PRELIMINARY REPORT

Firesteel Creek
Water Supply and Sediment Control
Damsite and Reservoir
Davison County, South Dakota
February 1974

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PRELIMINARY REPORT

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Water Supply and Sediment Control
Damsite and Reservoir

City of Mitchell, Davison County, South Dakota
February 1974

Prepared by:
USDA, Soil Conservation Service
Huron, South Dakota

In cooperation with:
Davison County Conservation District

written by:
Frank M. Hanson
Hydrologist 11/73

Firesteel Creek Structure

WATER SUPPLY HYDROLOGIC INVESTIGATIONS

Purpose:

(1) To provide the necessary hydrologic information for the design of a proposed reservoir in Section 28, T. 104 N., R. 61 W.; and (2) to estimate the availability of surface runoff from Firesteel Creek for municipal and industrial water supply for the city of Mitchell.

Physical Description

Firesteel Creek is located in Jerauld, Aurora, and Davison Counties and comprises an estimated total contributing drainage area above Lake Mitchell of 531 square miles. The drainage originates along the eastern slopes of the Wessington hills in Jerauld and Aurora Counties, flows in a southerly direction along the hills and then turns to a southeasterly direction where it joins the James River about 2 miles east of Mitchell. Except for the fairly steep slope of the Wessington hills the topography is generally flat to gently sloping. The main stem drainage heads in the hills to the north of Wessington Springs and flows for a distance of about 55 miles to Lake Mitchell. Its flood plain is about $\frac{1}{4}$ to $\frac{1}{2}$ mile in width and has a stream gradient of about 0.08 to 0.10 foot drop in 100 feet.

Vegetative cover conditions are estimated to be 19 percent in row crops, 15 percent in small grain, and 66 percent in pasture and hayland. Soil associations found in Firesteel Creek drainage area follows: Houdek-Stickney, Houdek-Prospen, Dudley-Stickney, Beadle-Stickney-Dudley, Clarno-Ethan, Highmore-Eakin, Enet-Delmont, Redstoe-Firesteel, Ethan-Clarno-Betts, Jerauld-Lane, Lane, Lamo, and Clayey Alluvium.

Water Supply

At the present time the city of Mitchell draws all of its water from Lake Mitchell. Because of the apparent shortage of water during drought periods and due to the depletion of storage in the lake through the accumulation of sediment, the city has shown an interest in the development of another reservoir about 3 miles upstream from Lake Mitchell.

A water budget table (see Figure 1H) was prepared for the proposed reservoir and Lake Mitchell using the following information:

PRELIMINARY REPORT

Firesteel Creek
Water Supply and Sediment Control
Dam and Reservoir
February 1974

INTRODUCTION

This preliminary engineering report was prepared at the request of the city of Mitchell, South Dakota, to the Davison County Conservation District. The city requested this assistance as part of an overall effort to enhance and protect Lake Mitchell, a multi-purpose structure providing water supply and recreation to the city. The city desires the proposed structure to (a) greatly reduce sediment inflow to Lake Mitchell, (b) stabilize the water level of Lake Mitchell, (c) increase the water supply available from Lake Mitchell, and (d) provide additional recreation for the general area. This report considers engineering feasibility for the type of structure requested and does not consider economic feasibility, environmental impact, availability of water rights, etc.

Technical data were collected, feasibility studies were made, and this report was prepared by the Soil Conservation Service of the U.S. Department of Agriculture.

This report consists of a preliminary geologic, hydrologic, and engineering evaluation of a damsite on Firseteel Creek, 3 miles upstream from Lake Mitchell. The site is located a few hundred feet upstream from the road in Section 28, T104N, R61W in Davison County, South Dakota.

Consideration was given to various types of dams and spillway combinations consistent with the anticipated used. Preliminary work indicates the most economical structure would be an earth dam with a storage capacity of 10,000 acre-feet, a large open concrete chute spillway and a wide vegetated emergency spillway. (Dimensions used are shown in the preliminary structural design report.)

The material in this report is preliminary and should be regarded as such. Additional data will have to be obtained and investigations made prior to the final design and construction phases. Some changes in structure dimensions may occur during final design, however, major changes are not anticipated.

The preliminary design is based on current Soil Conservation Service design criteria for high hazard dams designed for the above purposes.

The Bureau of Reclamation, report on Mitchell Unit, dated October 1968, based their investigations on the availability of water supply during the drought period of 1931 to 1942. The results showed that for this period the firm water yield from Firesteel Creek at Lake Mitchell amounted to 1500 acre-feet per year which does not meet present water requirements.

The following brief information is a comparison of surface runoff for periods of 1956 through 1972 and 1931 through 1941:

Drainage	Period of Record Years	Estimated Contrib. Drainage Area Sq. Mi.	Av. Ann. Runoff Ac-Ft	Av. Annual Runoff Ac-Ft/Sq.Mi.
Firesteel Creek above stream gauge	1956-1972	478	19,406	40.6
Drainage area between stream gauges on James River at Forestburg and Scotland	1956-1972	2,671	107,161	40.0
Drainage area above stream gauge on James River at Scotland	1956-1972	16,500	321,920	19.5
Drainage area above stream gauge on James River at Scotland	1931-1941	16,500	52,960	3.2

The above information shows that the amount of runoff at Scotland for the period of 1956-1972 was about 600 percent more than occurred during the period of 1931-1941. If you assumed that this same percentage would occur on Firesteel Creek the average runoff for period 1931-1941 would amount to 6.66 acre-feet per square mile. This would amount to an average annual runoff at Lake Mitchell of (6.66 x 531) 3,536 acre-feet. This amount of runoff would not be sufficient to satisfy the storage requirements at Lake Mitchell for consumptive use, evaporation and seepage loss.

Proposed Reservoir

The hydrologic data for the design of the proposed structure is as follows:

1. Annual runoff amounts measured at the stream gauge on Firesteel Creek for the period 1956 through 1972.

2. Contributing drainage area:

   a. above stream gauge = 478 square miles

   b. above proposed reservoir = 511 square miles

   c. above Lake Mitchell = 531 square miles

3. Assumed the same rate of runoff for the drainage area between the stream gauge and Lake Mitchell as for the drainage area above the stream gauge.

4. Annual precipitation amounts for station at Mitchell for period 1956 through 1972.

5. Average annual lake evaporation of 36 inches - from U. S. Weather Bureau TP 37.

6. Annual sediment yields (SCS State Geologist):

   a. Proposed reservoir = 40 acre-feet per year

   b. Lake Mitchell = none

7. Annual seepage loss (SCS State Geologist):

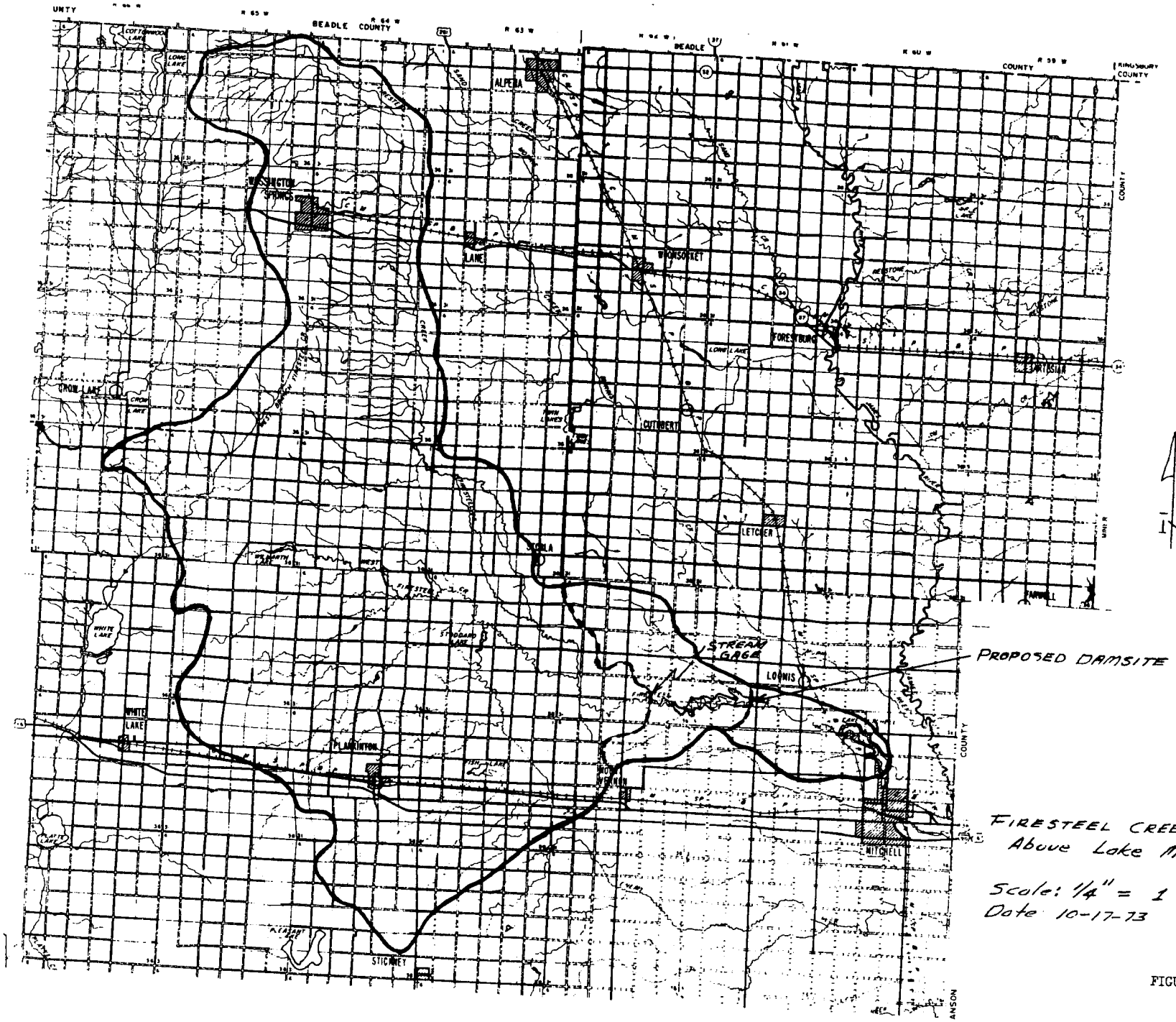
   a. Proposed structure = 1,100 acre-feet per year

   b. Lake Mitchell structure = 1,100 acre-feet per year

8. Estimated consumptive use of water for city of Mitchell will increase from the present use of 2,350 acre-feet per year in 1973 to 3,050 acre-feet per year in 1990, a 17-year period.

9. Total available storage in proposed reservoir of 10,056 acre-feet at elevation 1300.0.

In the preparation of the water budget table for the two reservoirs the main objective was to make use of the total available storage in the upper structure, releasing water if necessary, to maintain the water level in Lake Mitchell at an elevation of 1262.0 which is one foot below the crest of the emergency spillway. The table shows that there were 2 years (1956 and 1965) that this water level could not be maintained. The table also shows that there were 8 years where an excess of water would be discharged through the emergency spillway. Likewise, the upper reservoir shows 2 years with no water storage and 8 years with full storage.



FIRESTEEL CREEK DRAINAGE
Above Lake Mitchell

Scale: 1/4" = 1 mile
Date 10-17-73

FIGURE 2H

Contributing drainage area above structure = 511 sq. mi. (see Figure 2H)
Runoff curve number = 75
Time of concentration = 53 hours
Elevation - top of conservation pool = 1300.0
100-year sediment storage = 4,000 acre-feet
Structure classification (SCS ENG Memo 27) = "C"

Conclusions

The foregoing water budget table shows that the surface runoff on Firesteel Creek for the period of 1956 through 1973 is sufficient to meet the city of Mitchell's water requirement needs assuming the upper or proposed structure is in place. It also shows that the carry-over storage in the proposed structure, in 11 of the 16 years of record, is sufficient to maintain a water level in Lake Mitchell at 1.0 foot below the crest of the emergency spillway assuming no surface runoff occurs during the year.

The available data also show that for extended dry periods, as occurred during the 1931 through 1941, surface runoff from Firesteel Creek would not be sufficient to meet Mitchell's water needs.

WATER BUDGET FOR PROPOSED RESERVOIR AND LAKE MITCHELL

WATER YEAR		1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Proposed Reservoir	Units																	
Carryover previous year	ac-ft	0	0	9,245	8,812	3,789	9,233	6,447	9,507	6,711	3,103	0	1,119	7,165	4,960	8,542	8,440	8,454
Surface runoff (511 sq.mi.)	ac-ft	4,318	14,880	7,493	57	51,108	2,095	156,715	2,640	1,731	79	8,006	11,673	2,875	40,504	6,884	7,921	33,684
Seepage loss thru structure	ac-ft	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Net inflow storage	ac-ft	3,218	13,780	6,393	-1,043	50,008	995	155,615	1,540	631	-1,021	6,906	10,573	1,775	39,404	5,784	6,821	32,584
Total available storage	ac-ft	10,016	9,976	9,936	9,896	9,856	9,816	9,776	9,736	9,696	9,656	9,616	9,576	9,536	9,496	9,456	9,416	9,376
Flow through emergency spillway	ac-ft	0	3,804	5,702	0	43,941	412	152,286	1,311	0	0	0	2,116	0	34,868	4,870	5,845	31,662
Gated release to lower structure	ac-ft	3,218	0	0	3,426	0	2,806	0	2,227	3,717	2,082	5,232	1,410	3,486	0	0	0	0
Net water storage in structure	ac-ft	0	9,976	9,936	4,343	9,856	7,010	9,776	7,509	3,625	0	1,674	8,166	5,454	9,496	9,456	9,416	9,376
Accumulated sediment storage	ac-ft	40	80	120	160	200	240	280	320	360	400	440	480	520	560	600	640	680
Total storage water and sediment	ac-ft	40	10,056	10,056	4,503	10,056	7,250	10,056	7,829	3,985	400	2,114	8,646	5,974	10,056	10,056	10,056	10,056
Elevation water surface	feet	---	1300.0	1300.0	1292.2	1300.0	1295.6	1300.0	1296.3	1290.9	--	1288.3	1297.4	1294.0	1300.0	1300.0	1300.0	1300.0
Surface area	acres	0	770	770	440	770	575	770	605	360	--	312	650	510	770	770	770	770
Net evaporation loss	feet	1.59	.95	1.46	1.26	.81	.98	.35	1.32	1.45	--	1.78	1.54	.97	1.24	1.32	1.25	.98
Net evaporation loss	ac-ft	0	731	1,124	554	623	563	269	798	522	--	555	1,001	494	954	1,016	962	754
Carryover water storage	ac-ft	0	9,245	8,812	3,789	9,233	6,447	9,507	6,711	3,103	0	1,119	7,165	4,960	8,542	8,440	8,454	8,522
Lake Mitchell																		
Estimated water requirements (Mitchell)	ac-ft	2,352	2,393	2,434	2,476	2,518	2,560	2,603	2,646	2,690	2,733	2,778	2,822	2,867	2,912	2,957	3,003	3,048
Seepage loss thru structure	ac-ft	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Net evaporation loss	ac-ft	1,200	717	1,102	951	611	740	264	996	1,095	777	1,344	1,163	732	936	996	944	748
Water storage depletion-previous year	ac-ft	0	164	0	0	0	0	0	0	0	0	1,425	0	0	0	0	0	0
Total water storage requirements	ac-ft	4,652	4,374	4,636	4,527	4,229	4,400	3,967	4,742	4,885	4,610	6,647	5,085	4,699	4,948	5,053	5,047	4,896
Surface runoff 20 sq. miles 1/	ac-ft	170	585	295	1	2,008	82	6,157	104	68	3	315	459	113	1,591	270	311	1,382
Seepage from upper structure	ac-ft	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
Inflow from emergency spillway-upper str.	ac-ft	0	3,804	5,702	0	43,941	412	152,286	1,311	0	0	0	2,116	0	34,868	4,870	5,845	31,662
Total inflow to structure	ac-ft	1,270	5,489	7,097	1,101	47,049	1,594	158,543	2,515	1,168	1,103	1,415	3,675	1,213	37,559	6,240	7,256	34,144
Additional water needed	ac-ft	3,382	0	0	3,426	0	2,806	0	2,227	3,717	3,507	5,232	1,410	3,486	0	0	0	0
Gated release from upper structure	ac-ft	3,218	0	0	3,426	0	2,806	0	2,227	3,717	2,082	5,232	1,410	3,486	0	0	0	0
Water shortage 2/	ac-ft	164	0	0	0	0	0	0	0	0	1,425	0	0	0	0	0	0	0
Water excess (outflow thru emerg. spill)	ac-ft	0	1,115	2,461	0	42,820	0	155,576	0	0	0	0	0	0	32,611	1,187	2,209	29,198

1/ Drainage area between proposed structure and Lake Mitchell
2/ Amount of water required to maintain water surface at elevation 1262.0

FIGURE 1H

Firesteel Creek Structure

By:
James B. Hyland
Geologist 9/5/73

ENGINEERING GEOLOGY INVESTIGATION
FEASIBILITY INVESTIGATION OF FIRESTEEL CREEK DAMSITE

Proposal Data:

An earth fill damsite is proposed at SE¼ Section 28 and NE¼ Section 33, T104N, R61W, Davison County, South Dakota. The site is upstream from Lake Mitchell, approximately 3 miles, on Firesteel Creek. The primary purpose is sediment control and protection for Lake Mitchell.

The structure dimensions for the purposes of this geologic investigation are estimated as follows:

h = 45 feet
l = 3,000 feet
fill = 250,000 cubic yards
total storage = 25,000 acre-feet (@ 45 feet high)

Purpose of Investigation:

The investigation was conducted to determine the suitability of the general site conditions for a structure of this description and the sediment storage requirements of a site at this location and for this purpose.

The site was investigated using Soil Conservation Service owned drilling equipment and personnel during the week of September 4, 1973.

Physical Damsite Conditions:

The general geologic section is shown on Figure 1G. The Sioux Quartzite forms the basement rock. The quartzite is non-compressible and often fractured.

The Carlile shale overlies the Sioux Quartzite and consists of light gray to black shale interbedded with silt and sand layers. The Carlile includes the Codel sandstone member just below the Niobrara Formation and is exposed in the lower 4 feet of the left abutment of the proposed damsite.

The Niobrara Marl overlies the Carlile Formation and is exposed in the left abutment of the damsite. It is composed of light to medium blue gray (unweathered) and light yellow brown to dark yellow brown (weathered) shaley marl. The Niobrara is moderately permeable along bedding plains and joints. It is preconsolidated but light in specific gravity.

The non-indurated surficial deposits consist of non-consolidated glacial outwash sands and gravel and recent alluvium of silt, sand, and clay.

The topography is nearly flat to gently undulating.

Sediment Storage Requirements:

The contributing drainage area, taken from the Jim River Basin Study is 530 square miles. Sediment delivery rate was taken from the report on the Sedimentation Survey of Lake Mitchell, Monaghan, 1970. The 40.8-year average rate of sediment accumulation in Lake Mitchell, 41.86 acre-feet per year was used for sediment storage estimated requirements. The 100-year sediment storage requirement is approximately 4,000 acre-feet.

Conclusions:

No subsurface condition was observed which creates an insurmountable problem at the proposed location. During any detailed investigation for structural design several areas need to be determined.

One of these is in the vicinity of Station 10+00 to 11+00 on the proposed centerline of the dam. An old buried channel was located here during the investigation. The engineering characteristics of the materials associated with this feature need to be determined by additional drilling and undisturbed sample testing for consolidation potential. Nothing is so deep here but what a problem of differential consolidation could be remedied by excavation and shaping if such a problem is found to exist from the testing.

Another point which needs to be determined is the consolidation potential of the alluvium between Stations 3+00 and 10+00.

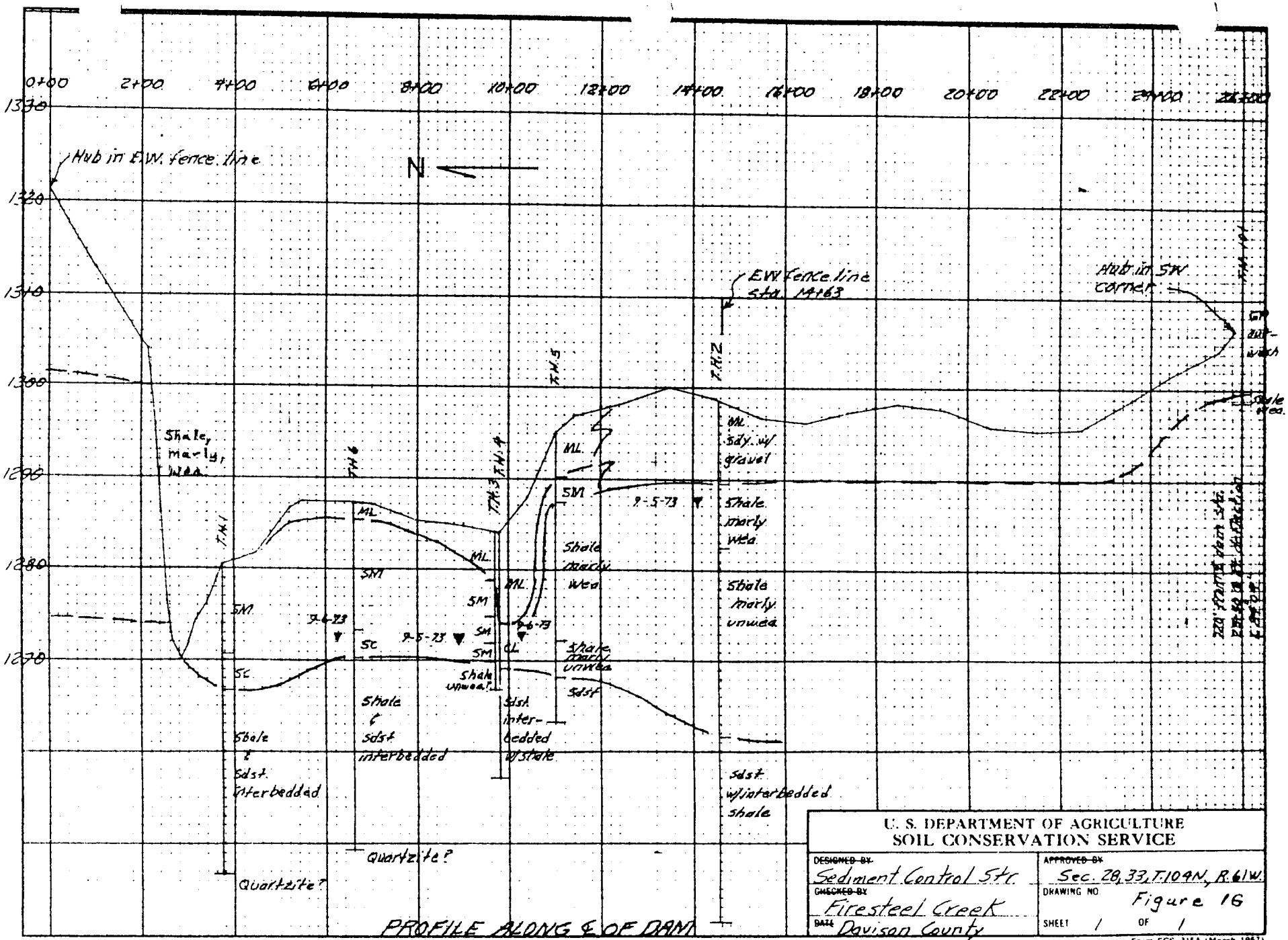
Sampling and testing of the borrow materials will also be needed.

In-place permeability tests should be run in both the non-indurated alluvial-colluvial material and the Niobrara and Carlile Formations. The Codel sandstone member of the Carlile Formation which is exposed along the north side of the channel below elevation 1274 can be effectively cutoff by blanketing. The jointed, weathered Niobrara which overlies the Carlile can be shaped and cored to effective cutoff in the left abutment. The required core depth will need to be determined by rock coring, permeability and pressure testing in the left abutment. A core of 12 feet deep between Stations 3+00 and 11+00 is estimated to reduce the expected seepage through the recent alluvium to between 3 to 4 acre-feet per day. The actual permeability rate of the alluvium will need to be determined in the field by constant head testing during the detailed investigation.

The glacial outwash from Station 12+00 to the south is the most permeable material on the site. The materials range from a loose, gravelly silt of moderate permeability to clean, poorly graded, sandy gravel with high permeability. The thickness of this material and the elevation of the Niobrara Formation contact in TH 101 indicate that a positive cutoff core is a feasible method of treatment. This would mean a core depth of approximately 10 feet from Station 12+00 to 26+00. This will be important if permanent storage is desired above elevation 1290.

Borrow materials are available on site. Both the weathered and unweathered Niobrara marly shale will compact to slowly permeable fill. Previous testing of these materials is available for guidance. The Unified Soil Classification of the broken down shale can be ML, MH, or CH. The maximum standard compacted weight can vary from 85 to 97 pounds per cubic foot at optimum moisture of between 20 and 25 percent. The material is subject to shrinkage cracking and should be protected from excessive drying.

The glacial outwash and the alluvium will make good outer shell material for the fill. Adequate quantities of both materials are available on site within nominal hauling distance.



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DESIGNED BY: Sediment Control Str.	APPROVED BY: Sec. 28, 33, T.109N, R.61W.
CHECKED BY: Firesteel Creek	DRAWING NO: Figure 16
DATE: Davison County	SHEET 1 OF 1

Form SCS 315A (March 1957)

Firesteel Creek Structure

By:
Dwight Hale
Design Engineer 2/74

STRUCTURE DESIGN HYDROLOGY AND HYDRAULICS

Purpose:

(1) To proportion the proposed Firesteel Creek structure to perform the desired functions in the most efficient and safest manner consistent with the purpose and hazard class.

(2) To study the effects of the proposed structure upon the safety of the Lake Mitchell Dam.

Physical Conditions:

The drainage area (uncontrolled) above the proposed Firesteel structure is 511 square miles with a runoff curve number of 75 and a time of concentration of 53 hours. Lake Mitchell (3 miles downstream from the Firesteel structure) has an additional uncontrolled drainage area of 20 square miles. Structural dimensions are shown in the preliminary structural design report. A physical description of the watershed and stage storage data are included in the section on water supply hydrologic investigations.

Hazard Classification

To protect lives and property of downstream interests, and due to the geographical position of this structure in relation to Lake Mitchell, Class C (Soil Conservation Service Engineering Memo 27), high hazard classification was used for design purposes.

Rainfall Data

Due to the large size of the drainage area, and the hazard classification of the proposed structure, it was necessary to obtain rainfall estimates directly from the Special Studies Branch, Office of Hydrology of the National Weather Service. The rainfall amounts requested and provided are as follows:

PROBABLE MAXIMUM PRECIPITATION (PMP)
FOR 511 SQUARE MILE DRAINAGE AREA
FIRESTEEL CREEK, SOUTH DAKOTA

Storm Duration, Hours	Rainfall, Inches
6	15.4
12	17.1
24	19.0
36	20.2
48	21.2
53	21.6

The area reduction factor was reported to be 0.68 at 53 hours duration.

Firesteel Structure Hydraulics, Hydrology

Floodroutings (by computer using the RESIN program) were made on the proposed structure for a 100-year frequency rainfall (6.90 inches) and for the PMP rain (21.6 inches), both using 53-hour duration storms.

These floodroutings indicate that the proposed Firesteel reservoir will have little effect upon the peak rates of flow for these storms as the reservoir will store less than one inch of runoff from the watershed, and will be filled to capacity many hours before the peak inflow occurs. For this reason, large spillways must be provided. It is not feasible to construct a dam large enough at this site, to significantly redue the flood flows for rare storms.

It was further concluded that a 100-foot wide concrete chute spillway (25,000 cfs capacity) should be provided to carry the flow from a 100-year frequency storm. A 1,000-foot wide vegetated spillway (75,000 cfs capacity) around the south end of the dam would be needed to supplement the chute spillway in handling the peak flow from the PMP or freeboard storm. (See preliminary structural design report.)

Lake Mitchell Hydraulics, Hydrology

In the interest of safety and public responsibility the floodroutings were extended through Lake Mitchell to determine their effects upon the Lake Mitchell dam and spillway.

These routings indicated that Lake Mitchell is not safe for storms exceeding the 100-year frequency. The Firesteel structure would reduce the peak rates of flow for rare storms by less than 4 percent, and cannot be feasibly designed to provide significant additional protection.

By:
Dwight Hale
Design Engineer 2/74

FIRESTEEL CREEK STRUCTURE
PRELIMINARY STRUCTURAL DESIGN REPORT

The hydrologic studies resulted in the following proposed dimensions:

Top of dam - elevation 1315.0 M.S.L.
Height of dam - 45.0 feet
Length of dam - 3,000 feet
Vegetated emergency spillway - crest elevation 1308.0
Frequency of use of emergency spillway - less than once per 100 years
Width of vegetated emergency spillway - 1,000 feet
Capacity of vegetated emergency spillway - 75,000 cfs
Total storage volume to crest of emergency spillway - 19,000 acre-feet
Concrete chute principal spillway - crest elevation 1300.0
Width of concrete chute spillway - 100 feet
Capacity of concrete chute spillway - 25,000 cfs
Volume of temporary storage - 9,000 acre-feet
Volume of permanent storage - 10,000 acre-feet
100-year sediment storage - 4,000 acre-feet
Gated storage (excluding sediment) - 6,000 acre-feet
(sediment storage will be available for other uses in decreasing amounts)
Elevation of top of gated storage (including sediment) - elevation 1300.0

Permanent storage of 10,000 acre-feet (gated) including 4,000 acre-feet reserved for sediment, was selected as the largest feasible permanent storage consistent with the purpose of the structure. The 6,000 acre-feet of storage is needed to provide an adequate supplement water supply for the city of Mitchell. The storage reserved for sediment can be used for water storage until filled with sediment. (This fact was considered in the water supply hydrologic investigation.)

The geologic feasibility investigation combined with engineering design and soil mechanics reviews resulted in the following:

A reasonably well suited foundation is present at this site.

Although extensive additional soil sampling and testing will be required for final design, the design can be expected to be generally as follows: A cutoff trench (10-foot bottom width 1:1 side slopes) under the dam will be needed and should extend to the shale across the valley. This should be excavated and then backfilled with plastic, nonpermeable materials.

In the downstream portion of the dam, a gravel filled foundation trench drain should extend to elevation 1275.0 from Station 3+00 to 10+00 (see profile in geologic report - Figure 1G). This drain would relieve any build up of water pressure in the SM (silty sand) foundation material located in that area. Gravel drains will also be required under portions of the chute spillway to reduce uplift pressures.

The top width of the dam should be about 16 feet. Embankment fill slopes are estimated to be 3:1. Berms (15 feet wide) are estimated to be necessary on the upstream and downstream slopes at elevation 1285.0. Twelve inches of topsoil should be placed in the surfaces of the fill and all exposed soil needs to be seeded and mulched. (Ref: Typical Profile - Figure 5H)

Due to the orientation of the dam, with respect to prevailing winds, and the proposed operation of the dam (deep water with fluctuating water levels) 18 inches of rock riprap with 6 inches of gravel filter bedding will be required across the upstream face of the dam from elevation 1285.0 to 1306.0. An alternative may be to use the sandy materials in the emergency spillway borrow area to manufacture soil cement as a substitute for the riprap.

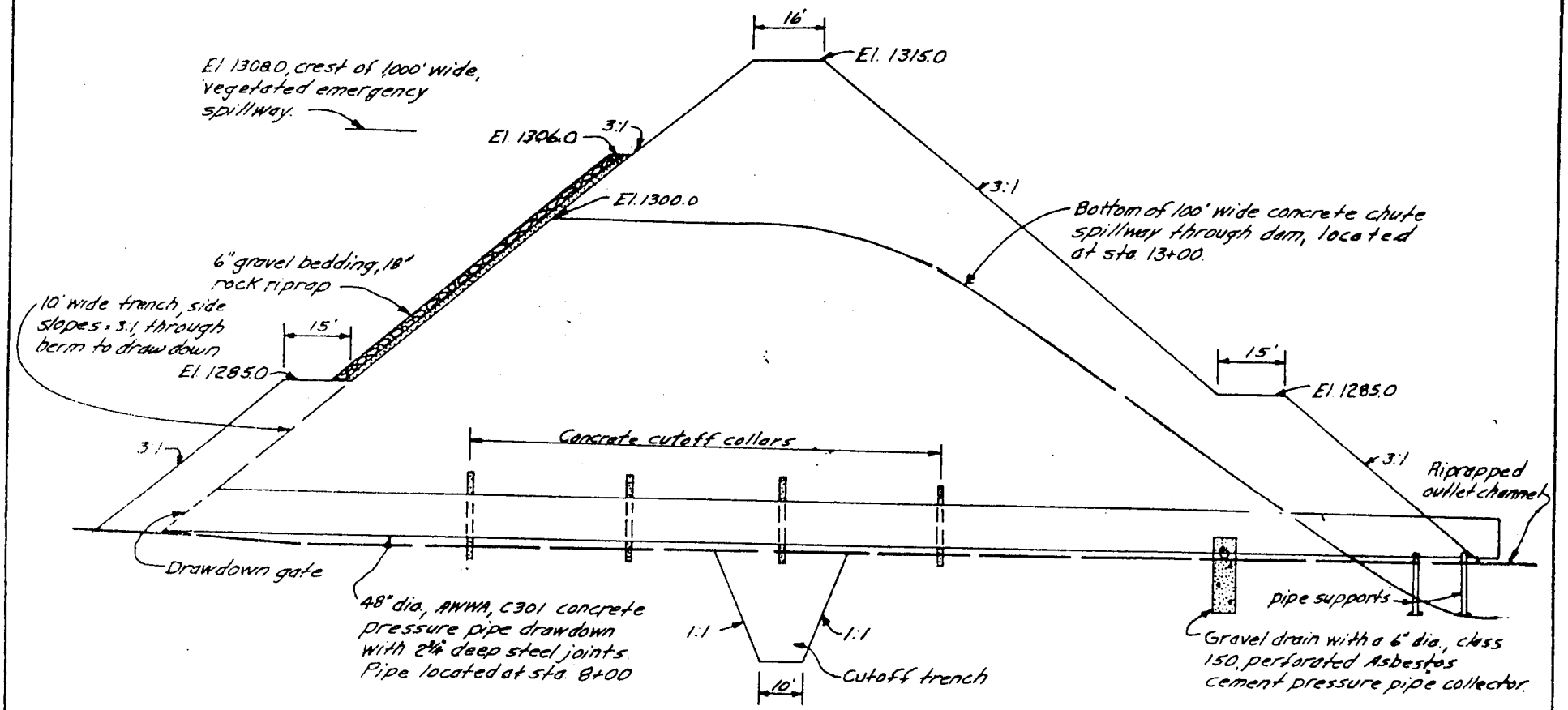
A 48-inch diameter reinforced concrete drawdown pipe is required (AWWA Specification C301 with 2-3/4-inch deep steel joints). This pipe will require four concrete antiseep collars, along with a concrete drawdown structure, steel trash rack, power operated slide gate, and concrete outlet support or an impact basin. This pipe would be located near Station 8+00.

The concrete chute principal spillway will require special design and exact dimensions cannot be provided at this time. It will be approximately 100 feet wide, with sidewalls extending up to 12 feet high. A concrete and riprap stilling basin of the SAF type will need to be provided at the outlet. The chute inlet is expected to be the straight, open type due to the very large flows encountered. It is recommended that this (chute) spillway be located near Station 13+00 to reduce the amount of fill and compressible foundation material under the spillway. It may be necessary to strip this area of the foundation to shale in order to assure firm support for the concrete. Concrete thickness can be expected to range from 10 inches at some points in the wall up to a few feet thick in the SAF basin floor, to control high uplift pressures at that location.

The earth emergency spillway would be located at the south end of the dam (in the gravel pit area). It would be 1000 feet wide and would contain flows up to 7 feet deep. However, this spillway would be used only for flows from storms exceeding a 100-year frequency. Materials excavated from this spillway can be used in construction of the dam fill. Any large amounts of gravel encountered may be used in the downstream portion of the dam.

The dam earth fill yardage based on the above dimensions is expected to be 250,000 cubic yards.

SD-ENG-42
2/73



TYPICAL PROFILE OF EMBANKMENT

NOT TO SCALE

FIRESTEEL CREEK STRUCTURE

Davison County, South Dakota

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date		
Designed	D. Hale P.E.	2-24	Approved by	
Drawn	D. Minsta	2-24	Title	
Traced			Title	
Checked			Sheet No. 1 of 1	Drawing No. Figure 5H

By:
Dwight Hale
Design Engineer 2/74

FIRESTEEL CREEK STRUCTURE
PRELIMINARY REPORT

CONCLUSIONS AND COST ESTIMATE

It is concluded that a safe stable structure can be constructed at the site selected without unusual and expensive remedial measures.

It is estimated that this dam could be constructed for approximately $825,000.00. (1974 prices - table of quantities and cost estimate, attached.)

The proposed structure will not offer flood protection for Lake Mitchell for storms larger than a 100-year frequency storm. Although 100-year level of flood protection is often considered as sufficient protection we feel that, due to the possibility of huge amounts of water (up to 500,000 acre-feet) and the duration (3 days) of high volume flows, extreme caution should be excercised in approving construction of dwellings and other valuable buildings in the flood plains between Lake Mitchell and the James River whether or not the proposed Firesteel structure is built.

The proposed structure would store 100-years of sediment yield from the drainage area, and would effectively increase the water supply to the city of Mitchell, and stabilize the water level in Lake Mitchell, in all but the very dry years (1931-1941). An alternate supply of municipal water will be needed for the very dry periods.

Report approved by:

David J. Tokach — Feb 22, 1974

State Conservation Engineer
David J. Tokach

Date

FIRESTEEL CREEK STRUCTURE

TABLE OF QUANTITIES AND COST ESTIMATE

Project Firesteel Creek Structure Cooperator City of Mitchell, SD

S & WCD Davison County Davison

Computations By: Dwight Hale, P.E. Date 2/74

Item No.	Item	Unit	Quantity	Unit Cost	Total Cost
1.	Mobilization	job	--	--	$ 5,000.00
2.	Excavation	c.y.	25,000	$ 0.60	$ 15,000.00
3.	Earth Fill	c.y.	250,000	$ 0.60	$150,000.00
4.	Concrete	c.y.	2,000	$ 175.00	$350,000.00
5.	Reinforcing Steel	lb.	200,000	$ 0.35	$ 70,000.00
6.	Riprap	c.y.	2,000	$ 20.00	$ 40,000.00
7.	Gravel filter bed for riprap	c.y.	500	$ 15.00	$ 7,500.00
8.	Gravel for drain	c.y.	1,000	$ 20.00	$ 20,000.00
9.	Class 150 Asbestos Cement Pressure Pipe 6" Dia.	ft.	1,000	$ 10.00	$ 10,000.00
10.	48" Dia. Reinforced Concrete Pipe	ft.	310	$ 80.00	$ 24,800.00
11.	Seeding, Fertilizing, Mulching	ac.	40	$ 300.00	$ 12,000.00
12.	[redacted], Safety Fence	job	--	--	$ 3,000.00
13.	Safety Signs				$ 100.00
14.	Drawdown Gate				$ 6,000.00
				Contingencies 15%	$107,000.00
				Total	$820,400.00
	Total Engineer's Estimate for Planning Purposes				$825,000.00

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 1357, Huron, South Dakota 57350

April 10, 1975

Mr. Robert Taylor
Chairman, Board of Supervisors
Davison County Conservation District
Box 141
Mitchell, South Dakota 57301

Dear Mr. Taylor:

In answer to your request as to the possibility of adding flood control and other benefits to the dam on Firesteel Creek, we submit the following information.

The preliminary report we prepared indicated this site has a potential for 10,000 acre-feet of permanent storage and 9,000 acre-feet of temporary storage. The 9,000 acre-feet of temporary storage does provide some protection from floodwaters. No monetary evaluation has been made of the effects of this temporary storage on floodwater damages.

In the 10,000 acre-feet of permanent storage, approximately 4,000 acre-feet will be occupied by sediments in about 100 years.

The 10,000 acre-feet of permanent storage (reduced to 6,000 acre-feet over 100 years) would be available to enhance the city's water supply in Lake Mitchell and thereby maintain the water level of Lake Mitchell. Maintaining the level of Lake Mitchell at near maximum would enhance the recreation potential of that lake.

Other effects of the proposed dam are:

1. The trapping of sediment in this structure will prevent the loss of depth and capacity of Lake Mitchell. (4,000 acre-feet over 100 years)

2. There will be a permanent loss of about 900 acres of agricultural land for the dam, spillway, and pool.

3. Marsh conditions will develop in the upstream portion of the pool which will provide habitat for wildlife.

4. The pool will provide drinking water and aquatic habitat for many species of wildlife and a resting area for migratory waterfowl.

5. Some production of waterfowl could be expected, particularly in the developing marsh area upstream.

6. It is anticipated this pool would be drawn down each summer; therefore it is not likely to develop a shoreline suitable for recreation.

   An annual draw down would also adversely affect the fishing potential of the pool. This would be mainly as concerns the shallow waters (3 feet to 8 feet) used as feeding and reproduction areas. Winter kill may also be a problem during years of severe draw down.

If you have any further questions, please let us know.

Sincerely,

V. W. Shally
State Conservationist

CONCLUSIONS

Water Quality Samples

Water Quality Standards

All of the tributary sample sites except Site #2 and #3 exceeded the state water quality standards at least once during the 1993 through 1995 tributary sample period. The water quality standard for temperature was exceeded twice at Site #1. The standard for fecal coliform was exceeded twice at Site #4 and once each at Sites #1, #5, #6, and #7A. The total suspended solids standard was exceeded three times at Site #1, twice at site #4 and once each at Sites #5, #6, and #7. The standard for dissolved oxygen was exceeded once at Site #7A. Many times the fecal coliform standard was exceeded at the same time as the suspended solids standard. This indicates agricultural run-off from concentrated feeding areas or livestock pasturing in riparian areas in the watershed.

Seasonal Water Quality

Typically, water quality parameters decrease in concentration as the volume of water increases because of dilution. In Firesteel Creek, intense summer rains not only increased the amount of water passing through the system, but also increased the concentrations. Either concentrated feeding areas or summer long pasturing are the most likely sources of increased nutrient concentrations.

Tributary Sampling

Sites #1 and #2 are the inlets to Lake Mitchell. Site #1 was located in a backwater situation. Due to the location of Site #1, suspended sediment loadings were underestimated by approximately 1/3. However, even using the inflated number, the sediment loadings to Lake Mitchell are extremely low (4 acre-feet/year). The fraction of phosphorus entering Lake Mitchell is largely dissolved (69% for Site #1 and 83% for Site #2). This is due in part to the low concentrations and loadings of suspended sediment. Although the loadings to Site #2 are small, the site is close to Lake Mitchell thus increasing its effect on the lake. Occasionally the site records high fecal coliform and high phosphorus concentrations.

Site #3 is the least impacted site in the watershed. The land slopes in the watershed are extremely flat and the riparian areas are well lined with vegetation. The concentrations are relatively low, and since very little water passes through the site, the loadings are also relatively low.

Site #4 receives water from both the east and west forks of Firesteel Creek. Site #4 is not in a back wash area like Site #1. Loadings from Site #4 were used to estimate the 4 acre-feet/year of suspended sediment stated above. High concentrations of phosphorus and suspended solids coincide with those at Site #6 more so than Site #5. Site #4 had high suspended solid samples which are probably coming from poor cropland management. The high phosphorus loads are