THE GEOLOGICAL SURVEY OF WYOMING

GEOLOGIC REPORT ON THE UPPER SUNSHINE BASIN DAM SITE, PARK COUNTY, WYOMING

by

S.H. Knight, R.H. Beckwith, J.D. Love, and G.L. Hurwitz

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LOCATION

The area discussed in this report is located on Sunshine Creek approximately twelve miles southwest of the town of Meeteetse, Park County, Wyoming. The site of the proposed dam is in the eastern part of the NW. $\frac{1}{4}$ sec. 12, T. 47 N., R. 102 W., 6th Principal Meridian.

SCOPE OF THE REPORT

This report is concerned primarily with the geology of the site of the proposed dam and the parts of the valley of Sunshine Creek and the adjacent divides which are close enough to the dam site to be pertinent to the subject of the feasibility and safety of the proposed dam. No inspection of the diversion dam site on Greybull River nor of the course of the proposed canal from the river to Sunshine Basin was made. The sites of the spillway and end of the inlet canal were visited. A reconnaissance around the edge of the reservoir site was made to ascertain whether there would be any possible leakage from the reservoir.

FIELD AND LABORATORY WORK

The work on which this report is based was done for the Greybull Valley Irrigation District. Field work was carried on from April 17th to April 30th, 1935. Laboratory work and drafting of maps occupied the time between May 2nd and May 14th, 1935.

Before the beginning of field work on the accompanying geological map (Pl. I) a base line with elevations carried up from a U.S. Geological Survey bench mark on Wood River had been established at right angles to the axis of the proposed dam by George Donnell, resident engineer. At 200-foot intervals along the base line he placed lines of stakes spaced 100 feet apart at right angles to the base line. The elevations of the stakes were determined by Mr. Donnell. In the preparation of the geological map with plane table and telescopic alidade the elevation stakes were used as control points.

TOPOGRAPHY AND DRAINAGE

Sunshine Creek rises on the eastern flanks of the Absaroka Mountains, flows northeastward across an area of gently folded beds of the Cretaceous Cody shale and Mesaverde sandstone, and enters the Greybull River approximately $5\frac{1}{2}$ miles northeast of the dam site. The creek has a meandering course, carries little water and is only a foot or two wide at the dam site. The stream valley is broad on the soft Cody shales and narrow on the resistant Cody and Mesaverde sandstones. The dam site is located at a constriction in the valley where Sunshine Creek passes from soft shales onto hard sandstones in the upper part of the Cody. Southwest of the dam site is a broad basin, the reservoir site, bounded on the east and west by escarpments of resistant sediments and on the north by the broad, low shale divide between Sunshine Creek and Papapaw Creek, a small tributary entering the Greybull River above Sunshine Creek. To the south of the reservoir-site basin is a broad, gently rolling shale divide separating Sunshine Creek from Wood River.

At the dam site Sunshine Creek flows on a flood plain approximately 200 feet wide. Some 20 feet above the flood plain on both sides of the valley are terraces, which are covered almost to their edges by alluvial fans, whose heads are at the bases of sandstone cliffs up to 50 feet high. (Pl. III) Approximately 700 feet north of the dam site is a dry gulch (Pl. IV) which enters Sunshine Creek about 1,000 feet below the dam site.

GEOLOGY OF THE DAM SITE

Cody formation. The stratigraphic succession of the Cretaceous sediments given below in Table I and in Plate II was measured along the low divide north of the reservoir and dam sites by the Brunton clinometer method described by Lahee*. It is not known just where the boundary between the Cody and Mesaverde formations should be drawn in this succession. Since the question of the exact age of the strata is of little consequence in the matter of the feasibility of a dam, the whole of the succession is arbitrarily assigned to the upper part of the Cody formation. Most of the sequence consists of shales. Sandstones attain importance only near the top.

TABLE I

Stratigraphic Succession of the
Upper Part of the Cody Formation near the Sunshine Dam Site

	Thickness in feet
SANDSTONE #6 Gray to buff coarse massive and cross-laminated sandstone. Forms cliffs along both sides of the valley. Outcrop has honeycomb structure......	39
Gray shaly sandstone and some soft gray shale bands	38
Hard flaggy buff sandstone	1
Thinly laminated gray shaly sandstone	6

* Lahee, F.H., Field Geology. McGraw-Hill Book Co., 2nd ed., 1923. pp. 369-72.

Table I - continued

Fissile flaggy sandstone, buff on weathered surface, gray on fresh surfaces	3
Gray shaly soft sandstone	6
Very fine-grained hard flaggy buff sandstone	4
Gray shaly soft sandstone	6
<u>SANDSTONE</u> #5 Very hard buff thin-bedded fine-grained flaggy sandstone, which is so resistant it forms ledges wherever it outcrops	2
Very soft gray shale containing numerous beds of hard thinly laminated buff flaggy sandstone at intervals of about 6 feet	28
Buff thinly laminated flaggy hard sandstone	2
Thinly laminated soft gray shaly sandstone	6
Hard buff fine-grained flaggy sandstone forming ledges wherever it outcrops	1
Soft gray shaly sandstone	2
Hard buff flaggy sandstone	1
Soft fissile fine white sandstone	6
Thin-bedded soft sandstone with gray shale beds. The sequence is about half sandstone and half shale	18
Buff hard thinly laminated fine sandstone	$\frac{1}{2}$
Gray finely laminated thin shales and soft thin fine-grained sandstones	63
<u>SANDSTONE</u> #4 Fine fissile cross-laminated white sandstone	1
Thinly laminated gray sandy shale	$1\frac{1}{2}$
Thin very fine fissile sandstone, gray in color, very finely cross-laminated	$\frac{1}{2}$
Fissile gray shale with numerous soft thin sandy zones	51
<u>SANDSTONE</u> #3 Gray to buff sandstone. Fine-grained moderately bedded sandstone of varying hardness. Predominately thick soft cross-laminated sandstones, gray in color, capped by thin beds of gray to buff sandstone	38
Gray sandy shales and numerous buff and gray inconspicuous sandstones	70
Buff platy sandstone, hard but not conspicuous	2
Gray sandy shale	5
<u>SANDSTONE</u> #2 Hard platy sandstone, buff on weathered surfaces, gray on fresh surfaces	1
Sandy gray shale, more sandy near top	78
Lenticular buff sandstones and small limestone concretions which are not numerous	2

Table I - continued

Interbedded gray to buff sandstones with gray shales. Sandstones are soft and seldom more than one foot thick	25
Gray shale with a few lenticular gray to white soft sandstones at irregular intervals	245
SANDSTONE #1 Soft gray to buff slabby sandstone interbedded with lenticular irregular shaly bands	16
Light gray shale becoming lighter and more sandy at the top	405
Very soft white sandstone	6
Gray shale	107
Soft slabby gray sandstone containing small limestone lenses and concretions	8
Gray sandy shale, more sandy near top	112
Buff slabby cross-laminated sandstone with limy concretions. This member is probably of local extent	4
Buff to gray sandy shale	19
Buff slabby fairly hard sandstone containing gray limy lenses ...	3
Gray sandy shale containing considerable soft sandy material and some thin gray sandstones	112
Gray sandy shale with numerous thin lenses of sandstone one inch or more in thickness	250
Gray arenaceous shaly limestone containing abundant *Baculites* sp.	2
Gray shale	1
Impure shaly gray limestone containing numerous *Baculites* sp. ...	1
Gray shale	8
Gray finely laminated sandstone	1
Gray sandy shale	6

Base of section probably near middle of Cody formation.

Total thickness measured 1,813½

The upper part of the Cody in the vicinity of the dam site is on the northeast flank of an anticline. The beds have a constant strike of N. 32° W. and a dip of 9½° to the northeast. There is no evidence of faulting.

Wind River formation. The valley which Sunshine Creek cut through the Cody formation was at one time deeper than at present at the dam site and for at least a quarter of a mile downstream and half a mile upstream.

In very late Cretaceous time or early Eocene time the edges of the folded Cretaceous beds were truncated by erosion and a valley was cut along the course now followed by Sunshine Creek. During the Wind River epoch of the Eocene, red, white, brown and greenish thickly bedded clays and sandy clays (Pl. V) were deposited in the valley. Part of the sediments were undoubtedly derived from the erosion of the Cody shales and sandstones and the Mesaverde sandstones. It is probable that the rest of the material is a very fine wind-transported ash. The thickness of the Wind River is unknown.

The contact between the Wind River and the underlying Cody is well exposed in the creek bottom approximately 3,500 feet upstream from the dam site. Here the basal beds of the Wind River consist of a foot or two of conglomerate containing pebbles up to an inch in diameter. The matrix of the conglomerate at this exposure is, however, a fine sandy clay similar to the rest of the Wind River. Consequently the perviousness of the conglomerate is probably very low. No other beds of conglomerate or clean sand were found. The Wind River beds have not been folded. Any low dip which they may now have is the result of the slope of the original deposition surface.

Five samples of Wind River sediments were collected from pits and clean outcrops. Some of them were reduced in the field by rolling on a cloth and quartering. In the laboratory the samples were further reduced by quartering. In the cases of large samples the material was put through a 3-mesh screen before the reduction to approximately 5-pound size and, in all cases, the material was put through an 8-mesh or smaller screen before quartering out a sample of approximately one pound. The one-pound samples were dried and the mud lumps were broken down by rolling on a board with a wooden roller until most of the material passed through a

20-mesh screen. A sample of 50 grams was shaken through a set of Tyler standard screens of the following mesh and opening sizes:

Meshes to the inch	Opening (inches)	Opening (mm.)
8	.093	2.362
10	.065	1.651
14	.046	1.168
20	.0328	.833
28	.0232	.589
35	.0164	.417
48	.0116	.295
65	.0082	.208
100	.0058	.147
150	.0041	.104
200	.0029	.074

The material was shaken through by hand with aid of iron washers in the screens. No set time of shaking was used. The process was continued with each succeedingly smaller screen until no fines could apparently be produced by rolling the material in the sieve between the finger tips. The results are given in Table II.

TABLE II

Mechanical Analyses of Wind River Sediments

% of Size	No. 2	No. 3	No. 5	No. 8	No. 10	Mean of 5 analyses
+ 8	0	0	0	0	0	0
8 - 10	0	0	0	.02	0	.004
10 - 14	.02	.15	.04	.02	0	.046
14 - 20	.22	.94	.52	.08	.04	.36
20 - 28	1.06	1.86	.68	.58	.36	.908
28 - 35	.98	.80	.78	.06	.14	.552
35 - 48	.64	.24	.32	.80	.56	.512
48 - 65	.18	.98	.54	.30	1.80	.76
65 - 100	13.26	13.52	6.70	9.22	16.02	11.744
100 - 150	13.02	5.70	15.02	9.36	18.80	12.38
150 - 200	16.28	9.38	12.60	16.60	20.62	15.096
- 200	52.92	64.44	60.82	62.28	40.76	56.244
Sum	98.58	98.01	98.02	99.32	99.10	98.66
Mechanical loss	1.42	1.99	1.98	.68	.90	1.394

No. 2. Composite sample taken by cutting a vertical groove 2" wide and 1" deep from the wall of pit I from a depth of 6' to the bottom of the pit at 11'. Gray to buff Wind River derived from Cody.

No. 3. Composite sample taken by cutting a vertical groove 2" wide and 1" deep from the wall of pit L from a depth of 5' to the bottom of the pit at 10'. Unweathered Wind River clay.

No. 5. Composite sample taken along an outcrop on the north side of Sunshine Creek 110' S. 48° E. from pit W. A double handful was taken every foot through 13' of thickness. The section consists principally of red clay with thin irregular streaks of yellowish-brown sandy clay. The red clay makes up 80% to 90% of the beds exposed.

No. 8. Composite sample taken by cutting a vertical groove 2" wide and 1" deep from the wall of pit G from a depth of 2½' to a depth of 9'. Wind River clays and sandy clays. The upper 2½' of material in the pit is alluvium.

No. 10. Yellowish-brown sandy clay taken from a band of not more than 2" thick in the lower part of the outcrop of Wind River from which No. 5 was collected.

With the exception of the conglomerate at the base of the Wind River and of No. 10, which was picked to obtain the coarsest sandy material seen in the Wind River, all of the samples contain more than 50% in the -200 mesh (-.074 mm.) fraction. Although no classification of material smaller than .074 mm. was made, the mechanical analyses of the Wind River sediments are very closely similar to the analyses given by Hatch* for the puddle core materials in the Garza, Sherman, Wichita, and Cobble Mountain hydraulic-fill dams. It is concluded that the perviousness of the Wind River sediments is extremely low.

Quaternary Alluvium. A terrace has been cut on the surface of the Wind River approximately 20 feet above the level of the present flood plain of Sunshine Creek. The terrace is well developed on the south side of

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* Hatch, Harry H., Tests for hydraulic-fill dams. Trans. Am. Soc. Civ. Eng., Vol. 99, 1934. Diagram p. 225.

the creek approximately 1,000 feet upstream from the dam site. In the narrower part of the valley the terrace is covered almost to the edges of the flood plain by laterally merging alluvial cones, which have their heads at the bases of the cliffs on both sides of the valley. It is possible that some of the material in the deeper parts of the cones interfingers with the Wind River. If this is the case, some of the alluvium may be as old as the typical Wind River, although the material on the present surfaces of the cones is Quaternary in age. There are no stream-assorted and stream-deposited gravels on the terrace and there is no indication of water-deposited gravel along the contact between the Wind River and the alluvium. Pit G penetrates two and a half feet of alluvium, beneath which is a distinct erosion surface, which is not marked by gravels. Beneath the erosion surface the pit has penetrated 8½ feet of gray sandy clays of the Wind River formation.

The alluvium is a buff to gray sandy clay which, in some places, has no large rock fragments. In other places, it contains lenticular beds of angular slabby sandstone fragments, up to six inches across, tightly embedded in sandy clay. The lenses of coarse material are not more than a few inches thick and pinch out laterally into typical fine alluvium The angular material constitutes less than 15 per cent of the alluvium in all exposures seen. The lenticular character of the coarse material and the fact that the spaces between fragments are tightly filled with sandy clay make it probable that the perviousness of the alluvium as a whole, or even that of the blocky bands, is not much greater than the perviousness of the sandy clay.

The alluvium below a depth of several feet is very well consolidated.

Pits up to 17 feet deep with vertical walls had been left open for several weeks before the geological examination was made. The walls showed no signs of caving. A few feet from the creek at a place which would come beneath the dam there is a natural vertical face twelve feet high. The lowest two feet are undercut. The horizontal surface above the face shows no sign of fractures.

The laboratory procedure for the mechanical analysis of the five samples of alluvium considered in the table below was the same as that used for the Wind River sediments, except that the large rock fragments were thrown out and an estimate made as to the relative volumes of the rock fraction and the volume of the total sample.

TABLE III

Mechanical Analyses of Quaternary Alluvium

% of Size	No. 1	No. 4	No. 6	No. 7	No. 9	Mean of 5 analyses
+ 8	.31	0	0	.10	0	.082
8 - 10	.85	0	.02	.12	0	.198
10 - 14	.85	0	.04	.10	.02	.202
14 - 20	.67	.10	.30	.58	.12	.354
20 - 28	1.09	.32	.78	2.06	.16	.882
28 - 35	.77	.42	.08	.48	.10	.370
35 - 48	.19	.36	.56	.36	.74	.442
48 - 65	1.05	.70	.34	.40	.38	.574
65 - 100	22.65	5.54	9.00	9.78	5.98	10.590
100 - 150	15.85	9.70	12.50	11.30	11.82	12.234
150 - 200	13.35	18.18	12.38	16.54	19.90	16.070
- 200	40.60	64.06	63.40	56.44	60.16	56.932
Sum	98.23	99.38	99.40	98.08	99.38	98.894
Mechanical loss	1.77	.62	.60	1.92	.62	1.126

No. 1. Composite sample taken by cutting a vertical groove 2" wide and 1" deep in the side of pit K from the surface to a depth of $7\frac{1}{2}$'. The pit, which is located 50' south of a shale outcrop, penetrates two feet of Cody shale. No sandstone fragments thrown out.

No. 4. Composite sample taken by cutting a vertical groove 2" wide and 1" deep in the side of pit L from the surface to a depth of 5'. No sandstone fragments thrown out.

No. 6. Composite sample taken by cutting a vertical groove 2" wide and 1" deep in the side of pit P from the surface to the bottom of the pit at 14' depth. Sandstone fragments up to 2" across, which make up approximately 5% of the sample, were thrown out before analysis.

No. 7. Composite sample taken by cutting a vertical groove 2" wide and 1" deep in the side of pit F from the surface to the bottom of the pit at 15' depth. Sandstone fragments up to 2" across, which make up 10% to 15 % of the sample, were thrown out before analysis.

No. 9. Composite sample taken by cutting a vertical groove 2" wide and 1" deep in the side of pit M from the surface to the bottom of the pit at 13' depth. Sandstone fragments larger than 3-mesh, which make up approximately 2% of the sample, were thrown out before analysis.

The mechanical analyses of the alluvium covering the Wind River formation and the upper part of the Cody near the dam site are closely comparable to the mechanical analyses of the Wind River sediments. Although no classification of material smaller than .074 mm. was made, the mechanical analyses of the alluvium are also similar to the analyses given by Hatch* for the puddle core materials in the Garza, Sherman, and Cobble Mountain hydraulic-fill dams. It is concluded that the perviousness of the Quaternary alluvium is extremely low.

Thickness of the alluvium and Wind River at the dam site. Table IV below was compiled from field notes to summarize data provided by test pits dug in the alluvium and Wind River and, in some cases, into the Cody shale. The pit letters are so arranged that they fall in rough order from south to north along cross-section AB, Plate I, and in the same order along cross-section EF, Plate I.

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* op. cit. Diagram p. 225.

TABLE IV

Notes on Test Pits

Cross-section AB, Plate I	
Pit	Notes
A	Alluvium 4' thick. Bottom in Cody shale.
O	8' deep. Alluvium 5' thick. Bottom in Sandstone #3 of Cody.
B	Begins in gully 3' deep. Depth 16'. Total depth 19'. Alluvium to depth of 14'. Beneath alluvium is an erosion surface. Beneath this is 5' of gray sandy clay containing Cody shale fragments. Probably Wind River. Cody not reached.
P	14' deep. Entirely in alluvium.
G	11' deep. Upper $2\frac{1}{2}$' alluvium. Lower $8\frac{1}{2}$' Wind River. Cody not reached.
C	2' deep in Wind River. Pit located on creek flood plain. Struck water. Cody not reached.
L	9' deep. Upper 5' alluvium. Lower 4' Wind River. Cody not reached.
I	11' deep. Wind River. Cody not reached.
D	In draw 8' deep. Total depth below general surface 25'. All in alluvium. Cody not reached.
F	15' deep in alluvium. Cody not reached.
N	14' deep in alluvium. Cody not reached.
M	13' deep in alluvium. Cody not reached.
H	In draw 10' deep. Pit 17' deep. Pit bottom in fresh Cody shale. Thickness of alluvium 27'.
J	17' deep in alluvium. Cody not reached.
K	10' deep. $7\frac{1}{2}$' of alluvium. Bottom in Cody shale.
E	10' deep. Sandstone #3 of Cody in bottom.
S	0' to 7' deep. Entirely in Cody above Sandstone #4.
T	0' to 10' deep. Entirely in Cody shale.

Table IV - continued

Cross-section EF, Plate I	
Pit	Notes
Y	7' deep in draw filled with talus from a sandstone above. Cody shales exposed 50' to the west.
X	7' deep. Upper 5' alluvium. Lower 2' in Cody shale.
Z	14' deep in alluvium. Cody not reached.
W	3' deep in Wind River. Pit located on creek flood plain. 1' of water in bottom. Cody not reached.
V	20' deep in alluvium. In bottom there are fragments of sandstone and shale. Bottom probably close to Cody shale.
U	2' deep. 6" alluvium on surface. Bottom in Cody shale.
Q	0' to 4'. In Cody shale.

The alluvium and Wind River filling the valley thicken from zero at the bases of the cliffs to some 20 feet to 30 feet approximately halfway from the cliff bases to the terrace edges. None of the pits have penetrated more than two feet below the level of the water in Sunshine Creek. Test borings were made by L. G. Carpenter, reportedly about 1919, on the flood plain of the creek approximately 1,200 feet upstream from the position of the axis of the proposed da m. His map gives logs of the borings which are rather difficult to interpret. It is taken that such terms as "stiff clay" and "clay" refer to Wind River sediments and such terms as "sand rock" and "shale rock" refer to material in the Cody. If this is the case, the borings indicate that there are some 10 feet to 15 feet of Wind River sediments lying on the Cody beneath water level in Sunshine Creek.

STRENGTH OF THE ROCKS BENEATH THE PROPOSED DAM

The Cody shales and sandstones which pass beneath the Wind River and alluvium at the dam site and form the upper walls of the valley are well consolidated sediments strong enough to support an earth dam.

The Wind River and alluvium are the materials from which an earth dam would necessarily be built, since they are the only loose materials available in the vicinity. They are considerably stronger than the material in the dam would be for the first few years, since the Wind River and alluvium in place have had a long time for consolidation. Nevertheless any works, such as outlets through the dam or through Wind River or alluvium beneath the dam, should be designed to take care of any slight settling of these sediments caused by the weight of the dam.

POSSIBLE LEAKAGE FROM THE RESERVOIR SITE AND AROUND OR BENEATH THE PROPOSED DAM

The rocks beneath the reservoir site and the broad divides north and south of the reservoir site consist almost entirely of impervious shales. Sandstone #1 and Sandstone #2 extend from within the reservoir site through the divide northward into the valley of Papapaw Creek. Sandstone #1, a 16-foot bed of soft sandstone containing shale lenses, is covered by alluvium within the reservoir site except for a vertical distance of approximately 30 feet below high water level. Water moving laterally through this bed would have to travel approximately 500 feet to find an exit below high water level on the north side of the divide. Some slight loss of water through this bed could be anticipated with the reservoir filled to capacity, but there is no possibility of piping through the bed. Since the outcrop of Sandstone #1 is near the inlet ditch, migration of water through the bed would be lessened by silting up of the pores.

Sandstone #2 is only a foot thick and the distance which water would have to travel laterally to escape is even greater than in the case of Sandstone #2.

Sandstone #3, a soft porous sandstone 38 feet thick, crops out in the reservoir site below high water line west of the dam site both north and south of the creek. From the exposure north of the creek the edge of the bed extends diagonally down the valley side beneath the alluvium and Wind River sediments and crosses the valley at the dam site. From here the edge extends diagonally back up the south hillside beneath the Wind River and alluvium to the outcrop on the south hillside. If the cover were stripped off, the outcrop of Sandstone #3 would be a band of the shape of a V with its apex at the dam site and pointing downstream. Since there were no test pits sunk through the sediments beneath the flood plain at and downstream from the axis of the dam, it is not known exactly where the bed crosses. Assuming that the thickness of the sediments beneath the flood plain is 10 or 15 feet, (Cross-section CD, Pl. I) the bottom of Sandstone #3 would cross beneath the axis of the dam and the top near the downstream toe.

Most of the edge of the bed is covered by the alluvium and Wind River within the reservoir site. There are, however, outcrops beneath high water line. Water could enter these, migrate along the bed and come up near the downstream toe. To prevent this it is recommended that all outcrops of Sandstone #3 below high water line be adequately covered with impervious clay or sandy clay and that this covering be protected so that it could not be removed by wave action. In the selection of borrow pit sites, care should be taken to place them so that the edge of Sandstone #3 would not be uncovered nor the natural cover on it be reduced in thickness.

Sandstone #4, a soft fine cross-laminated sandstone 1 foot to 3 feet thick and higher in the succession, makes the same type of V in crossing the valley. The apex of the V is at least 800 feet downstream from the axis of the dam. Any leakage through this bed would be through the rock walls at the ends of the dam and not present the same type of problem as that of Sandstone #3. Leakage can be prevented by the same method as that proposed for Sandstone #3.

Some parts of the floor of the gulch north of the dam site (Pl. IV) are below the reservoir high water level. The gulch is, however, cut into sandstone beds which lie higher in the succession than those which crop out in the reservoir site. No leakage from the reservoir site through the narrow divide into the gulch is to be expected.

The 2-foot conglomerate at the base of the Wind River crops out some 3,500 feet upstream from the dam site. This distance is great enough to cause a very low rate of flow beneath the dam, if the bed extends this far. In addition, the matrix of the conglomerate, where it is exposed, is a sandy clay similar to the rest of the Wind River.

CONSTRUCTION MATERIALS

The alluvium and Wind River sediments are the only materials for earth fill available near the dam site. No tests to determine at what rate water will pass through the sediments were made. The mechanical analyses indicate that the perviousness of both types of sediments is probably closely comparable to that of material used in the cores of some hydraulic-fill dams. No tests were made to determine the angles of repose of the Wind River and alluvium materials after excavation.

Hard well-cemented slabby sandstone interbedded with shales in the valley walls above the dam site (Pl. VI and Pl. VII) would furnish excellent riprap material. The sandstones vary in thickness up to $1\frac{1}{2}$ feet and are strong enough to stand in nearly horizontal ledges overhanging up to 6 feet. The hillside is littered with large fallen blocks, most of which could be used.

There are no gravels near the dam site. Although no detailed investigation was made, it is probable that the nearest sands and gravels are those exposed in the terraces of the Greybull River and Wood River and along their flood plains. Coarse rock which does not have to measure up to any specifications for strength could be removed from the earth fill material by passing it through a trommel or other suitable apparatus. Many of the sandstone fragments within the alluvium are weathered and crumbly. This materials would hardly be suitable for concrete aggregate. Crushed rock of high strength could be obtained by crushing the resistant sandstones in the beds mentioned as a source of riprap material.

CONCLUSIONS AND RECOMMENDATIONS

The site for a properly designed earth dam with its crest at elevation 6,610 feet and its axis lying along the line EF is safe. The character of the Cody shale, Wind River clays and Quaternary alluvium is such that there is no possibility of piping through them beneath or around an earth dam. Seepage losses through these rocks are certain to be very small. There might be a minor seepage loss from the reservoir, when filled to capacity, through Sandstone #1 and Sandstone #2, but muddy water passing through the sandstones would tend to silt up the voids and decrease the loss.

It is recommended that all outcrops of Sandstone #3 in the reservoir site below high water level be covered by impervious material and that this material be protected from removal by wave action. The cover of alluvium and Wind River sediments lying on the eroded edges of Sandstone #3 should not be removed to obtain fill material. The dam should be so designed that water which may have entered Sandstone #3 within the reservoir site be allowed to escape from this bed at the lower side of the dam, unless it is demonstrated that the cover of Wind River sediments on Sandstone #3 underneath the dam is sufficient to withstand the pressure of water entering the bed at the elevation of the high water line.

State Geologist of Wyoming

Associate Professor of Geology,
University of Wyoming

Assistant Geologist,
Geological Survey of Wyoming

Assistant Geologist,
Geological Survey of Wyoming

May, 1935

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Plate III. General view of the Sunshine dam and reservoir sites looking west upstream.

Plate IV. The divide and gulch north of the Sunshine dam site.
The left end of this photograph overlaps
the right end of Pl. III.

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Plate V. Natural vertical face cut through
Wind River sediments by Sunshine Creek
below the dam site. Height of face
12 feet.

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Plate VI. Resistant sandstone beds in the upper part of the Cody near the north abutment of the proposed dam.

Plate VII. Talus slope north of the dam site showing blocks of resistant sandstone up to 6 feet long.

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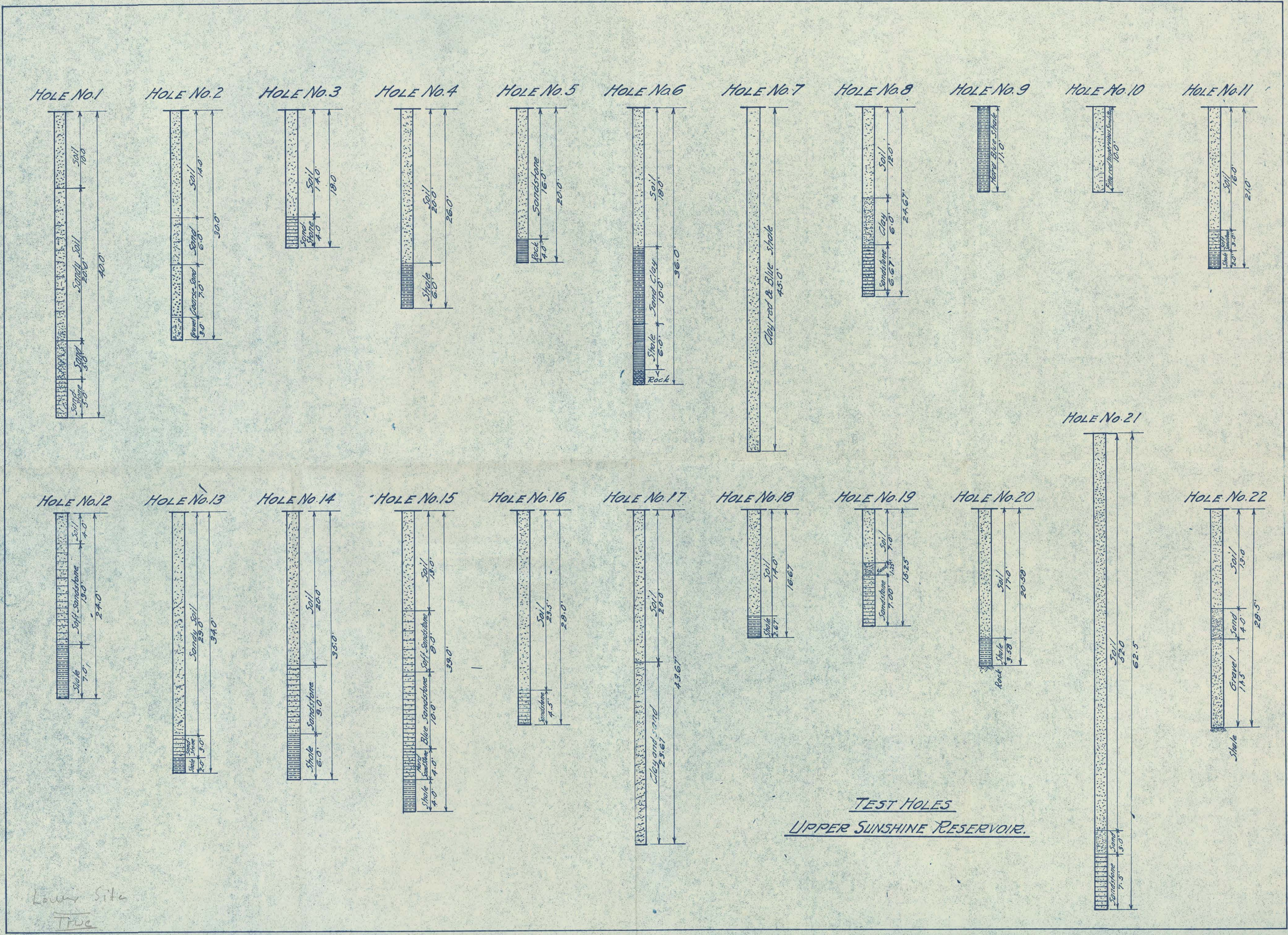
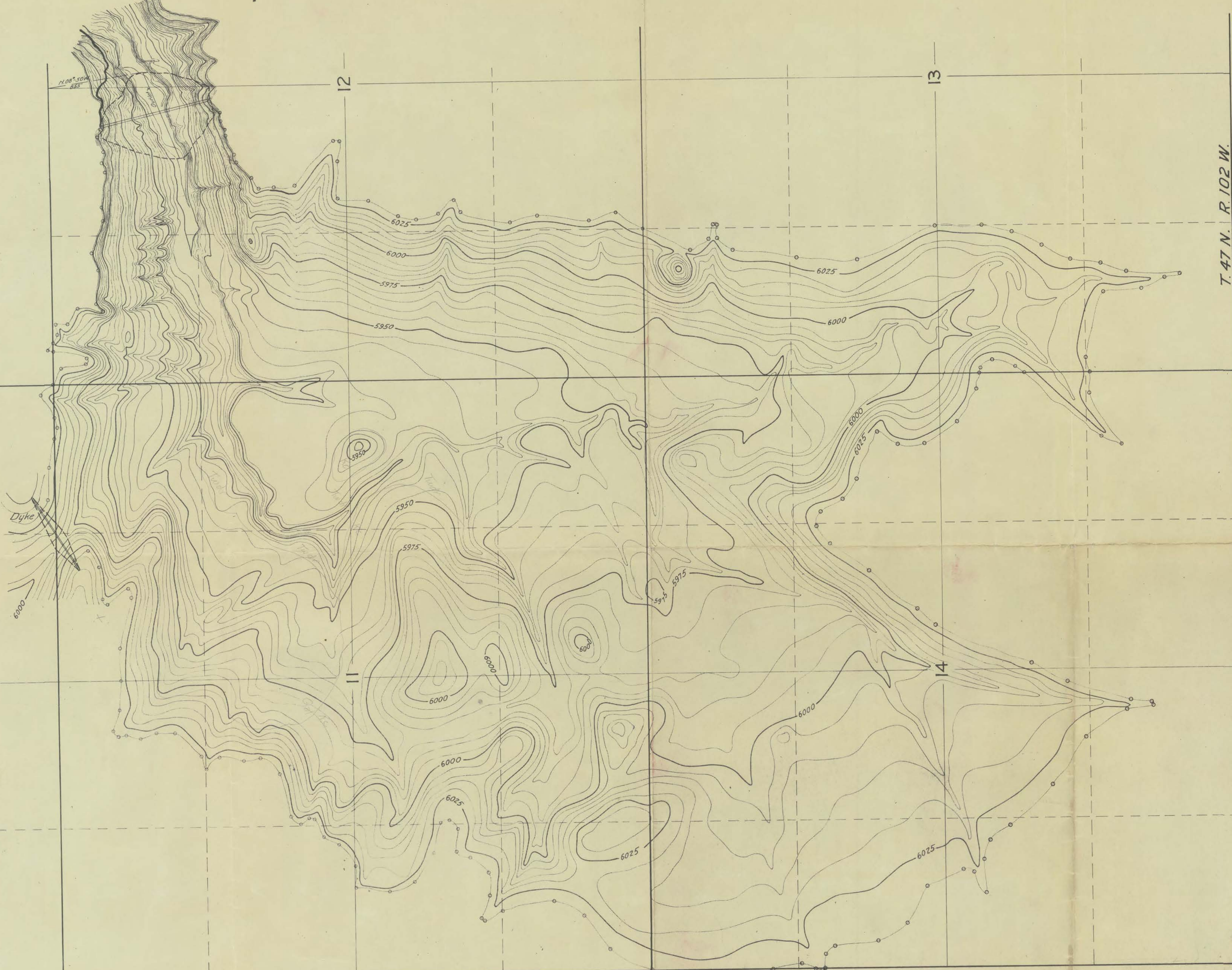


TEST HOLES

UPPER SUNSHINE RESERVOIR.



T. 47 N. R. 102 W.

Contour	Area	Average	Acre-Feet	Capacity
5890	0.00			
		0.22	1.10	
95	0.45			1.10
		1.12	5.60	
5900	1.80			6.70
		4.18	20.90	
05	6.57			27.60
		9.36	46.80	
10	12.15			74.40
		15.30	76.50	
15	18.45			150.90
		21.38	106.90	
20	24.30			257.80
		28.22	141.10	
5925	32.13			398.90
		38.16	190.80	
30	44.19			589.70
		60.84	304.20	
35	77.49			893.90
		95.94	479.70	
40	114.39			1373.60
		133.87	669.35	
45	153.36			2042.95
		171.27	856.35	
5950	189.18			2899.30
		208.82	1044.10	
55	228.46			3943.40
		248.74	1243.70	
60	269.01			5187.10
		287.19	1435.95	
65	305.37			6623.05
		325.30	1626.50	
70	345.24			8249.55
		365.85	1829.25	
5975	386.46			10078.80
		410.55	2052.75	
80	434.63			12131.55
		463.78	2318.90	
85	492.93			14450.45
		524.27	2621.35	
90	555.61			17071.80
		584.39	2921.95	
95	613.18			19993.75
		641.36	3206.80	
6000	669.54			23200.55
		698.87	3494.35	
05	728.19			26694.90
		758.11	3790.55	
10	788.04			30485.45
		824.36	4121.80	
15	860.67			34607.25
		905.48	4527.40	
20	950.30			39134.65
		991.71	4958.55	
6025	1033.11			44093.20
		1073.02	5365.10	
30	1112.94			49458.30

RESERVOIR CAPACITY TABLE

CERTIFICATE OF SURVEYOR

State of Wyoming } s.s.
County of Laramie }

I, Jas. B. True, of Cheyenne, Wyoming hereby certify that these maps were made from notes taken during an actual survey made under my direction by John E. Lloyd, for whose work I stand personally responsible, on July 25th to 28th 1919, and that they correctly represent the irrigation works described in the accompanying applications.

Jas. B. True

MAP TO ACCOMPANY APPLICATION
FOR
UPPER SUNSHINE RESERVOIR

Applicants:
S. Skovgard, Basin, Wyo., Geo. S. Maller R. L. Praetor
and Grant Yarnell, Burlington Wyo.
Scale 500 feet = 1 inch

Approved February 20, 1920,
Frank C. Emerson
State Engineer

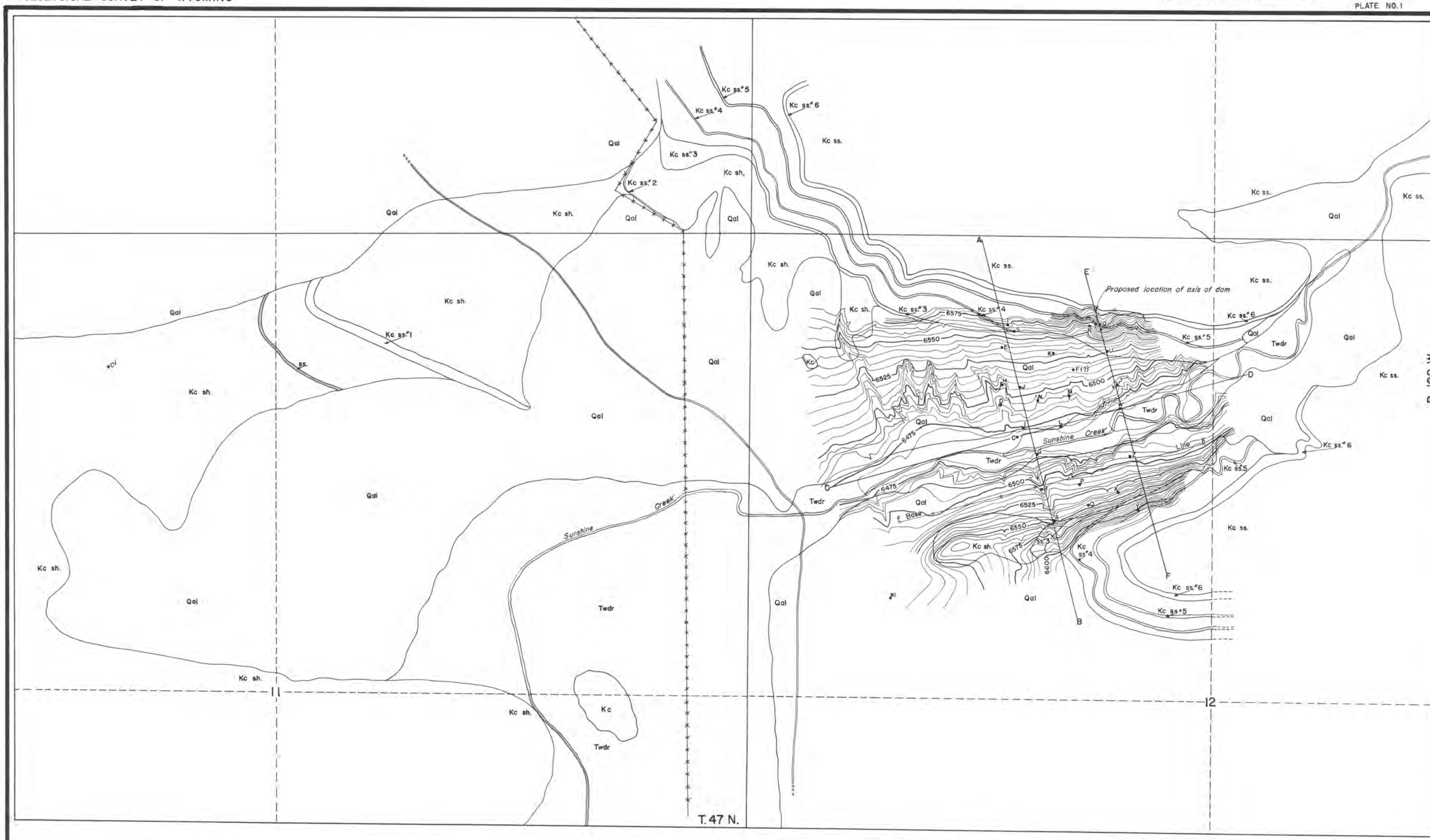
OFR 35-2

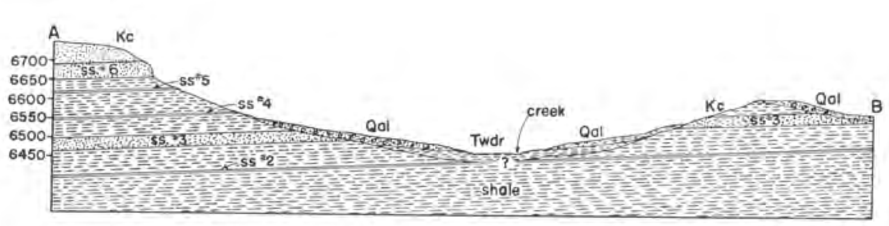
Sheet 1 of 3 Sheets

15734
3615 R
11 4/264 E

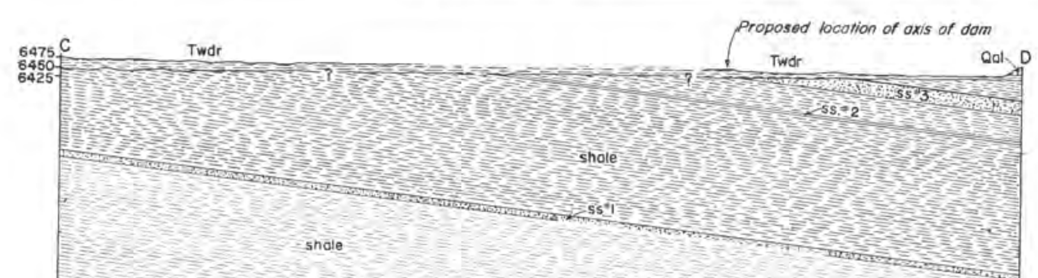
OPEN FILE REPORT 35-2

PLATE NO. 1

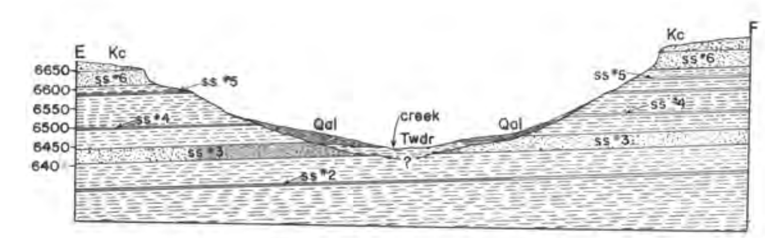




CROSS SECTION ALONG LINE A—B



CROSS SECTION ALONG LINE C—D



CROSS SECTION ALONG LINE E—F

GEOLOGY CHECKED IN THE FIELD AND MAP APPROVED BY:—

S.H. Knight S. H. Knight, *State Geologist of Wyoming, and*

R.H. Beckwith R. H. Beckwith, *Associate Professor of Geology at the University of Wyoming, Laramie.*

FEET

GEOLOGY BY DAVID LOVE

PLANE TABLE CONTROL BY G.L. HURWITZ

1935

TOPOGRAPHY IN VICINITY OF DAM SITE TAKEN FROM MAP BY GEORGE DONNELL

LEGEND

QUATERNARY	Qal	ALLUVIUM
LOWER EOCENE	Twdr	WIND RIVER FORMATION
UPPER CRETACEOUS	Kc — Shale; Kc ss. — Sandstone	CODY FORMATION

GEOLOGIC MAP OF UPPER SUNSHINE BASIN DAM SITE

GENERALIZED GEOLOGIC COLUMN OF ROCKS
EXPOSED IN VICINITY OF DAM SITE OFR35-2

SEE TEXT FOR DETAILED DESCRIPTION OF SECTION

PLATE NO. 11

SYST.	SERIES	FORMATION	SYM.	SEC.	THK.	CHARACTER
QUATERNARY		ALLUVIUM	Qal		0-50	UNCONSOLIDATED CLAYS, SANDS AND SANDSTONE FRAGMENTS
EOCENE	LOWER EOCENE	WIND RIVER	Twdr		0-50	FINE VARIEGATED SHALES
CRETACEOUS	UPPER CRETACEOUS	CODY	Kc		39	SANDSTONE #6 GRAY TO BUFF MASSIVE AND CROSS-BEDDED HONEYCOMB STRUCTURE
					38	SHALY SANDSTONE AND SHALE
					26	SHALES & BUFF SANDSTONES
					2	SANDSTONE #5 HARD FLAGGY
					28	SHALE AND SANDSTONE
					18	SHALES AND FLAGGY SANDSTONE
					18	SANDSTONE AND SHALE
					63	GRAY THIN SHALES AND SANDSTONES
					1	SANDSTONE #4 FINE, WHITE
					53	GRAY SANDY SHALE
					38	SANDSTONE #3 GRAY TO BUFF CROSS-LAMINATED
					77	GRAY SANDY SHALES AND SANDSTONES
					1	SANDSTONE #2 HARD PLATY
					78	SANDY GRAY SHALE
					27	BUFF SANDSTONE AND SHALE
					245	GRAY SHALE AND WHITE LENTICULAR SANDSTONE
					16	SANDSTONE #1 GREY SLABBY
					405	LIGHT GREY SHALE
					6	SOFT WHITE SANDSTONE
					107	GRAY SHALE
					8	SOFT SLABBY SANDSTONE
					112	GRAY SANDY SHALE
					4	BUFF SLABBY SANDSTONE
					19	BUFF TO GRAY SANDY SHALE
					3	BUFF SLABBY SANDSTONE
					362	GRAY SANDY SHALE WITH THIN SANDSTONE LENSES
					4	SHALY GRAY LIMESTONE
					15	GRAY SHALE