July 1990 in conjunction with the Corps' annual inspection. The inspection consisted of a two-day boat trip during which erosion areas were noted on aerial photographs and were videotaped. The reach from the Montana border to Lake Sakakawea was inspected in November, local individuals who were familiar with the conditions along the river accompanied Water Commission personnel who recorded erosion sites.

Site 54 in the Garrison Dam to Lake Oahe reach is on the Heart River. The Heart River enters the right side of the Missouri River at approximately river mile 1311. The right bank of the Heart River is eroding from the confluence to a point approximately 3800 feet upstream. The area is directly affected by the backwater of Lake Oahe and the flows of the Missouri River which cause ice jams, ice gouging, and water surface elevation fluctuations on this reach of the Heart River. The result is increased bank erosion rates and the loss of valuable park land and historical sites.

Cost Estimates:

The cost estimates for most of the Montana sites are taken from the Corps of Engineers' report. The few exceptions occurred when the cost of a reinforced revetment is less than the Corps' estimate. The cost of a reinforced revetment was determined by estimating the length of eroding bank and estimating the cost at \$150 per linear foot. The cost for sites in North Dakota was estimated at most locations using \$150 per linear foot of protection, however, where long revetments were needed the revetments were segmented leaving unprotected gaps ranging from 200 to 300 feet in length. The gaps can be left unprotected because complete protection is not only unnecessary to stabilize the project area, but is also prohibitively expensive. Many of the sites may be protected with a smaller investment using hard points or other types of protection. This would provide some early attention to a greater number of sites. The smaller structures may also have potential to serve as water intake sites and as fish spawning areas.

Erosion Sites

Table 6 summarizes all the erosion sites between Fort Peck Dam in Montana and Lake Sakakawea in North Dakota. Table 7 contains the same information for the reach between Garrison Dam and Lake Oahe in North Dakota. In both tables the river mile column reports the approximate location along the river using the 1960 river mile. River miles start at zero at the mouth of the river and increase upstream. The bank column indicates the erosion is located on the left or right bank, left or right bank is determined by looking downstream. Table 8 presents the site which need immediate protection to halt the loss of valuable land or structures. Archeological sites that are known to be actively eroding and endangered in North Dakota were included in Table 8. The locations of the historic sites in Montana were not available at the time this report was completed. Table 9 contains site which need protection, but are not as urgent as the site in Table 8. Table 10 contains the remaining sites which are eroding, but due to the low rate of erosion or the low value of land being lost, these sites do not require protection in the immediate future. It should be noted that the need for protection at each site may change over time due to the dynamic nature of the Missouri River. In Tables 8, 9, and 10, the reach column indicates the dam on the upstream end of the reach in which the site is located.

Table 6 - Erosion Sites
Fort Peck Dam to Lake Sakakawea

Site	River Mile	Bank	Length	Cost
1	1766.50	L	5,000	$ 249,000
2	1765.50	R	2,500	141,000
3	1764.30	L	3,000	242,000
4	1762.60	L	1,500	167,000
5	1762.40	R	3,500	255,000
6	1757.70	R	5,000	423,000
7	1756.60	L	9,500	703,000
8	1752.20	L	7,200	570,000
9	1751.80	R	7,400	322,000
10	1747.10	L	5,800	472,000
11	1744.60	R	7,800	473,000
12	1742.40	R	3,000	89,000
13	1740.80	R	1,200	146,000
14	1740.50	L	4,000	336,000
15	1737.40	R	3,000	77,000
16	1737.30	L	3,800	251,000
17	1735.50	R	9,200	569,000
18	1733.90	L	2,800	160,000
19	1733.50	R	5,000	267,000
20	1731.30	L	3,200	212,000
21	1728.70	R	11,200	657,000
22	1727.30	L	8,000	724,000
23	1726.50	R	5,000	263,000
24	1725.20	L	3,000	251,000
25	1722.00	R	5,200	266,000
26	1721.60	L	6,000	426,000
27	1719.60	R	8,500	546,000
28	1719.50	L	3,000	267,000
29	1718.60	R	9,000	660,000
30	1714.00	R	12,000	686,000
31	1713.80	L	8,500	644,000
32	1713.00	R	2,000	199,000
33	1711.40	L	2,500	305,000
34	1709.70	R	7,000	464,000
35	1709.00	L	2,000	207,000
36	1707.00	L	1,500	209,000
37	1705.90	R	10,000	633,000
38	1704.70	L	4,000	422,000
39	1703.00	R	4,000	289,000

Table 6 - Erosion Sites (Cont.)
Fort Peck Dam to Lake Sakakawea

Site	River Mile	Bank	Length	Cost
40	1701.60	R	4,000	$ 230,000
41	1701.50	L	6,000	481,000
42	1699.50	R	5,500	388,000
43	1699.40	L	1,700	55,000
44	1697.10	R	5,000	345,000
45	1695.30	L	7,500	594,000
46	1693.20	R	2,500	219,000
47	1691.10	L	10,000	459,000
48	1689.90	R	6,000	573,000
49	1688.90	L	8,000	648,000
50	1688.30	R	1,500	165,000
51	1684.80	R	2,000	250,000
52	1684.10	L	8,000	564,000
53	1683.50	L	300	45,000
54	1683.10	R	1,500	223,000
55	1681.60	R	3,000	204,000
56	1680.00	L	5,000	473,000
57	1677.80	R	9,500	629,000
58	1676.00	L	4,500	654,000
59	1674.20	R	8,000	414,000
60	1672.50	L	4,000	263,000
61	1672.10	R	7,000	330,000
62	1669.00	L	5,500	545,000
63	1667.90	L	1,000	145,000
64	1667.00	R	4,200	447,000
65	1665.10	L	8,000	697,000
66	1664.00	R	2,500	310,000
67	1663.50	L	2,500	251,000
68	1662.00	R	5,000	534,000
69	1659.40	L	10,500	682,000
70	1656.00	R	13,500	1,695,000
71	1653.80	L	4,000	416,000
72	1653.50	R	1,500	209,000
73	1650.10	R	12,500	583,000
74	1649.50	L	6,000	776,000
75	1647.10	L	8,000	749,000
76	1647.00	R	7,000	448,000
77	1644.30	L	4,000	273,000
78	1643.70	R	9,000	723,000
79	1640.60	R	12,000	1,338,000
80	1639.80	L	19,000	1,144,000
81	1637.20	R	9,000	980,000
82	1637.10	L	5,000	491,000
83	1635.90	L	4,000	191,000
84	1632.00	R	5,000	565,000
85	1631.60	L	3,000	339,000

Table 6 - Erosion Sites (Cont.)
Fort Peck Dam to Lake Sakakawea

Site	River Mile	Bank	Length	Cost
86	1630.30	R	4,300	$ 512,000
87	1629.50	R	6,000	459,000
88	1627.50	L	7,300	861,000
89	1627.00	R	3,500	418,000
90	1624.80	R	7,500	393,000
91	1623.00	L	11,500	738,000
92	1622.00	R	2,000	300,000
93	1621.30	L	3,000	353,000
94	1619.10	L	3,500	314,000
95	1617.40	R	6,200	471,000
96	1616.10	L	5,300	377,000
97	1614.20	R	7,500	705,000
98	1611.70	L	8,000	774,000
99	1609.00	R	11,500	513,000
100	1608.50	L	5,000	567,000
101	1604.90	R	7,500	496,000
102	1599.40	L	12,500	1,536,000
103	1599.00	R	3,000	414,000
104	1597.70	L	3,100	445,000
105	1596.00	R	6,000	480,000
106	1593.50	R	4,000	415,000
107	1592.50	L	4,500	542,000
108	1589.40	L	6,000	521,000
109	1588.70	R	2,500	375,000
110	1586.20	L	2,500	290,000
111	1585.50	R	4,000	356,000
112	1585	L	6,000	678,000
113	1581	R	1,000	150,000
114	1577	L	200	30,000
115	1577	R	2,000	249,000
116	1575	R	7,500	872,000
117	1565	R	2,000	249,000
118	1559	R	2,500	249,000
119	1558	L	2,000	249,000
				$53,330,000

Table 7 - Erosion Sites
Garrison Dam to Lake Oahe

Site	River Mile	Bank	Length	Cost
1	1385	R	100	$ 15,000
2	1381	R	2,000	249,000
3	1379	R	4,000	415,000
4	1379	R	1,000	150,000
5	1377	R	4,000	415,000
6	1375	L	1,500	225,000
7	1375	L	9,500	1,055,000
8	1375	R	1,800	204,000
9	1365	L	2,000	300,000
10	1362	R	2,800	420,000
11	1360	L	2,200	249,000
12	1358	L	1,500	225,000
13	1357	L	3,800	270,000
14	1356	L	4,000	415,000
15	1356	R	3,800	377,500
16	1355	R	7,000	680,000
17	1353	L	1,800	196,000
18	1352	L	4,000	572,000
19	1352	R	7,500	905,000
20	1351	L	200	30,000
21	1349	R	800	120,000
22	1348	L	900	135,000
23	1348	L	100	15,000
24	1347	L	4,500	520,000
25	1347	R	1,200	180,000
26	1346	L	6,200	521,000
27	1346	R	1,600	204,000
28	1345	L	1,500	225,000
29	1344	R	500	75,000
30	1343	R	4,000	244,000
31	1342	L	1,800	196,000
32	1340	L	5,500	640,000
33	1340	R	2,000	226,000
34	1340	R	1,400	210,000
35	1340	R	800	120,000
36	1339	L	3,800	422,000
37	1339	R	1,200	180,000
38	1339	R	900	135,000
39	1337-1338	L	8,000	1,000,000
40	1336	L	4,200	570,000
41	1336	R	6,000	715,000
42	1334	L	800	120,000
43	1333-1334	R	7,000	680,000
44	1331	R	1,225	183,750
45	1326	R	4,300	512,000

Table 7 - Erosion Sites (Cont.)
Garrison Dam to Lake Oahe

Site	River Mile	Bank	Length	Cost
46	1325	L	1,000	$ 120,000
47	1321	L	200	30,000
48	1321	R	100	15,000
49	1320	L	3,000	339,000
50	1319	R	1,900	211,000
51	1310	L	4,000	415,000
52	1309	L	2,800	332,000
53	1305	L	1,200	180,000
54	1311 1/	R	3,800	100,000
			Total	$17,258,250

1/ On the Heart River at Confluence with the Missouri River.

Table 8 - Highest Priority Sites Requiring Immediate Protection

Reach	Site	Mile	Bank	Cost
Fort Peck	17	1735	R	$ 569,000
Fort Peck	19	1733	R	267,000
Fort Peck	36	1707	L	209,000
Fort Peck	56	1680	L	473,000
Fort Peck	67	1663	L	251,000
Fort Peck	68	1662	R	534,000
Fort Peck	70	1656	R	1,695,000
Fort Peck	72	1653	R	209,000
Fort Peck	74	1649	L	776,000
Fort Peck	84	1632	R	565,000
Fort Peck	87	1629	R	459,000
Fort Peck	89	1627	R	418,000
Fort Peck	92	1622	R	300,000
Fort Peck	116	1575	R	872,000
Garrison	5	1377	R	415,000
Garrison	7a	1375	L	150,000
Garrison	9	1365	L	300,000
Garrison	10	1362	R	420,000
Garrison	18	1352	L	572,000
Garrison	21	1349	R	120,000
Garrison	23	1348	L	15,000
Garrison	24	1347	L	520,000
Garrison	26	1346	L	521,000
Garrison	30	1343	R	244,000
Garrison	39	1337-1338	L	1,000,000
Garrison	40	1336	L	570,000
Garrison	41	1336	R	715,000
Garrison	46	1325	L	120,000
Garrison	53	1305	L	180,000
Garrison	54	1311 1/	R	100,000
			Total	$13,559,000

1/ On the Heart River at Confluence with the Missouri River.

Table 9 - Sites Needing Protection Soon

Reach	Site	Mile	Bank	Cost
Fort Peck	3	1764	L	$ 242,000
Fort Peck	5	1762	R	255,000
Fort Peck	6	1757	R	423,000
Fort Peck	7	1756	L	703,000
Fort Peck	8	1752	L	570,000

Table 9 - Sites Needing Protection Soon (Cont.)

Reach	Site	Mile	Bank	Cost
Fort Peck	9	1751	R	$ 322,000
Fort Peck	11	1744	R	473,000
Fort Peck	13	1740	R	146,000
Fort Peck	21	1728	R	657,000
Fort Peck	22	1727	L	724,000
Fort Peck	23	1726	R	263,000
Fort Peck	24	1725	L	251,000
Fort Peck	25	1722	R	266,000
Fort Peck	26	1721	L	426,000
Fort Peck	27	1719	R	546,000
Fort Peck	28	1719	L	267,000
Fort Peck	29	1718	R	660,000
Fort Peck	30	1714	R	686,000
Fort Peck	31	1713	L	644,000
Fort Peck	34	1709	R	464,000
Fort Peck	37	1705	R	633,000
Fort Peck	38	1704	L	422,000
Fort Peck	39	1703	R	289,000
Fort Peck	40	1701	R	230,000
Fort Peck	42	1699	R	388,000
Fort Peck	43	1699	L	55,000
Fort Peck	44	1697	R	345,000
Fort Peck	46	1693	R	219,000
Fort Peck	48	1689	R	573,000
Fort Peck	49	1688	L	648,000
Fort Peck	51	1684	R	250,000
Fort Peck	52	1684	L	564,000
Fort Peck	55	1681	R	204,000
Fort Peck	57	1677	R	629,000
Fort Peck	58	1676	L	654,000
Fort Peck	59	1674	R	414,000
Fort Peck	60	1672	L	263,000
Fort Peck	61	1672	R	330,000
Fort Peck	62	1669	L	545,000
Fort Peck	64	1667	R	447,000
Fort Peck	65	1665	L	697,000
Fort Peck	66	1664	R	310,000
Fort Peck	71	1653	L	416,000
Fort Peck	73	1650	R	583,000
Fort Peck	75	1647	L	749,000
Fort Peck	78	1643	R	723,000
Fort Peck	81	1637	R	980,000
Fort Peck	83	1635	L	191,000
Fort Peck	85	1631	L	339,000
Fort Peck	86	1630	R	512,000
Fort Peck	88	1627	L	861,000
Fort Peck	90	1624	R	393,000

Table 9 - Sites Needing Protection Soon (Cont.)

Reach	Site	Mile	Bank	Cost
Fort Peck	91	1623	L	$ 738,000
Fort Peck	95	1617	R	471,000
Fort Peck	96	1616	L	377,000
Fort Peck	97	1614	R	705,000
Fort Peck	98	1611	L	774,000
Fort Peck	99	1609	R	513,000
Fort Peck	104	1597	L	445,000
Fort Peck	105	1596	R	480,000
Fort Peck	107	1592	L	542,000
Fort Peck	108	1589	L	521,000
Fort Peck	109	1588	R	375,000
Fort Peck	112	1585	L	678,000
Fort Peck	118	1559	R	249,000
Fort Peck	119	1558	L	249,000
Garrison	2	1381	R	249,000
Garrison	6	1375	L	225,000
Garrison	12	1358	L	225,000
Garrison	13	1357	L	270,000
Garrison	14	1356	L	415,000
Garrison	15	1356	L	377,500
Garrison	16	1355	R	680,000
Garrison	17	1353	L	196,000
Garrison	22	1348	L	135,000
Garrison	25	1347	R	180,000
Garrison	27	1346	R	204,000
Garrison	32	1340	L	640,000
Garrison	43	1333-1334	R	680,000
Garrison	45	1326	R	512,000
			Total	$35,949,500

Table 10 - Noncritical Sites

Reach	Site	Mile	Bank	Cost
Fort Peck	1	1766	L	$ 249,000
Fort Peck	2	1765	R	141,000
Fort Peck	4	1762	L	167,000
Fort Peck	10	1747	L	472,000
Fort Peck	12	1742	R	89,000
Fort Peck	14	1740	L	336,000
Fort Peck	15	1737	R	77,000
Fort Peck	16	1737	L	251,000
Fort Peck	18	1733	L	160,000
Fort Peck	20	1731	L	212,000

Table 10 - Noncritical Sites (Cont.)

Reach	Site	Mile	Bank	Cost
Fort Peck	32	1713	R	$ 199,000
Fort Peck	33	1711	L	305,000
Fort Peck	35	1709	L	207,000
Fort Peck	41	1701	L	481,000
Fort Peck	45	1695	L	594,000
Fort Peck	47	1691	L	459,000
Fort Peck	50	1688	R	165,000
Fort Peck	53	1683	L	45,000
Fort Peck	54	1683	R	223,000
Fort Peck	63	1667	L	145,000
Fort Peck	69	1659	L	682,000
Fort Peck	76	1647	R	448,000
Fort Peck	77	1644	L	273,000
Fort Peck	79	1640	R	1,338,000
Fort Peck	80	1639	L	1,144,000
Fort Peck	82	1637	L	491,000
Fort Peck	93	1621	L	353,000
Fort Peck	94	1619	L	314,000
Fort Peck	100	1608	L	567,000
Fort Peck	101	1604	R	496,000
Fort Peck	102	1599	L	1,536,000
Fort Peck	103	1599	R	414,000
Fort Peck	106	1593	R	415,000
Fort Peck	110	1586	L	290,000
Fort Peck	111	1585	R	356,000
Fort Peck	113	1581	R	150,000
Fort Peck	114	1577	L	30,000
Fort Peck	115	1577	R	249,000
Fort Peck	117	1565	R	249,000
Garrison	1	1385	R	15,000
Garrison	3	1379	R	415,000
Garrison	4	1379	R	150,000
Garrison	7b	1375	L	905,000
Garrison	8	1375	R	204,000
Garrison	11	1360	L	249,000
Garrison	19	1352	R	905,000
Garrison	20	1351	L	30,000
Garrison	28	1345	L	225,000
Garrison	29	1344	R	75,000
Garrison	31	1342	L	196,000
Garrison	33	1342	R	226,000
Garrison	34	1340	R	210,000
Garrison	35	1340	R	120,000
Garrison	36	1339	L	422,000
Garrison	37	1339	R	180,000
Garrison	38	1339	R	135,000
Garrison	42	1334	L	120,000

Table 10 - Noncritical Sites (Cont.)

Reach	Site	Mile	Bank	Cost
Garrison	44	1331	R	$ 183,750
Garrison	47	1321	L	30,000
Garrison	48	1321	R	15,000
Garrison	49	1320	L	339,000
Garrison	50	1319	R	211,000
Garrison	51	1310	L	415,000
Garrison	52	1309	L	332,000
			Total	$21,079,750

There are 172 sites identified as needing protection against bank erosion in Montana and North Dakota. The total cost to protect all of the sites was estimated to be $70 million. There are 30 sites identified as needing protection immediately at a estimated cost of $13,559,000. In addition, there are 69 structures in need of repair at a estimated cost of $336,900. The total cost estimate for the work need immediately is $13,895,900. The 80 sites identified as needing protection soon would require an estimated $35,949,500. The remaining 64 sites which do not require protection in the immediate future were estimated to cost $21,079,750. The cost estimates are based on the information currently available. It is very difficult to determine the best type of protection without detailed information at each site. Due to the lack of detailed information and the dynamic nature of the Missouri River, the cost estimates, as well as the sites themselves, will undoubtedly change over time.

VI. PHASE 1 - CRITICAL AREA BANK STABILIZATION PLAN

The Water Resources Development Act of 1988 directed the Secretary of the Army to undertake an ongoing program of bank protection on the Missouri River between Fort Peck Dam and a point 58 miles downstream of Gavins Point Dam. Due to the complexity of this program, it is recommended that the program be developed in phases, with the following actions completed during the first phase: 1) Evaluate the existing information on conditions along this reach and conduct an archeological survey to determine the location and condition of cultural resources; 2) Develop and implement a plan of protection for the most critical areas over a proposed construction period of 5 years; and 3) Develop a maintenance program for any existing projects, and projects to be constructed under this program.

The plan for implementation should give top priority to the repair of existing structures; the estimated cost of these repairs is $337,000. The plan should also give high priority to sites that impact archaeology sites. The critical sites that require immediate protection are listed in table 8 on page 47. The estimated cost to protect all of these sites is approximately $13.6 million. The Corps of Engineers is encouraged to review the selection of critical erosion sites and work with the states and local organizations in the early phases of the plan to maximize the benefits of bank stabilization works.

Funding for implementation of this act should be appropriated immediately and be reimbursed by apportionment among project purposes as a joint-use operation and maintenance expense of the Pick-Sloan project. By law the expenditures are limited to $3 million per year. Annual expenditures of $3 million are recommended each year for a 5-year period, after which an evaluation of conditions and needs would be necessary. The development of these sites along with an implementation plan, represents an excellent framework for a $3 million, five-year plan.

Bank protection along the Missouri River is a maintenance expense of the Pick-Sloan program, and as such does not require additional studies. However, the entire reach will need to be inspected each fall to determine and prioritize sites to be protected the following summer.

The cost estimates throughout this report include construction, engineering, design, supervision, and administration. The cost estimates associated with these sites are conservatively estimated. Savings may be achieved by using smaller, more cost-effective structures for correcting erosion. The Corps of Engineers should be encouraged to use the smallest most cost-effective structures possible to provide adequate protection.

VII. SUMMARY

The states in the upper basin of the Missouri River have and are continuing to experience a net loss of land due to bank erosion along the river. The reservoirs built and operated by the Corps of Engineers are the primary cause of the erosion due to the discharge of clear water, fluctuations of flow rate, and the elimination of the rebuilding of high valley lands. The Congress of the United States has assigned responsibility for these losses to the Corps of Engineers by directing the Secretary of the Army to undertake measures to alleviate bank erosion and related problems. However no money has been appropriated for bank protection and the Corps maintains that bank protection is a low priority item.

The upper basin has already sacrificed more than its share to provide the benefits of the Pick-Sloan plan. Most of these benefits are enjoyed by the lower basin, where much less was given up to produce the benefits. Congress should act to correct the ongoing loss of land in the upper basin by appropriating sufficient funds and directing the Corps of Engineers to complete bank protection.

APPENDIX A

Section 33 of the Water Resources Development Act of 1988 Pub. L. No. 100-676, Section 33, 102 Stat. 4013 (1988)

SEC. 33. MISSOURI RIVER BETWEEN FORT PECK DAM, MONTANA, AND GAVINS POINT DAM, SOUTH DAKOTA AND NEBRASKA.

Section 9 of the Act entitled "An Act authorizing the construction of certain public works on rivers and harbors for flood control, and for other purposes", approved December 22, 1944 (58 Stat. 891), is amended by adding at the end thereof the following new subsection:

"(f) The Secretary of the Army is directed to undertake such measures, including maintenance and rehabilitation of existing structures, which the Secretary determines are needed to alleviate bank erosion and related problems associated with reservoir releases along the Missouri River between Fort Peck Dam, Montana, and a point 58 miles downstream of Gavins Point Dam, South Dakota, and Nebraska. The cost of such measures may not exceed $3,000,000 per fiscal year. Notwithstanding any other provisions of law, the costs of these measures, including the costs of necessary real estate interests and structural features, shall be apportioned among project proposes[1] (sic) as a joint-use operation and maintenance expense. In lieu of structural measures, the Secretary may acquire interests in affected areas, as the Secretary deems appropriate, from willing sellers."

1. This apparent typographical error "proposes" rather than "purposes" was made in the conference committee report on the bill and subsequently carried over to the statute itself.

APPENDIX B

Resolutions and Letters of Support

Midwest Electric Consumers Association

WHEREAS, to protect and stabilize the banks of the Upper Missouri River is of vital importance to maximize the life of the reservoirs; and

WHEREAS, the continuing buildup of deltas such as at Bismarck, North Dakota, not only creates very serious local problems such as ice jams and high water tables, but will curtail power production from time to time; and

WHEREAS, protection of the banks of the Missouri River, including construction, operation and maintenance of works by the Corps of Engineers is a federal obligation under the Pick-Sloan plan and should be a federal responsibility;

NOW, THEREFORE, BE IT RESOLVED, that Mid-West urges Congress and the U.S. Army Corps of Engineers to budget and appropriate sufficient funds to complete this vital part of the Pick-Sloan plan and prevent further land losses.

North Dakota Association of Rural Electric Cooperatives

Riverbank erosion along the Missouri River from Garrison Dam to the Oahe Reservoir continues to be a serious problem causing substantial loss of valuable farm and residential land and consequent silting problems downstream. In addition, low-water discharge affects the hydroelectric peaking capacity of the dam, which in turn holds potential conflict of interest between the landowners and the need for peak power generation from the hydroelectric system.

We urge our congressional delegation, the state legislature, and our state officials to convince the Congress that a long-term bank stabilization plan is needed, this project is properly the responsibility of the Corps of Engineers, and should be federally funded in the Pick-Sloan maintenance budget.

State of North Dakota

A concurrent resolution urging the Congress of the United States and the United States Army Corps of Engineers to assume responsibility for Missouri River bank erosion downstream from all Pick-Sloan plan dams, including the Garrison Dam to Oahe Reservoir reach in North Dakota, and to begin an annual program of appropriating funds for the maintenance and construction of bank protection projects.

WHEREAS, the Flood Control Act of 1944, as amended by Senators O'Mahoney and Milliken, assured all 10 states within the Missouri River Basin equal benefits under a control and management program that came to be commonly known as the Pick-Sloan plan; and

WHEREAS, the Congress of the United States has directed the United States Army Corps of Engineers to build, operate, and maintain all the features of the Pick-Sloan plan; and

WHEREAS, the Pick-Sloan plan provides major flood control benefits, recreational benefits, power supply benefits, and navigational benefits for states lying below Sioux City, Iowa, through construction of large reservoirs in states lying above that point, and by channelizing the Missouri River from Sioux City, Iowa, to St. Louis, Missouri, at federal expense; and

WHEREAS, the Pick-Sloan plan reservoirs have been in place for many years, thus providing the downstream states in the Missouri River Basin all of the benefits promised in the Pick-Sloan plan for the past 35 years; and

WHEREAS, construction of facilities under the Pick-Sloan plan has, to date, resulted in $3 billion of flood protection to downstream interests which continue to accrue and has allowed these downstream interests to develop the original floodplain of the Missouri River for industrial, municipal, and agricultural uses; and

WHEREAS, the United States Army Corps of Engineers has stabilized and continues to maintain the entire channel of the Missouri River from Sioux City, Iowa, to St. Louis, Missouri, all at federal cost; and

WHEREAS, under the Pick-Sloan plan, the State of North Dakota has sacrificed over 550,000 acres of land, much of which was prime agricultural land; and

WHEREAS, almost two-thirds of the inexpensive hydroelectric power generated by Garrison Dam in North Dakota, which was built pursuant to the Pick-Sloan plan, is utilized in states other than North Dakota; and

WHEREAS, the United States Army Corps of Engineers stated in its final report to Congress dated December, 1981, concerning Missouri River stream bed erosion that "bank erosion in this reach results in a permanent net loss of high value lands. This process, unless halted, would eventually transform the present river into a wide area of sandbars and channels, occupying an increasing proportion of the valley width between the bluffs"; and

WHEREAS, the lands adjacent to the Missouri River have been and will continue to be seriously eroded and permanently lost to the local landowners and the State of North Dakota because of reservoir management which releases highly fluctuating amounts of clear water capable of eroding and transporting large amounts of soil; and

WHEREAS, soil eroded from the banks of the Missouri River is being deposited as a delta in the headwaters of the Oahe Reservoir thereby causing the water table to rise under the adjacent land, and is increasing the frequency sand severity of ice jam hazards and has, according to recent United States Army Corps of Engineers pronouncements, endangered 6,000 acres of land containing 40 homes and valuable farmland; and

WHEREAS, a similar bank erosion problem exists for a 58-mile reach on the South Dakota-Nebraska border downstream from the Gavins Point Dam and also below the Fort Peck Dam in Montana; and

WHEREAS, destructive bank erosion continues when high winter water releases for power generation occur, even in these drought years of sharply lower total annual releases; and

WHEREAS, the Water Resources Development Act of 1988 amended the Flood Control Act of 1944 and directed the Secretary of the Army to undertake measures, such as the maintenance and rehabilitation of existing structures, which the Secretary of the Army determines are needed to alleviate bank erosion and related problems associated with reservoir releases along the Missouri River between Fort Peck Dam in Montana and a point 58 miles downstream of the Gavins Point Dam on the South Dakota-Nebraska border;

NOW, THEREFORE, BE IT RESOLVED BY THE SENATE OF NORTH DAKOTA, THE HOUSE OF REPRESENTATIVES CONCURRING THEREIN:

That the Fifty-second Legislative Assembly urges the United States Congress to assume responsibility for the protection of lands endangered below all Pick-Sloan dams by the operation of the Pick-Sloan plan; and

BE IT FURTHER RESOLVED, that the Fifty-second Legislative Assembly urgently requests the United States Congress to begin a program of annually appropriating funds to repair existing bank protection projects now in danger of complete failure and to begin to construct bank protection projects in the most critical locations; and

BE IT FURTHER RESOLVED, that Senator Quentin N. Burdick, Senator Kent Conrad, and Congressman Byron L. Dorgan are urged to work diligently with the senators and congressmen of the states of Montana, South Dakota, and Nebraska to secure appropriations of these necessary funds; and

BE IT FURTHER RESOLVED, that funding for this project not be a normal federal water project appropriation, but rather be charged to the operation of the Pick-Sloan plan; and

BE IT FURTHER RESOLVED, that copies of this resolution be forwarded by the Secretary of State to the Secretary of the Interior; the District Engineer, Omaha District; United States Army Corps of Engineers; Governor George A. Sinner; the members of the North Dakota State Water Commission; and each member of the North Dakota, South Dakota, Nebraska, and Montana congressional delegations.

Williams County Water Resource District

Riverbank erosion along the Missouri River continues to be a serious problem causing substantial loss of valuable farm and residential land and contributes to silting problems in the upstream reaches of the reservoirs. The delta formation resulting from the silt causes ice jams and floods endangering farms, irrigation systems, residential areas.

We urge our congressional delegation, the state legislature, and our state officials to convince the Congress that a long-term bank stabilization plan is needed, this project is properly the responsibility of the Corps of Engineers, and should be federally funded in the Pick-Sloan maintenance budget.

North Dakota Water Users Association and
North Dakota Water Resource District Association

Bank Stabilization. We urge Congress and the U.S. Army Corps of Engineers to budget sufficient funds so that needed bank stabilization projects can be constructed on a timely basis. This will prevent additional loss of valuable land and will permit more flexibility of water releases at the Pick-Sloan dams.

RECEIVED
MAR 01 1991
MONTANA DEPT. OF NATURAL RESOURCES & CONSERVATION

Kirk Warren
Department of Natural Resources & Conservation
1520 East Sixth Avenue
Helena, Mt 59620

Feb 26, 1991

Dear Kirk:

The Missouri River Development Group has a vested interest in stream-bank erosion. Presently, the Missouri River has excessive bank erosion that leaves many irrigation and municipal diversion points unstable. Of the irrigated land presently developed, much of it is threatened by erosion that destroys canals, drains, and travel areas for center pivots.

Stream-bank losses not only affect individuals and municipalities but also wildlife. Pallid Sturgeon, an endangered specie, is also affected. The Pallid Sturgeon requires deep fresh water to spawn, because of erosion these types of favorable environments are disappearing.

As the Missouri River Development Group has adopted stream-bank erosion as it's priority goal. We support the Department of Natural Resources & Conservation in their efforts for requesting stream-bank erosion control measures along the Missouri River.

Sincerely,

Doug Smith

Doug Smith
Project Coordinator
Missouri River Development Group

B★O★M★M★M—JOINT BOARD

Dedicated to the Protection and Preservation of the Banks of the Missouri River.

POSITION STATEMENT OF BOMMM JOINT WATER RESOURCE BOARD
ANDY MORK, CHAIRMAN
March 20, 1991

1. Before the installation of the Pick-Sloan dams, the Missouri River like any alluvial (dirt bottom) river did erode its banks. However, the process was relatively slow and it always built back land of value equal to the eroded land so the net loss of land was zero.

2. After the installation of the dams, the now clear water, released at times and in amounts most advantageous to navigation, power production, flood control, environmental and wildlife concerns has the capacity to rapidly erode large amounts of land. Some rebuilding of land is occurring, but the elevation of the new land is too low to be of much value. Thus, the net loss of land is of great significance. Another alarming development is the deposition of much of the eroded soil in the headwaters of the next downstream reservoir causing a large delta formation, this delta has and will cause higher ground water tables in adjacent land and will also cause ice jam formation during the fall freeze up and the spring ice break up. The headwaters of the Oahe and Garrison reservoirs already have large delta formations.

3. This great change in bank erosion pattern was verified by a 1988 Government Accounting Office Study and also by the U. S. Army Corps of Engineers. In their December 1981 report to Congress they stated: "Bank erosion in this reach results in a permanent net loss of high value lands. This process, unless halted would eventually transform the present river into a wide area of sandbars and channels, occupying an increasing portion of the valley width between the bluffs". The Corps of Engineers also attempted to buy up 6,000 acres adjacent to the Oahe delta, so they obviously agree there is a developing delta problem.

4. The obvious conclusion is that this erosion problem is caused by the installation and operation of the Pick-Sloan dams and the prevention of continuing erosion and the loss of valuable land is the responsibility of the Pick-Sloan project.

5. There are many precedents for correcting the project's problems at project's expense after they became apparent. In the Pick-Sloan project significant precedents are the complete removal of the town of Niobrara, Nebraska, after it become water-logged by projects waters, and the buy out of irrigation projects west of Williston, North Dakota, after they also were adversely affected by high ground water tables.

6. Financing bank protection should not be a great problem to this Pick-Sloan project which has accumulated $3 billion in flood averted benefits to the downstream states, which develops $100 million worth of electrical energy per year, and which has spent $750,000 per mile to channelize the downstream Missouri River for navigation from Sioux City to St. Louis and which maintains this navigation channel at full federal expense. Other huge direct and indirect benefits continue to accumulate to the downstream states.

7. All public power entities have by resolutions favored the installation of bank protective projects in spite of the minute percentage increase in Pick-Sloan project operations. There are apparently no environmental restraints to bank protective projects.

8. Since this is a Pick-Sloan project caused problem, it is not appropriate to require local cost sharing or benefit cost studies.

9. That this bank erosion problem, which is obviously caused by the Pick-Sloan project, has not been corrected long ago, remains one of the outrages of our time to the five counties which constitute the BOMMM district and to the states of Montana, North Dakota, South Dakota and Nebraska.

APPENDIX C

Photographs

Recent mass wasting is evident as freshly fallen soils accumulate on the river ice (February, 1990). The cables are remnants of previous attempts to stabilize the banks. The landowner at this location noted that the local power company had moved power lines along this reach, and the bank recedes at an average rate of about 5 feet per year. This erosion site is about 9000 feet long.

Looking west along the south side of the Missouri River in Richland County, Montana. These individuals are standing on a former county road, which has since been moved to the south.

Garrison to Oahe Reach Erosion Site #18

The left bank of the Missouri River at approximately river mile 1352. Part of approximately 4000 feet of eroding bank.

Garrison to Oahe Reach Erosion Site #30

The right bank of the Missouri River at approximately river mile 1343. This is part of approximately 4000 feet of bank which is eroding.

Dike 1351.3

The dike is protecting the bank downstream, the photo above shows sediments deposited downstream of the dike. However, the photo below shows a scour hole on the upstream side of the dike. If the damage is not repaired, the entire dike may erode, allowing the river to began attacking the bank once again.

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