
SOUTH DAKOTA
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REPORT OF INVESTIGATIONS
No. 23

GEOLOGY
OF THE
CROW CREEK DAM SITE

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GEOLOGY OF THE CROW CREEK DAM SITE

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PURPOSE OF REPORT

The following report is the result of a question which arose as to the possibility of making a water-tight dam across the Valley of Crow Creek for the purpose of impounding an artificial lake. As the project involved the establishment of a construction camp of Civilian Conservation Corp laborers, the possibility of a failure in the dam was considered a serious one. At the request of the Governor, therefore, the State Geologist made an examination of the site with the results which are presented in the following report.

LOCATION AND TOPOGRAPHY

The proposed dam will be located in the extreme southwestern corner of Buffalo county near the middle of the eastern boundary of Township 106 N., Range 71 West. It lies across Crow Creek valley about three miles above its junction with the Missouri River. The city of Chamberlain, about 14 miles to the south, can be reached from the project over a good graveled highway, and Gann Valley, about 20 miles to the east, can be reached over good graded roads.

At the dam site, the Valley trends northward, but within a quarter of a mile bends to the west and south encircling a high

gravel flat which lies between the Missouri and Crow Creek Valleys, 60 or 70 feet above the stream channel. The western end of the dam abuts this terrace. The eastern end is to be anchored against the highland into which the valley has been cut.

The valley is characterized by very steep bluffs which, in places, become small cliffs. The bluffs are covered with gravel and cobbles to a depth of a foot or two. A short distance upstream, however, the bed rock is exposed. The valley floor is a flat, about a quarter of a mile in width, which is made of alluvium. Across this flat the stream has cut a trench about ten feet in depth which meanders from bluff to bluff across the entire valley.

GEOLOGY

Bed Rock:

The present Crow Creek Valley has been cut through an ancient, gravel covered terrace into the underlying bed rock. It has since been filled to a depth of 14 to 20 feet with material washed into the valley. Any consideration of the possible failure of a dam in this valley, therefore, must take in account these three geologic features, namely:- the gravel cap on the highland, the bed rock, and the alluvial fill.

This section of the valley may be considered as a large trough whose bottom and lower sides are composed of chalk rock above which lies a sticky, black, clay shale. The extreme top of the trough is made of gravel and sand.

The chalk rock which forms the bottom and lower portions of the valley bluffs belongs to the Niobrara Formation, which has the total thickness of about two-hundred feet in this vicinity. The valley has only cut a notch in the top of the formation, however, as it exposes less than thirty feet of the formation. The sticky shales which lie above the chalk rock belong to the basal portion of the Pierre Formation. This formation has a total thickness of about two-thousand feet, but less than forty feet of it is exposed in the bluffs at the Crow Creek dam.

A well drilled on the upper flat near the dam would encounter the following rock strata:-

Generalized Section at Crow Creek Dam

8-10	Sand and Gravel
20-30	Black Shale with White Clay (Bentonite Streak)
30 plus	Chalk Rock light near top, dark grey to black below.

The following sections, measured at the East and West ends of the dam, will indicate the bedrock against which the dam can be built by removing the top two or three feet of loose float material.

Section on East Bluff of Crow Creek
200 feet North of Dam Site

Feet

8-10 Gravel

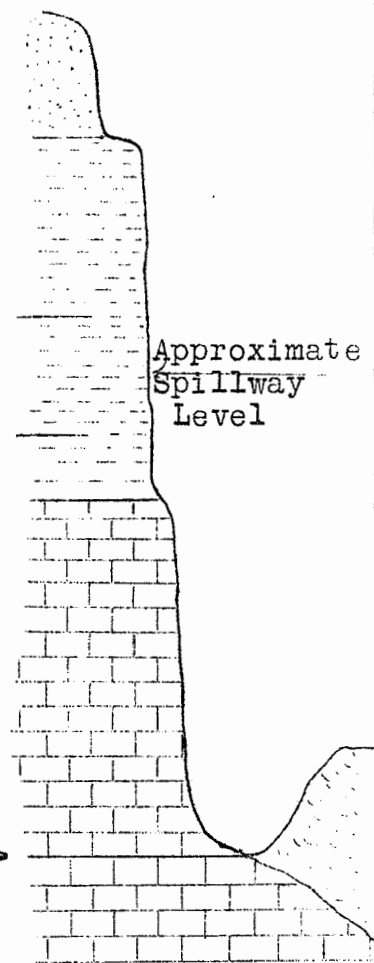
15 Shale. Gravel cover

10 Shale covered. Much gravel strewn on surface

5 Black Shale

30 Chalk

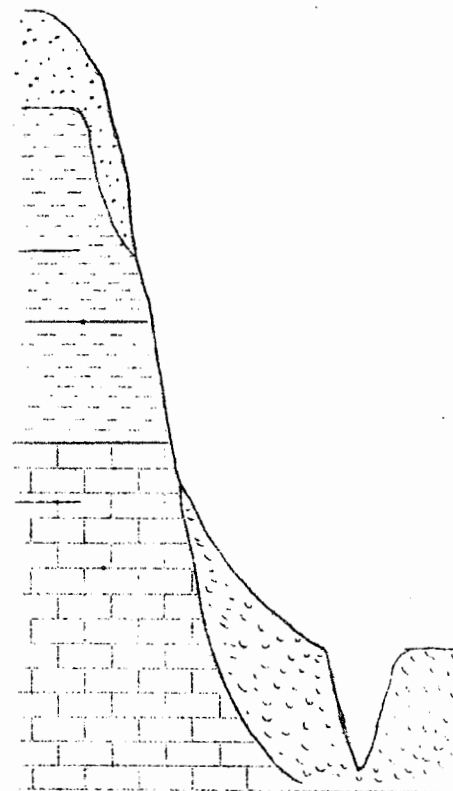
Water level in Crow Creek



Section on East Bluff of Crow Creek

200 feet South of Dam Site

Feet	
15-20	Covered. Gravel littered surface may be underlain with Shale. (Top of Shale 50' above base of this section in next valley South)
6	Black Shale, $\frac{1}{2}$ -1 inch Bentonite streak in the bottom
10	Black Shale
5	Weathered Chalk
23	Alluvium to the Water level in Crow Creek

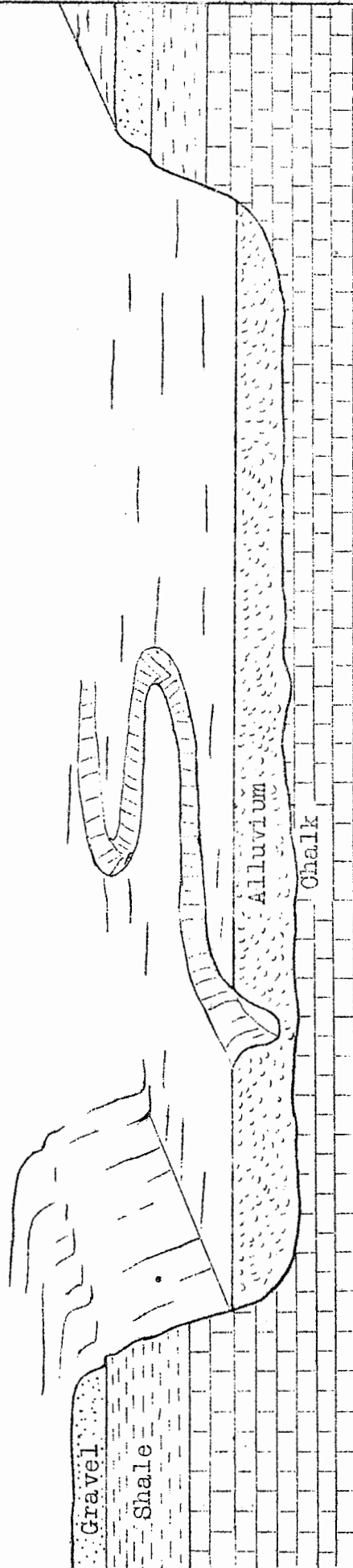


Cross Section of the Valley of

Crow Creek

at

Dam Site



Section on West Bluff of Crow Creek

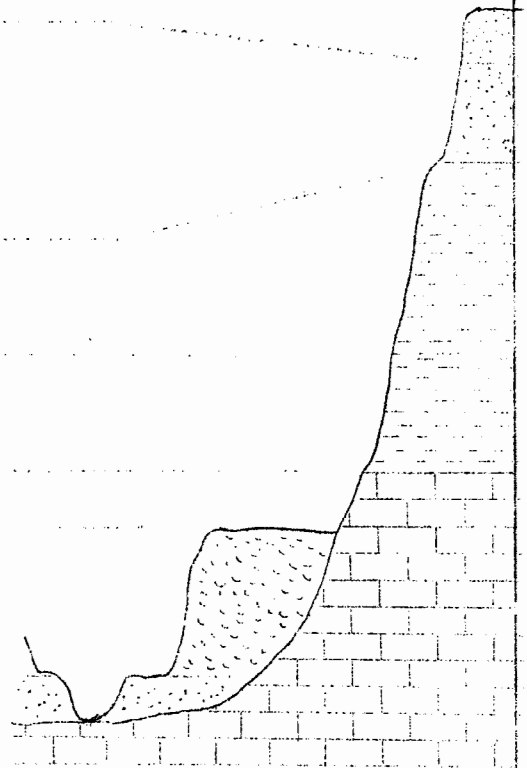
at

Dam Site

Exposure made by digging for core of Dam

Feet

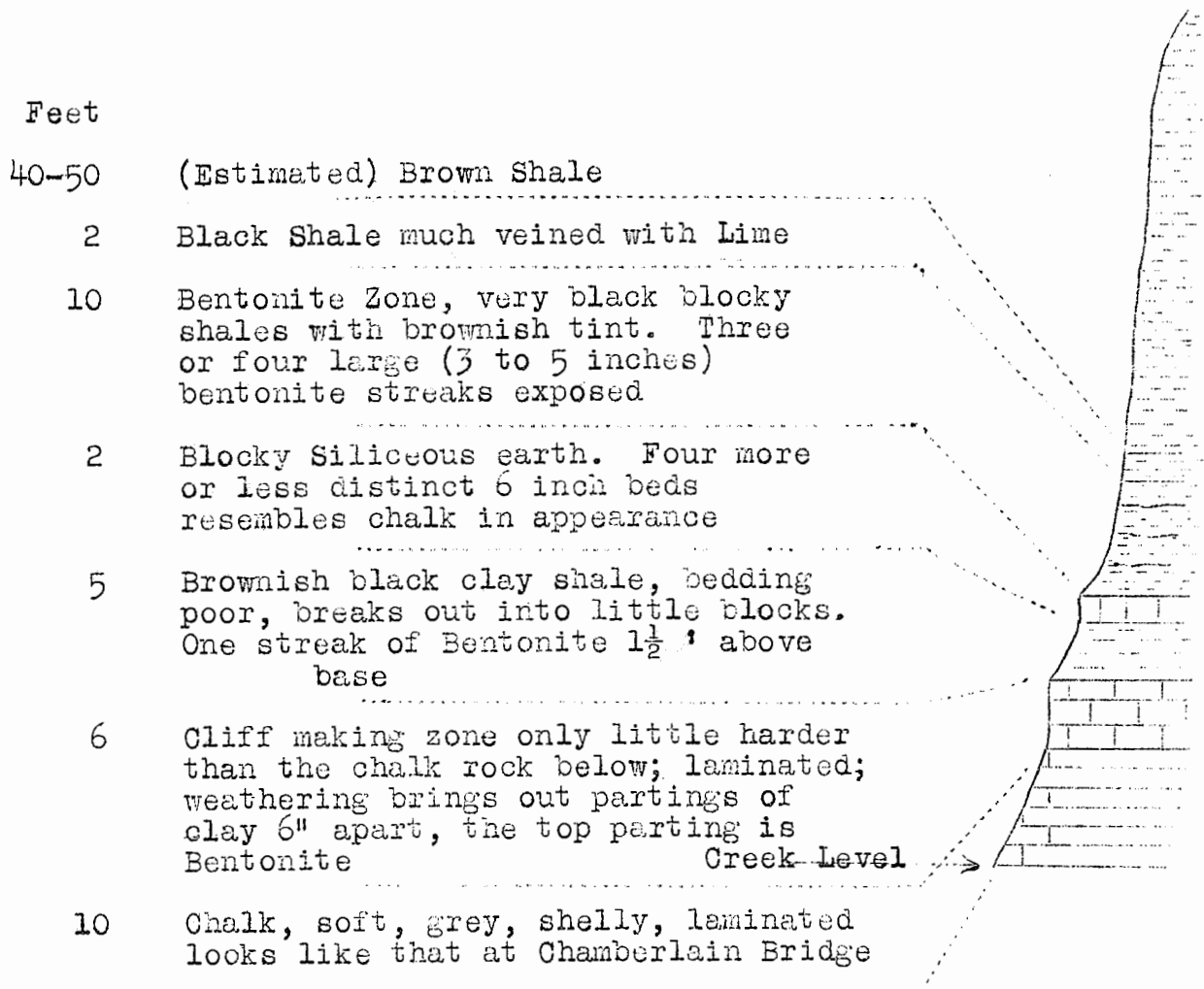
- 3-4 Silt Cover
- 8 Gravel and sand, upper half fine medium sand, lower half coarse gravel pebbles 2-6" in diameter mixed with finer gravel and sand. Much red color due to oxidized iron
- 16 Black Shale, heavy and sticky typical "fish scale zone" shale
- 10 Calcareous grey shale
- 5 Chalky Alluvium
- 12 Heavy Clay Alluvium with lenses of coarse dirty gravel
- 4 Coarse Gravel, giving much water which contains: wood, clam shells, and mammal teeth in the bottom. Bottom foot or so is stiff sandy muck with many black streaks. Evidently an old swamp
- Chalk rock exposed in the bottom of the hole



Section on West Bluff of Crow Creek

$\frac{1}{2}$ Mile South of Dam

Good exposure due to undercutting by Crow Creek



The Gravel Terraces:-

These gravel terraces have been mentioned in the report on Topographic Features. They are apparently a part of a sheet of gravel which once stretched across the entire site of the present Crow Creek Valley and were deposited by glacial waters flowing from an ice front which lay to the east. The present valley was cut through this gravel sheet into the underlying bedrock leaving remnants of the ancient gravels as terraces high above the present valley flats. Gravel terrace remnants on the west side of the valley lie 50 feet above the flat, while on the east side they are only 30 feet above it due to the original westward slope of the gravel sheet.

Most of the terraces are small affairs, the one west of the dam site being the largest. It lies between Crow Creek Valley and the valley of the Missouri River into which the waters from the ancient ice sheet must have discharged and covers an area of approximately a square mile. Its lower part shows a coarse gravel mixed with some sand, grading upward in poorly sorted beds, to medium and fine sand which occupies the upper half of the deposit exposed at the dam site. This exposure shows a thickness of eight feet of this material. The gravels are covered with three or four feet of fine river silt.

The Valley Fill:-

The channel of Crow Creek and the trench which had been cut for the core of the dam at the time this investigation was made, gave excellent exposures of the alluvial fill in the bottom of

the valley. Most of the fill is composed of soil, sand and gravel washed into the valley by rainstorms and floods and consequently represent the materials found on the bluffs and in the upper drainage basin of Crow Creek. The deepest part of the trench had reached bedrock exposing the following material:-

Section in Crow Creek Valley Fill

200-300' from West Bluff at

Dam Site

12 feet	Black clay loam, formed of soil washed from valley bluffs
4	Coarse sand and gravel containing considerable water
$\frac{1}{2}$ -1	Dark grey to black sandy muck with clam shells, fresh wood, and mammals teeth
-	Chalk rock

Farther east the black soil fill contained a large lens of dirty sand, a score of feet in length and 6 to 8 feet thick at its widest part. At other places in the ditch, small lenses of sand and shelly pieces of chalk were visible. These patches, however, are all small and detached and do not form continuous beds. Altogether they make only a small fraction of the total volume of the fill.

SUGGESTIONS FOR SEALING THE DAM

Seepage through the Bedrock:-

An earthen dam properly constructed across this valley should hold water without serious leakage. Neither the chalk nor the shale of the bedrock is of such character as to allow water to pass through readily. The chalk rock is not cavernous and the only leaks which could occur would have to be through joints and small crevices. These are extremely small and very well sealed however, and offer little chance for water to escape. It may be of interest, for purposes of comparison, to note that the dam across Fire Steel Creek at Mitchell is built on chalk rock and has been holding the ponded water satisfactorily.

The shales lying on the chalk are the most impervious of rocks and offer no chance whatever for serious water leakage.

Seepage from Terrace Gravels:-

The gravels on the high terraces will allow a seepage of any water ponded against them. This seepage would move westward and might cause springs and possible slumps and cavings on the western and northern sides of the terrace. Such difficulties will not be encountered in the proposed construction because the base of the gravel lies 30 feet above the valley flats and is above the proposed water level. The water behind the dam therefore, will be contained in a basin formed entirely of chalk and shale bedrock already described, thus eliminating the high gravels as a source of water loss.

Seepage through the Valley Fill:-

From the forgoing it will be seen that the valley fill offers a better chance for seepage than the bedrock. It contains considerable amounts of sand and gravel in beds and lenses. To offset this however, at least four-fifths of the fill is clay and clay loam which allows very little water to pass through. The only chance for a continuous bed of sand or gravel which might carry water under the dam would be in the bottom of the fill in the deepest part of the valley. The 12 feet or more of clay exposed across the entire valley would tend to steal off any such sand, from the lake water above it. So that even if such a sand existed it should not offer a serious obstacle.

It is worthy of note that the basal sand which was exposed at the time of this investigation furnished only a small amount of water. The hole, approximately 10 feet across and penetrating 4 feet of sand, was kept dry with an ordinary hand pump. None of the smaller lenses exposed in the trench furnished water. It is probable that a dam built on the top of the valley fill would hold water satisfactorily. One which was well sealed into the bedrock of the bluff and to the bedrock beneath the alluvial fill has little chance for an excessive leakage.