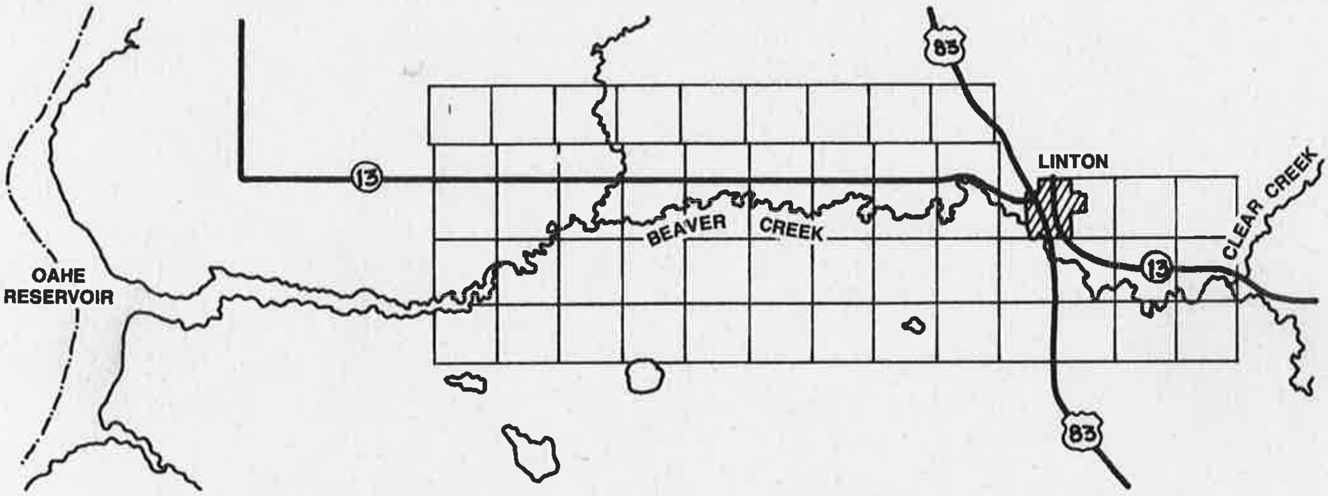
PRELIMINARY ENGINEERING REPORT

BEAVER CREEK SNAGGING & CLEARING

EMMONS COUNTY

SWC PROJECT NO. 558-1



NORTH DAKOTA STATE WATER COMMISSION
JANUARY 1988

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SNAGGING AND CLEARING PROJECT
EMMONS COUNTY
SWC PROJECT #558-1

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North Dakota State Water Commission
State Office Building
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I. INTRODUCTION

STUDY OBJECTIVES

In April of 1987, the North Dakota State Water Commission entered into an agreement with the City of Linton and the Emmons County Water Resource Board to investigate and determine the feasibility of a snagging and clearing project on Beaver Creek in Emmons County. A copy of the agreement is included in Appendix A. The purpose of the investigation is to determine the condition of the river channel, aid in correcting stream flow problems caused by obstructions, and evaluate the relative hydraulic effects of a snagging and clearing project.

As a part of the investigation, ground crews inspected the project area and inventoried the material that should be removed from the primary channel. This report contains a description of the study area and the proposed snagging and clearing project, a suggested schedule for the project considering a phased implementation, and a detailed cost estimate for each proposed phase of the project.

LOCATION

The project is located in south-central North Dakota. The project is situated in Emmons County, with the upstream portion of the project lying east of Linton. The project limits start on the east side of the Corps of Engineers property, 23 river miles downstream from the confluence of Beaver and Spring Creek and follow the creek approximately 33 river miles. The project limits end at the confluence of Beaver Creek and Clear Creek located east of Linton. The project begins at the west edge of Section 14, Township 132 North, Range 78 West and follows the creek to the southeast corner of Section 15, Township 132 North, Range 76 West. Figure 1 shows the location of the proposed project.

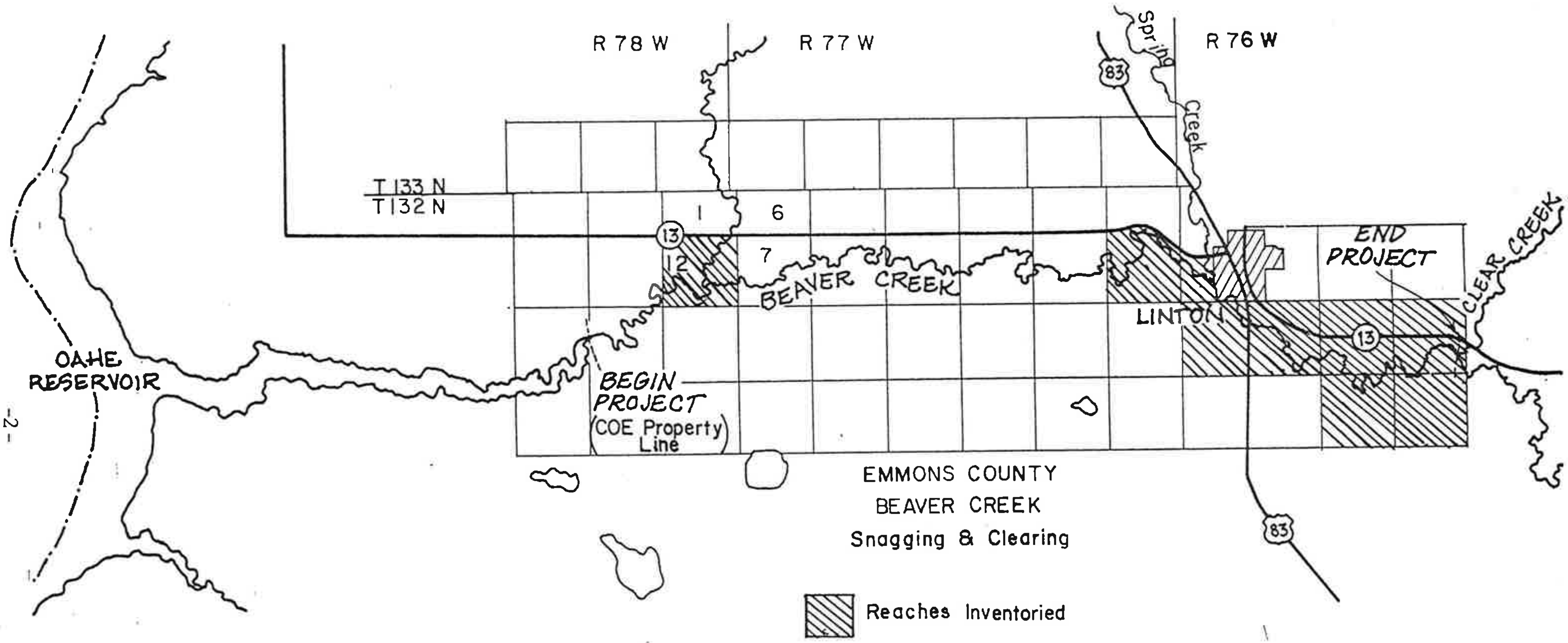


Figure 1 Location Map

BEAVER CREEK

Beaver Creek flows in a westerly direction and enters Oahe Reservoir about 60 river miles downstream from Bismarck. The Beaver Creek basin is about 30 miles wide and 55 miles long with a total drainage area of approximately 1,000 square miles. The total drainage area upstream from Linton is approximately 720 square miles, of which 453 miles contributes to peak runoff. Spring Creek, which drains a 41 square mile area north of Linton, joins Beaver Creek at the west edge of the city. The land areas upstream from Linton are composed of gently rolling grass range land and cultivated fields planted chiefly to small grains.

Beaver Creek, which has a valley approximately 1/2-mile wide, winds sinuously through the southwest side of Linton. The channel averages a 20-foot bottom width and is 12 feet deep. Beaver Creek has an average slope of 2.5 feet per mile in the project area. Beaver Creek valley is bordered by steep bluffs rising roughly 300 feet above the valley floor. The valley contains a large amount of trees which line the river bank in most areas. The City of Linton and a number of rural dwellings and farms are also located along the river channel in the project area.

HISTORICAL BACKGROUND

Spring snowmelt and heavy rains often result in flooding on Beaver Creek. The primary source of the flood waters is the winter's accumulation of snowfall. The depth of frost in the ground at break-up time and the condition of the river channel affect the stages of the spring floods. Frozen earth contributes to larger runoff by preventing infiltration. A channel in poor condition due to fallen trees, stumps, snags and general debris has a reduced ability to transport water. The obstructions cause blockage of the channel by ice or drifts of packed snow which result in higher stages. Heavy rain or a combination of rains over a short period of time in the late spring or summer can provide conditions for floods during the warm season.

Historically, floods in Linton happen only once a year. There is no record of Linton experiencing both a large spring flood and a flood resulting from heavy rainfall in the same year. It is not unusual for Linton to experience two crests of flooding, one from Spring Creek and another from Beaver Creek. Fortunately, conditions that would cause Spring Creek and Beaver Creek to crest at the same time occur infrequently. Spring Creek and Beaver Creek have peaking times of 6 hours and 48 hours, respectively.

Linton has experienced 20 floods from 1914 to 1987. There were floods in the years 1914, 1916, 1926, 1927, 1934, 1939, 1943, 1944, 1945, 1948, 1950, 1952, 1953, 1956, 1969, 1972, 1977, 1978, 1987. Based on this information, the frequency of a flood occurring in Linton is one approximately every 3.7 years. April of 1952, is the year of the largest recorded flood in Linton. A flow of 9,800 cfs was recorded.

A frequency analysis was computed on the Linton gaging station. This analysis followed the guidelines of WRC Bulletin #17B and data obtained from WATSTORE. The discharge frequency curve was computed for the 1950 through 1986 water year gaging record. The resulting frequency curve was compared with the 1980 Flood Insurance Study (FIS) frequency curve and is shown in Table 1.

Table 1 - Beaver Creek Discharge Frequency

Frequency	1986 Adopted Discharges (cfs)	1980 FIS Discharges (cfs)
10-year	4,500	4,200
50-year	10,500	9,700
100-year	14,000	12,000
500-year	25,200	20,000

II. GEOLOGY AND CLIMATE

Beaver Creek watershed is located on the southeast flank of the Williston Basin, an intracratonic, structural basin consisting of a thick sequence of sedimentary rocks. The project lies within the Coteau Slope, an area of rolling to hilly plains east of the Missouri River. The Coteau Slope is characterized by both erosional and glacial land forms. The topography of the Coteau Slope is a rolling to hilly, mature plateau.

Through much of Beaver Creek Basin, the land is an undulating to rolling surface of Fox Hills formation sand. Fox Hills bedrock sand is the main surface material with patches of glacial sediment and wind blown material. In the Linton area, Beaver Creek has eroded downward into the Pierre Formation.

Summers are usually hot and dry with periods of prolonged high temperature occurring from May through September. Winters are cold and dry and subject to severe blizzards. The extremes in temperature range from 116°F to a low of -52°F. The normal mean temperature in the basin is about 43°F with a January normal mean of 10°F and a July normal mean of 72°F. The growing season is comparatively short averaging about 120 days from the latter parts of May to September.

The normal annual precipitation for the basin averages about 18 inches, of which about 14.6 inches occur during the period from April through September. Snowfall over the basin averages about 35 inches per year and amounts to about 20 percent of the annual precipitation.

III. INVESTIGATION

STUDY METHODS

The first step in the creek survey began with an aerial survey over the study area. The aerial survey was used to view the problem areas and aid in determining ingress and egress routes. Still and video photography was taken for documentation purposes during the flight. Once the aerial survey was completed a ground survey was initiated along the study area. The purpose of the ground survey was to develop a field inventory of the number of standing and fallen trees, driftwood, snags, brush, loose stumps and trunks found within the established project boundaries.

State Water Commission personnel conducted the field inventory and reconnaissance on August 11 and 12, and continued the week of August 17, 1987. Preselected reaches of the creek channel ranging from those containing a sparse amount of trees to areas having a very dense tree cover were inventoried. This approach was used due to the length of the project and severity of the problems involved. From the reaches that were inventoried, a correlation was made between those reaches and the non-inventoried reaches. From this correlation, the condition of non-inventoried reaches was estimated. The field inventory had complete coverage through the Linton area and good coverage upstream and downstream of Linton. The field inventory covered 18 of the 33 creek miles involved in the study area. Figure 1 and Table 2 show the inventoried miles. Due to the severity of problems along the creek a large portion of the creek was unnavigable by canoe. The field inventory records, ground-based photographs, and the aerial videotape are available at the State Water Commission.

Table 2
Creek Miles Inventoried

Section	Creek Mile	Tree Growth	Inventoried
S14, T132N, R78W	0.00 - 3.00	VERY LITTLE TO MINOR	NO
S11, T132N, R78W	3.00 - 4.50	VERY LITTLE TO MINOR	NO
S12, T132N, R78W	4.50 - 6.50	MODERATE	YES
S7, T132N, R77W	6.50 - 8.75	MODERATE	NO
S8, T132N, R77W	8.75 - 11.50	MINOR TO MODERATE	NO
S9, T132N, R77W	11.50 - 13.75	MINOR TO MODERATE	NO
S10, T132N, R77W	13.75 - 16.25	MINOR TO MODERATE	NO
S11, T132N, R77W	16.25 - 18.75	HEAVY	NO
S12, T132N, R77W	18.75 - 22.25	HEAVY	YES
S7, T132N, R76W	22.25 - 24.00	HEAVY	YES
S18, T132N, R76W	24.00 - 24.75	THIN TO MODERATE	YES
S17, T132N, R76W	24.75 - 27.25	HEAVY	YES
S17, T132N, R76W	27.25 - 28.00	THIN TO MODERATE	NO
S16, T132N, R76W	28.00 - 29.00	MODERATE	NO
S21, T132N, R76W	29.00 - 30.50	MODERATE	NO
S16, T132N, R76W	30.50 - 31.00	MODERATE	YES
S15, T132N, R76W	31.00 - 31.25	MODERATE	YES
S22, T132N, R76W	31.25 - 31.75	MODERATE TO HEAVY	YES
S15, T132N, R76W	31.75 - 33.00	MODERATE TO HEAVY	YES

The field inventory estimated the number of standing trees, fallen trees, snags and debris, stumps and brush that would need to be removed. The inventory revealed that Beaver Creek is choked with accumulation of snags and debris. The debris with the most important influence is the large deciduous trees, such as elms, which have fallen into the river from the banks. This debris has resulted from several actions: erosion of the banks, diseased elms collapsing into the channel, and beavers cutting the trees down adjacent to the bank. Whatever the means by which the debris entered the channel, once there it can have a significant impact under existing conditions.

The areas with highest number of snags is the area directly downstream of Linton and the area between Highway 83 and Seeman Park. These reaches have heavy to severe accumulation with areas of complete jams in the channel. The inventory showed that the stretch through Linton had moderate to heavy accumulation of debris including 51 old car bodies within the banks of Beaver Creek. The inventory also showed that Beaver Creek has a large abundance of dead elm trees still standing and in imminent danger of falling into the waterway. The rest of the inventory revealed substantial accumulation of snags and debris blockage but decreasing in magnitude as Beaver Creek approached the Missouri River system. Table 3 shows the estimated quantities of material needed to be removed throughout the project.

HEC-2 backwater computer modeling efforts were attempted to evaluate the relative benefits of the proposed project, but were considered inadequate to compute water surface profiles. Additional cross-section data would need to be obtained at several locations to determine the extent of reduction in water surface profiles. Due to the nature of the agreement, time and funding did not allow additional refinements to the backwater model.

Without detailed computer model, the benefits of the proposed project could not be shown in terms of flood stages. Although with the available flood insurance study data, effects and benefits of the proposed project could be generalized. The benefits would be substantial for the more frequent events. The flood stage of large events could also be reduced. The snags and debris provide the opportunity for ice and debris jams to form in the spring runoff. With the removal of this material, the threat of increased stages would be reduced.

The need for a snagging and clearing project is evident from the spring flood of 1987. A maximum flow of 7,580 cubic feet per second was recorded which resulted in high water marks approximately the same as the 1952 flood of 9,800 cubic feet per second. The accumulation of the snags and debris over the last several decades has reduced the conveyance of the waterway and has reduced the average channel velocities. The proposed project would restore the waterway and would allow water to pass faster and more efficiently downstream.

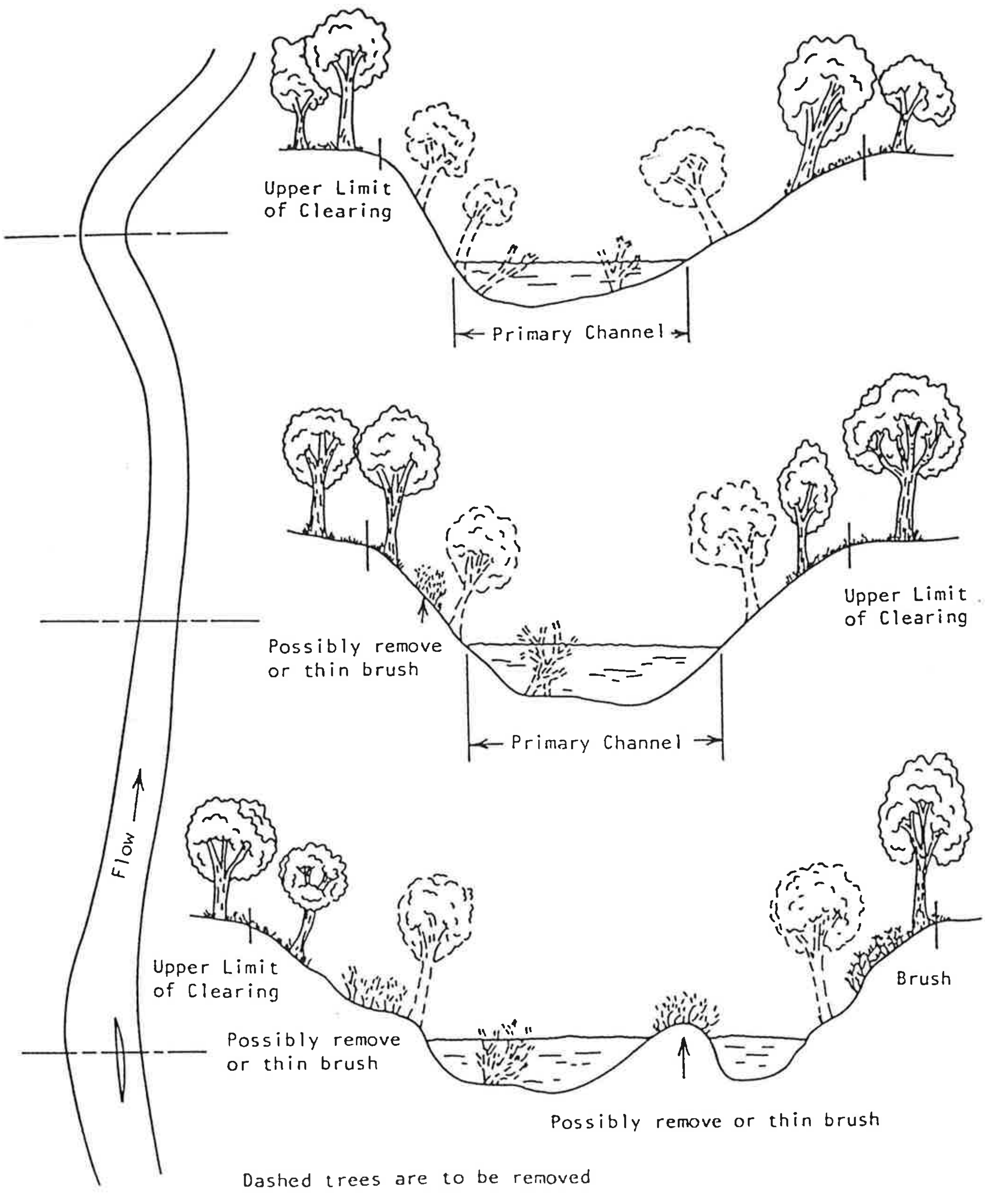
Table 3 - Estimated And Averaged Quantities

River Mile	No. Standing Trees @ $16/each	No. Fallen Trees @ $11/each	No. Snags & Debris @ $250/each	No. Stumps @ $9/each	No. Brush @ $10/each
0-1	38	33	4	8	5
1-2	38	33	4	8	5
2-3	38	33	4	8	5
3-4	38	33	4	8	5
4-5	118	64	11	7	7
5-6	199	95	17	7	8
6-7	200	94	17	7	8
7-8	199	95	17	7	8
8-9	169	87	15	9	9
9-10	75	66	8	16	11
10-11	75	66	8	16	11
11-12	120	103	13	18	19
12-13	165	139	20	22	27
13-14	170	138	22	25	26
14-15	183	135	25	30	22
15-16	183	135	25	30	22
16-17	183	135	25	30	22
17-18	183	135	25	30	22
18-19	184	135	25	30	22
19-20	183	135	25	30	22
20-21	183	135	25	30	22
21-22	183	135	25	30	22
22-23	157	96	20	40	27
23-24	143	70	18	47	29
24-25	129	82	14	25	14
25-26	176	178	34	38	20
26-27	176	178	34	38	20
27-28	136	104	19	15	15
28-29	120	81	14	9	12
29-30	120	81	14	9	12
30-31	123	95	13	4	13
31-32	164	103	18	14	17
32-33	164	104	19	14	16
Total	4,715	3,331	581	659	525

IMPLEMENTATION

The snagging and clearing work would include the removal and disposal of all fallen and standing trees, driftwood, snags, brush, loose stumps, trunks, and debris found within the primary channel between the project boundaries. In addition, all fallen trees, driftwood, and potential obstructions on the immediate bank including either standing (dead or living) trees or leaning trees which are in imminent danger of falling into the primary channel are to be removed. For the purpose of this report, the primary channel is that portion of the channel covered by water under average conditions. Standing trees to be removed include all those located within the primary channel, those located on the bank whose root systems are exposed due to undermining and any American Elm trees in danger of eventually falling into the waterway due to contracting Dutch Elm disease. In addition, some trees and brush on eroded banks or very low on the bank above the primary channel should be removed. Standing trees should be cut as flush to the ground as possible. Trunks and root systems which aid in stabilizing the channel banks should be left in place. All items which aid in reducing bank erosion and do not interfere with streamflow should not be removed. Figure 2 illustrates the extent of the clearing to be done. The final decision as to which items are to be removed should be made in the field by an inspector at the time the work is being done.

All floatable material loosened by the snagging operations should be removed from the channel. Timber or debris should be disposed of in such a manner as to preclude its being washed into the channel during periods of high water. Materials and debris resulting from the snagging operations should be removed from the site, burned, or otherwise disposed of by approved means. The burning of debris must comply with Chapter 33-15-04, of the North Dakota Administrative



EXTENT OF CLEARING AND SNAGGING PROJECT

FIGURE 2

Code. The State Health Department recommends no burning of material on the ice due to the increased carbon loadings to the waterway. The materials must be hauled to an upland site according to the project's specifications in order to be burned. A burning permit will be required.

Due to the interest in firewood, another strategy for removal is to permit local residents to cut down the trees for use as firewood. Steps would need to be taken to ensure that the proper trees are removed. During the fall and winter local residents can help remove the trees. The proper permission must be granted by landowners. One problem with this type of program for snagging and clearing is that it is very difficult to supervise the activities of the many people at the site during irregular hours. This type of project has worked well in gaining favorable public opinion, however, some type of project would be needed to clear the areas left by the participants and remove material they left behind.

The State Forest Service has recommended special measures to prevent the spread of Dutch Elm disease during snagging and clearing operations. It is recommended that the diseased trees be debarked if removed from area. There is additional recommendations if the wood is to be stored for firewood and will be defined in project specifications.

The results of the field inventory indicate that numerous reaches of the river channel contain excessive amounts of snags and debris so as to impair streamflow in the channel and cause increases in the flood stage. Due to the magnitude of problems encountered along Beaver Creek, a maintenance project should be initiated to remedy the restricted channel capacities. The project and its costs have been split into six reaches according to seriousness of the obstruction to flow at Linton. The best time to implement a snagging and clearing project is during the winter months when the creek and ground are frozen. It is most effective to begin a project were the flood benefits for Linton can be maximized. Therefore, Reach 5 located within the City of Linton should be snagged and cleared as soon as possible. The obstructions within Reach 5 cause Beaver Creek to go overbank prematurely. This reach starts at the county bridge at the west end of town and continues upstream through Linton until reaching the west end of Seeman Park. Reach 5 consists of snagging and clearing five creek miles beginning at mile 22.25 and ending at river 27.25, as shown in Figure 3.

Reach 4 should also be snagged and cleared as soon as possible after Reach 5. This reach includes all of Section 12, Township 132 North, Range 77 West, and consists of snagging and clearing 3.5 creek miles beginning from mile 18.75 to 22.25, as shown in Figure 3. This area is located directly downstream from Linton and contains the greatest amount of obstructions to flow. Due to the large number of snags this section has a significant impact on the lower frequency events causing a backwater to build up and cause a greater potential for flooding through Linton. The effects of these snags decrease with larger events. Other factors including channel capacity, gradient, and man-made controls placed in and along the waterway have more significance for the larger events.

Reach 3 has the next highest priority. This reach includes all of Sections 10 and 11, Township 132 North, Range 77 West. This reach consists of snagging

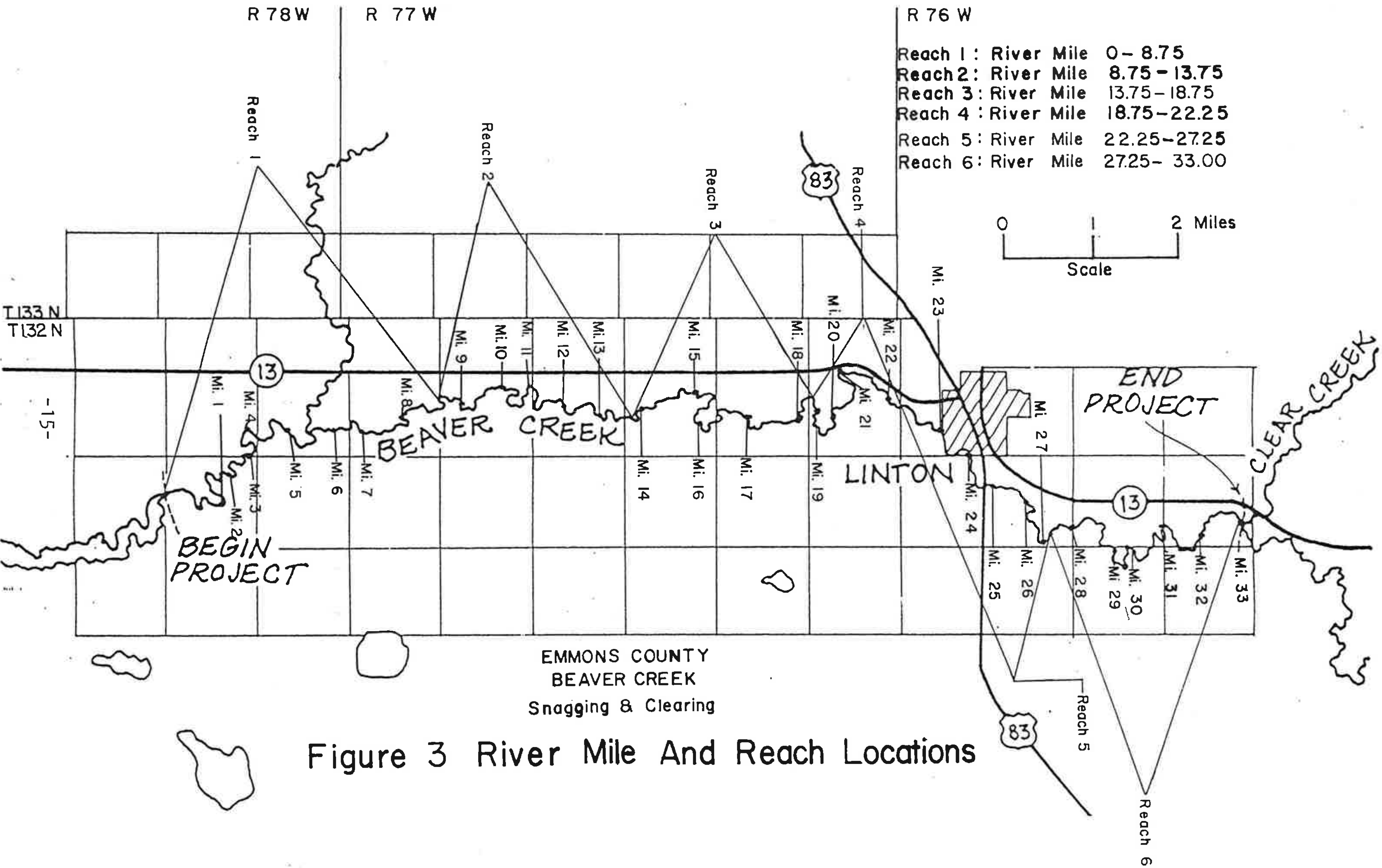


Figure 3 River Mile And Reach Locations

and clearing five creek miles beginning from mile 13.75 to 18.75, as shown in Figure 3. It is also recommended that this reach be snagged and cleared as soon as possible. The obstructions impede flows causing a backwater effect and also extend the travel time for the flows to enter the Missouri River system. If this reach was not snagged and cleared, but Reach 5 and 4 were completed, the benefits of doing work around Linton would be minimal. The water would pass through town easily but would than be severely obstructed below town causing water to back upstream through Linton. In order for Linton to receive benefits, the first three reaches must be snagged and cleared.

Reaches 2, 6, and 1 should then be snagged and cleared in successive order. Figure 3 shows the location of these reaches. These reaches have lower priority and could be delayed if necessary. Table 4 shows the breakdown of reaches and their significance.

In order to implement a project of this magnitude it may be necessary to have a maintenance plan that spans several years. Once a stretch of Beaver Creek has been restored, periodic reexaminations are necessary to assure that past work was adequate to alleviate channel problems. The reexamination is also necessary to determine if any new work is needed. Reexaminations are particularly important after periods of high water when erosive force of the waterway is the greatest.

Table 4 - Reach Priority

Priority	Reach Number	Creek Mile	Reach Length (Miles)
1	Reach 5	22.25 - 27.25	5.0
2	Reach 4	18.75 - 22.25	3.5
3	Reach 3	13.75 - 18.75	5.0
4	Reach 2	8.75 - 13.75	5.0
5	Reach 6	27.25 - 33.00	5.75
6	Reach 1	0.00 - 8.75	8.75

IV. COST ESTIMATE

The cost of snagging and clearing Beaver Creek is difficult to estimate. The cost is dependent upon many factors including the method used for clearing the area, the climatic conditions, the amount of work to be performed, and the difficulty in moving the equipment. The estimated snagging and clearing quantities and cost estimates for each river mile for each reach are given in Tables 5, 6, 7, 8, 9, and 10. The total cost for each reach includes engineering, administrative, and contingency costs amounting to 25 percent of the construction costs. Contingency costs include variable and unforeseen costs such as increased costs for labor or fuel, accessibility to the project site, and landowner difficulties.

As stated in the description portion of the investigation, the reaches that were not estimated were correlated and averaged based on the inventoried reaches. Reach 5, which is given first priority has a cost estimate of $64,154 for 5 miles. Table 5 shows the cost estimate breakdown for Reach 5. Reach 4 which is given second priority has a cost estimate of $50,470 for 3 1/2 miles. Table 6 shows the cost estimate breakdown for Reach 4. Reach 3, which is given third priority, has a cost estimate of $69,750 for 5 miles. Table 7 shows the cost estimate breakdown for Reach 3. Reach 2, which is given fourth priority, has a cost estimate of $41,474 for 5 miles. Table 8 shows the cost estimate breakdown for Reach 2. Reach 6 is given the next priority and has a cost estimate of $51,975 for 5 3/4 miles. Table 9 shows the cost estimate breakdown for Reach 6. Reach 1 has the lowest priority, is given a cost estimate of $57,818 for 8 3/4 miles. Table 10 shows the cost estimate breakdown for Reach 1.

The total estimated construction cost, including administrative, engineering and contingencies is $335,641 for the 33 creek miles. If the State of North Dakota and private contractors become involved the construction costs could possibly be cost-shared with the State Water Commission and a 75 percent local, 25 percent state basis.

If the project sponsors get assistance from the National Guard the local costs would be for the fuel required which could possibly be cost-shared with the State Water Commission on a 75 percent local, 25 percent state basis. A project of this magnitude will require large equipment that have high and variable energy costs. Therefore, no estimate was calculated.

TABLE 5 - REACH 5

Section & (Creek Mile)	Number Of Standing Trees	Subtotal @ $16	Number Of Fallen Trees	Subtotal @ $11	Number Of Snags & Debris	Subtotal @ $250	Number Of Stumps	Subtotal @ $9	Number Of Brush	Subtotal @ $10	Total *
S7,T132N,R76W (22.25-23.00)	85	$1,360	42	$ 462	11	$2,750	28	$252	18	$180	$ 6,255
S7,T132N,R76W (23.00-24.00)	143	2,288	70	770	18	4,500	47	423	29	290	10,339
S18&S17,T132N,R76W (24.00-25.00)	129	2,064	82	902	14	3,500	25	225	4	140	8,539
S17,T132N,R76W (25.00-26.00)	176	2,816	178	1,958	34	8,500	38	342	20	200	17,270
S17,T132N,R76W (26.00-27.00)	176	2,816	178	1,958	34	8,500	38	342	20	200	17,270
S17,T132N,R76W (27.00-27.25)	45	720	44	484	9	2,250	9	81	5	50	4,481
										Total	$64,154
										$/Mile	$12,831

* Total Includes 25% For Contingencies, Contract Administration, And Engineering.

TABLE 6 - REACH 4

Section & (Creek Mile)	Number Of Standing Trees	Subtotal @ $16	Number Of Fallen Trees	Subtotal @ $11	Number Of Snags & Debris	Subtotal @ $250	Number Of Stumps	Subtotal @ $9	Number Of Brush	Subtotal @ $10	Total *
S12,T132N,R77W (18.75-19.00)	46	$ 736	34	$ 374	6	$1,500	7	$ 63	5	$ 50	$ 3,404
S12,T132N,R77W (19.00-20.00)	183	2,928	135	1,485	25	6,250	30	270	22	220	13,941
S12,T132N,R77W (20.00-21.00)	183	2,928	135	1,485	25	6,250	30	270	22	220	13,941
S12,T132N,R77W (21.00-22.00)	183	2,928	135	1,485	25	6,250	30	270	22	220	13,941
S12,T132N,R77W (22.00-22.25)	72	1,152	54	594	9	2,250	12	108	9	90	5,243
										Total	$50,470
										$/Mile	$14,420

* Total Includes 25% For Contingencies, Contract Administration, And Engineering.

TABLE 7 - REACH 3

Section & (Creek Mile)	Number Of Standing Trees	Subtotal @ $16	Number Of Fallen Trees	Subtotal @ $11	Number Of Snags & Debris	Subtotal @ $250	Number Of Stumps	Subtotal @ $9	Number Of Brush	Subtotal @ $10	Total *
S10,T132N,R77W (13.75-14.00)	46	$ 736	34	$ 374	6	$1,500	8	$ 72	6	$ 60	$ 3,428
S10,T132N,R77W (14.00-15.00)	183	2,928	135	1,485	25	6,250	30	270	22	220	13,941
S10,T132N,R77W (15.00-16.00)	183	2,928	135	1,485	25	6,250	30	270	22	220	13,941
S10&S11,T132N,R77W (16.00-17.00)	183	2,928	135	1,485	25	6,250	30	270	22	220	13,941
S11,T132N,R77W (17.00-18.00)	183	2,928	135	1,485	25	6,250	30	270	22	220	13,941
S11,T132N,R77W (18.00-18.75)	138	2,208	101	1,111	19	4,750	23	207	17	170	10,558
										Total	$69,750
										$/Mile	$13,950

* Total Includes 25% For Contingencies, Contract Administration, And Engineering.

TABLE 8 - REACH 2

Section & (Creek Mile)	Number Of Standing Trees	Subtotal @ $16	Number Of Fallen Trees	Subtotal @ $11	Number Of Snags & Debris	Subtotal @ $250	Number Of Stumps	Subtotal @ $9	Number Of Brush	Subtotal @ $10	Total *
S8,T132N,R77W (8.75-9.00)	19	304	16	$ 176	2	$ 500	4	$ 36	3	$ 30	$ 1,308
S8,T132N,R77W (9.00-10.00)	75	1,200	66	726	8	2,000	16	144	11	110	5,225
S8,T132N,R77W (10.00-11.00)	75	1,200	66	726	8	2,000	16	144	11	110	5,225
S8&S9,T132N,R77W (11.00-12.00)	120	1,920	103	1,133	13	3,250	18	162	19	190	8,319
S9,T132N,R77W (12.00-13.00)	165	2,640	139	1,529	20	5,000	22	198	27	270	12,046
S9,T132N,R77W (13.00-13.75)	124	1,984	104	1,144	16	4,000	17	153	20	200	9,351
										Total	$41,474
										$/Mile	$ 8,295

* Total Includes 25% For Contingencies, Contract Administration, And Engineering.

TABLE 9 - REACH 6

Section & (Creek Mile)	Number Of Standing Trees	Subtotal @ $16	Number Of Fallen Trees	Subtotal @ $11	Number Of Snags & Debris	Subtotal @ $250	Number Of Stumps	Subtotal @ $9	Number Of Brush	Subtotal @ $10	Total *
S17,T132N,R76W (27.25 - 28.00)	91	$1,456	60	$ 660	10	$2,500	6	$ 54	10	$100	$ 5,963
S16,T132N,R76W (28.00-29.00)	120	1,920	81	891	14	3,500	9	81	12	120	8,140
S21,T132N,R76W (29.00-30.00)	120	1,920	81	891	14	3,500	9	81	12	120	8,140
S21&S16,T132N,R76W (30.00-31.00)	123	1,968	95	1,045	13	3,250	4	36	13	130	8,036
S15&S22,T132N,R76W (32.00-31.00)	164	2,624	103	1,133	18	4,500	14	126	17	170	10,691
S15,T132N,R76W (32.00-33.00)	164	2,624	104	1,144	19	4,750	14	126	16	160	11,005
										Total	$51,975
										$/Mile	$ 9,039

* Total Includes 25% For Contingencies, Contract Administration, And Engineering.

TABLE 10 - REACH 1

Section & (Creek Mile)	Number Of Standing Trees	Subtotal @ $16	Number Of Fallen Trees	Subtotal @ $11	Number Of Snags & Debris	Subtotal @ $250	Number Of Stumps	Subtotal @ $9	Number Of Brush	Subtotal @ $10	**Total ***
S14,T132N,R78W (0.00-1.00)	38	$ 608	33	$ 363	4	$1,000	8	$72	5	$50	$ 2,616
S14,T132N,R78W (1.00-2.00)	38	608	33	363	4	1,000	8	72	5	50	2,616
S14,T132N,R78W (2.00-3.00)	38	608	33	363	4	1,000	8	72	5	50	2,616
S11,T132N,R78W (3.00-4.00)	38	608	33	363	4	1,000	8	72	5	50	2,616
S11&S12,T132N,R78W (4.00-5.00)	118	1,888	64	704	11	2,750	7	63	7	70	6,844
S12,T132N,R78W (5.00-6.00)	199	3,184	95	1,045	17	4,250	7	63	8	80	10,778
S12&S7,T132N,R78W&R77W (6.00-7.00)	200	3,200	94	1,034	17	4,250	7	63	8	80	10,784
S7,T132N,R77W (7.00-8.00)	199	3,184	95	1,045	17	4,250	7	63	8	80	10,778
S7,T132N,R77W (8.00-8.75)	150	2,400	71	781	13	3,250	5	45	6	60	8,170
										Total	$57,818
										$/Mile	$ 6,608

* Total Includes 25% For Contingencies, Contract Administration, And Engineering.

V. SUMMARY

The results of the field inventory of the 33-mile segment on the Beaver Creek reveal that many reaches are in extremely poor condition. Excessive obstructions occur within the primary channel and its banks, reducing the ability of the waterway to transport water. These obstructions include fallen and standing trees, driftwood, snags, brush, loose stumps, trunks, car bodies and debris. They have considerable hydraulic effects on Beaver Creek, causing more frequent, more extensive, and prolonged flooding which have caused monetary flood damage in Linton as well as agricultural damages upstream and downstream. The investigation indicates a snagging and clearing project should be implemented within the project area immediately. This type of restoration project would alleviate and minimize flood damages not only to the City of Linton and adjacent farmland but will protect the integrity of bridges and structures along Beaver Creek.

The project and its costs have been divided into six prioritized reaches. The cost estimates were based on private contractors proposals and bids from previous snagging and clearing projects. The estimates include administrative, engineering, and contingency costs. Reach 5, located within and adjacent to the City of Linton, was given highest priority and has a estimated cost of $64,154. The priority of the remaining reaches were as follows, Reach 4 estimated cost $50,470; Reach 3 estimated cost $69,750; Reach 2 estimated cost $41,474; Reach 6 estimated cost $51,975; and Reach 1 estimated cost $57,818. The total for the six reaches is $335,641. If the State of North Dakota and private contractors become involved, the construction costs could possibly be cost-shared with the State Water Commission on a 75 percent local, 25 percent state basis. If the project sponsors get assistance from the National Guard, the local costs would be for the fuel required, which could possibly be cost-shared with the State Water Commission on a 75 percent local, 25 percent state basis.

VI. RECOMMENDATIONS

In order for a snagging and clearing project to provide much improvement on flood stages through Linton, a large-scale maintenance plan has to be implemented. As stated, Beaver Creek's channel conditions are in extremely poor condition. The work required to remedy these problems is excessive. Therefore, a maintenance plan based on reach lengths and priority is recommended. The estimated construction cost, including administrative, engineering and contingencies is $335,641 for the 33 creek miles. A snagging and clearing project is efficacious and capable of decreasing flood stages, but it is limited in value. This point must be stressed, a snagging and clearing project will lessen the severity, length, and recurrence interval of floods but will not prevent floods from occurring. The decision to proceed with the project is the responsibility of the Emmons County Water Resource Board and the City of Linton.

APPENDIX

Appendix A - Investigation Agreement

SWC Project #558-1
April 15, 1987

AGREEMENT

Preliminary Investigation
of a Snagging and Clearing Project
on Beaver Creek

I. PARTIES

THIS AGREEMENT is between the City of Linton, hereinafter referred to as the City, acting through its Mayor, Melvin Jahner; the Emmons County Water Resource Board, hereinafter referred to as the Board, acting through its Chairman, Glen McCrory; and the North Dakota State Water Commission, hereinafter referred to as the Commission, acting through the State Engineer, Vernon Fahy.

II. PROJECT, LOCATION, AND PURPOSE

The City and the Board have jointly requested the Commission to investigate and determine the feasibility of a snagging and clearing project on Beaver Creek in Emmons County. The project area extends three miles east of Highway 83 to the U.S. Army Corps of Engineers' land approximately eight miles west of Linton on Beaver Creek. The purpose of the investigation is to determine the condition of the river channel, prepare a cost estimate for a snagging and clearing operation, and evaluate the relative hydraulic effects of a snagging and clearing project.

III. PRELIMINARY INVESTIGATION

The parties agree that further information is necessary concerning the proposed project. Therefore, the Commission shall conduct a preliminary investigation to provide the following:

1. An inspection of all areas along the channel described in Section II of this agreement with crews on the ground to inventory material that should be removed from the primary channel.

2. A hydraulic study which evaluates the relative benefits of the proposed project.

3. A written report documenting the findings of the inspection, an evaluation of relative benefits and a suggested schedule for implementation of the proposed project.

4. A detailed cost estimate for the project considering a possible phased implementation.

The inventory shall consist of only those items outlined herein. Field surveys and design work for the construction phase of this project shall not be included in this agreement.

IV. DEPOSIT-REFUND

The City and/or Board shall deposit $750.00 with the Commission to partially pay the costs of the investigation. Upon completion of the investigation outlined herein, upon receipt of a request from the City or the Board to terminate the investigation, or upon a breach of this agreement by any of the parties, the Commission shall provide the City and the Board with a statement of all expenses incurred in the investigation and shall refund to the City and/or the Board any unexpended deposit funds.

V. RIGHTS-OF-ENTRY

The City and/or Board agrees to obtain written permission from any affected landowner allowing the Commission to enter upon their property to conduct field surveys which are required for the investigation.

VI. INDEMNIFICATION

The City and the Board hereby accepts responsibility for and holds the Commission free from all claims and damages to public and private properties, rights or persons arising out of this investigation. In the event a suit is initiated or judgment rendered against the Commission, the City and the Board shall indemnify it for any judgment arrived at or judgment satisfied.

VII. CHANGES TO AGREEMENT

Changes in any contractual provisions herein will not be effective or binding unless such changes are made in writing, signed by the parties, and attached hereto.

NORTH DAKOTA STATE WATER COMMISSION
By:

Vernon Fahy

VERNON FAHY
State Engineer

DATE:

4/16/87

WITNESS:

David A. Sprynczynatyk

EMMONS COUNTY WATER RESOURCE BOARD
By:

Glenn McCrory

GLEN MCCRORY
Chairman

DATE:

April 22-87

WITNESS:

Elaine Jochim

CITY OF LINTON
By:

Melvin Jahner

MELVIN JAHNER
Mayor

DATE:

April 27, 1987

WITNESS:

Rosalia A. Dewald