PRELIMINARY REPORT

on

THE GEOLOGY OF THE ANCHOR DAM AND RESERVOIR SITES HOT SPRINGS COUNTY, WYOMING

by

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and

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Introduction.- This report treats with the geological conditions which prevail at the proposed Anchor dam and reservoir sites and their bearing upon the construction and serviceability of the project. The report is of necessity preliminary in character. Additional studies should be made at such times as subsurface explorations have revealed the position and condition of the bed rock beneath the talus and stream channel deposits at the dam site. Detailed studies should also be made of the character of the rock materials to be used in the construction of the dam. For purposes of discussion the position and character of the dam as shown by plans prepared by Bell and Donnell under date of December, 1933 (sheets No. 1 and 2) have been used. This report was made at the solicitation of Mr. George C. McCormick of Thermopolis.

Conclusions.- Investigation made in connection with this report substantiate the following conclusions:

1. It is believed that the project is feasible in so far as geological relationships bear upon it.

2. The bed rock of the dam site is adequate to support an earth fill dam 160 feet high.

3. No avenues of escape are known whereby large water losses would be encountered within the enclosing contour of the reservoir site. No such avenues are believed to exist.

4. There is no danger of water piping through the bed rock of the dam abutments.

5. Some seepage loss may occur along weathered joint planes which cut the bed rock of the dam abutments. Investigation of this problem awaits subsurface explorations of the dam site.

Location.- The area discussed in this report is located on the South Fork of Owl Creek 39 miles west of the town of Thermopolis, Hot Springs County, Wyoming. The proposed dam site is just west of the center of Section 26, T. 43 N., R. 100 W. and in the southern part of S½ of Section 13, T. 8 N., R. 1 W. Wind River Meridian.

The reservoir basin includes land in Sections 26, 27, and 28, T. 43 N., R. 100 W., and in Sections 13, 14, 23 and 24, T. 8 N., R. 1 W. Wind River Meridian.

Field Work.- Field investigations were conducted by Mr. Hurwitz from November 28th to December 4th, 1935. Particular attention was paid to the dam site. A reconnaissance investigation was made of the reservoir basin. The proposed diversion dam site on the North Fork of Owl Creek and the supply canal were not inspected. The geological map which accompanies this report is compiled from a sketch map made in the field.

Topography and Drainage.- The South Fork of Owl Creek rises on the northeastern flank of the Owl Creek Mountains, flows northeastward across

The folded eroded Paleozoic and Mesozoic sediments and enters the Big Horn River below Lucerne. The stream enters the reservoir basin from the southwest through a narrow canyon, the walls of which rise 600 feet above the stream, flows across a broad synclinal valley eroded in the non-resistant Chugwater formation and leaves the valley through a canyon, the walls of which are 500 feet high.

GEOLOGY OF THE RESERVOIR SITE

The proposed reservoir site is located in a synclinal basin which has been eroded in the non-resistant shales and sandstones of the Chugwater formation. The structural axis of the syncline trends in a northwest-southeast direction and plunges to the northwest. The axis of the syncline passes through the reservoir site from a point near the middle of Section 24, T. 8 N., R. 1 W. Wind River Meridian, to a point approximately 1,000 feet west of the NW. corner of Section 27, T. 43 N., R. 100 W. The syncline is asymmetric. The northeastern limb has a maximum dip of 45° and the southwestern limb a maximum dip of 12°. The greater part of the reservoir site lies west of the axis of the syncline. This syncline is flanked by anticlinal folds on both its northeast and southwest sides. In both of these anticlines the more resistant Embar (Phosphoria and Dinwoody formations) and Tensleep formations form prominent ridges paralleling the synclinal basin. Owl Creek has cut precipitous canyons through these ridges.

On its north and south sides the reservoir site is enclosed by gravel-capped terraces cut in the Chugwater formation. These terraces are over 200 feet in height and they constitute effective enclosing barriers on the north and south sides.

The upturned and truncated edges of the Phosphoria and Dinwoody formations (Embar group) are exposed along the eastern flank of the reservoir site. These formations lie between the Tensleep sandstone and the Chugwater red shales.

Possible seepage loss of the reservoir site.

The physical character and the attitude of the rocks underlying the reservoir site are such that it is not anticipated that there would be any appreciable loss of water by seepage. The Chugwater formation underlies the entire reservoir site with the exception of a narrow strip along the eastern side where the Phosphoria and Dinwoody formations are brought to the surface. The Chugwater formation is composed of an alternating succession of red shales and sandstones with the red shales predominating. Conspicuous sandstones which might absorb appreciable amounts of water were not noted within the area below the enclosing contour of the reservoir site. Much of the surface of the reservoir site is covered with residual soil derived from the underlying beds. Gypsum beds are a characteristic feature of the Chugwater formation. No gypsum beds were found in that portion of the Chugwater formation underlying the reservoir. Gypsum beds were noted in the upper portion of the Chugwater formation in beds lying above and outside of the reservoir site.

The upturned and eroded edges of the Dinwoody and Phosphoria formations are exposed in a narrow strip along the east flank of the reservoir site. The Phosphoria formation lies next above the Tensleep formation and is conformable to it. The Phosphoria formation is approximately 200 feet thick in this locality and consists of an alternating succession of shales and limestone beds. The character of this formation is exhibited in the following

partial section which was measured on the South Fork of Owl Creek in Section 28, T. 43 N., R. 100 W.:

	Thickness in feet
Talus	
Brown flaggy limestone	10
Gray massive fossiliferous limestone	25
Shaly limestone with chert nodules	6
Gray fossiliferous limestone	7
Brown phosphate rock	1
Tan colored limestone	1
Cherty limestone	18
Brown to black phosphate rock	3
Dense brown limestone	9
Limy shales	56
Tensleep formation	
Total exposed thickness	136

The upper 75 feet of the formation is not shown in the above section. It consists of a succession of shaly limestones which are capped by a dense gray limestone from 30 feet to 50 feet thick. This capping limestone offers such resistance to weathering that it caps long dip slopes along the north flank of the Owl Creek Mountains. The surface of the limestones of the Phosphoria formation are as a rule dense and compact and the rocks present little evidence of solution fissures or cavities. This fact taken together with the fact that the formation is downwarped into a shallow syncline leads to the belief that very little, if any, water would be lost by seepage through this formation.

The Dinwoody formation lies between the Phosphoria formation and the Chugwater formation. Where it is exposed along the northeastern side of the reservoir site it consists of a thin succession of light colored shales not more than 20 feet thick. The physical character of this shale succession is such as to make it virtually impervious to water, consequently the formation does not offer an avenue of escape for water from the reservoir site.

A study of available surface exposures within the reservoir site did not reveal the presence of any crushed or faulted zones through which water losses might occur. Some minor faulting was noted near the center of the NW¼ of Section 26. The faulted area lies, for the most part, above the enclosing contour although a portion of fault planes extend below the high water level of the reservoir. The character and position of this fault zone is such that it does not constitute a zone of weakness through which large seepage losses would occur.

It is concluded that there is no well defined avenue of escape whereby heavy seepage losses would be encountered within the proposed reservoir site.

Fig. No. 1 is a general view of the reservoir site and the location of the proposed dam. The view was taken looking north across the basin eroded in the downwarped Chugwater formation. The ridge to the right is formed by the Phosphoria and Tensleep formations which are arched into an anticlinal fold. The dam site is located in the upper end of the canyon which traverses this ridge. To the left the South Fork of Owl Creek is seen emerging from a canyon cut across the anticline which encloses the basin on its southwest flank. The terraces which enclose the reservoir site on its north and south sides are also visible in the middle distance.

GEOLOGY OF THE DAM SITE

The proposed location of the Anchor dam is in the upper end of a steep-walled canyon (see Figs. No. 1, 2 and 3) which the South Fork of Owl Creek has cut across the northeast flanking anticline. This canyon is cut through the Tensleep formation and into the underlying Amsden formation in its central and deepest portion. The dam site is located entirely upon the

Tensleep formation. The contact between the Tensleep formation and the underlying Amsden is approximately 1,500 feet downstream from the downstream end of the dam. The axis of the proposed dam is located some 450 feet downstream from the upper mouth of the canyon, and the upper end of the dam will extend to the upstream mouth of the canyon. The base of the dam will extend from the Phosphoria-Tensleep contact at the upper end of the canyon downstream for a distance of 800 feet. The dam will therefore rest entirely on the Tensleep formation. At the site of the dam the Tensleep formation dips 40° to the southwest. As the canyon is cut in an east-west direction in this part of its course it cuts diagonally across the strike of the rocks at an angle of approximately 45°. The canyon varies in width from 25 feet at the stream bed to 420 feet at the crest of the dam, which is located 160 feet above the stream bed. Above the points where the crest of the dam meets the canyon walls the side walls of the canyon increase in steepness and terminate in nearly vertical cliffs.

The Tensleep formation at the dam site is composed of massive buff to gray fine to medium grained sandstones aggregating more than 200 feet in thickness. The formation is on the whole a resistant and competent rock member. In places the rock has been cemented by the infiltration of secondary silica into a dense hard quartzite, while in other places the rock has the consistency of a firm sandstone. The physical character of eroded surfaces of the Tensleep sandstone is shown in Fig. No. 2, which is a view looking into the canyon at the site of the dam. The man on the right is standing approximately on the axis and some distance above the point where the crest of the dam will meet the north wall of the canyon. The physical character of the more resistant phase of the Tensleep sandstone is exhibited

in the cliff face and in the large angular talus blocks strewn along the south face of the canyon. This view (Fig. No. 3) also illustrates the fact that the sandstone is extensively jointed, a feature common to rock of this character. Three sets of joints are present. Two sets are in a vertical or nearly vertical plane and a third irregular set cuts the other sets at high angles. Additional fractures cut the rock irregularly in places. The rock is massive, well developed bedding planes are not common, although cross-lamination is visible on some vertical rock faces.

The Amsden formation lies directly beneath the Tensleep formation. This formation is not exposed in the immediate vicinity of the dam site although it is exposed in the canyon walls some 1,500 feet below the dam site. This formation is composed of 250 feet of alternating limestones and sandy shales. It offers sufficient resistance to erosion to present nearly vertical rock faces where exposed on the sidewalls of the canyon. The character of the formation is such as to give it a high degree of competency. It is mentioned here to show that the Tensleep formation rests upon competent rock members. There is very little likelihood that the weight of the dam and the impounded water would cause any settling whatever of the bed rock beneath the dam.

It is believed that the physical character and the attitude of the Tensleep sandstone which will constitute the bed rock upon which the dam will be built are such as to safely support a properly constructed earth fill dam leaving a 3 to 1 slope on its upstream face and a 2 to 1 slope on its downstream face and a maximum height of 160 feet.

Possible leakage through bed rock around the dam.

As previously stated the Tensleep sandstone is extensively jointed. On weathered surfaces these joints exhibit cracks of varying widths. Weathered cracks along joint planes disappear rapidly as the joint planes are traced from the exposed surfaces into the rock mass. Some seepage may take place through weathered joint planes in the rock mass adjacent to the earth fill. Movement of water through these cracks would not be sufficient to permit piping through the bed rock, thereby entailing large water loss. An adequate cut off wall sunk into bed rock would tend to eliminate seepage loss through weathered cracks developed along the joint planes.

SUGGESTIONS OF A GEOLOGICAL NATURE PERTINENT TO DAM CONSTRUCTION

Character of rock talus and its relations to dam construction.- An undetermined amount of talus debris is strewn on the bed rock surfaces along the canyon walls and in the stream channel. The extent and character of this accumulation should be determined. If it is composed of coarse angular blocks with only minor amounts of fine material it may permit appreciable seepage in which event it should be removed so that the fine material used in the construction of the dam would make an effective seal against the bed rock of the canyon wall.

Available material for earth fill.- No analyses have been made in connection with this report of available materials for the construction of the earth fill. It is believed that the residual soils derived from the Chugwater formation would be suitable.

Available rock for rip-rap.- Excellent rock for rip-rapping the upper surface of the dam is readily accessible. The quartzitic phase of the Tensleep sandstone is adapted to this use. Blocks of any desired size can be secured.

Engineering studies should be made of the materials to be used for the dam fill to determine their perviousness and their angles of repose both dry and saturated.

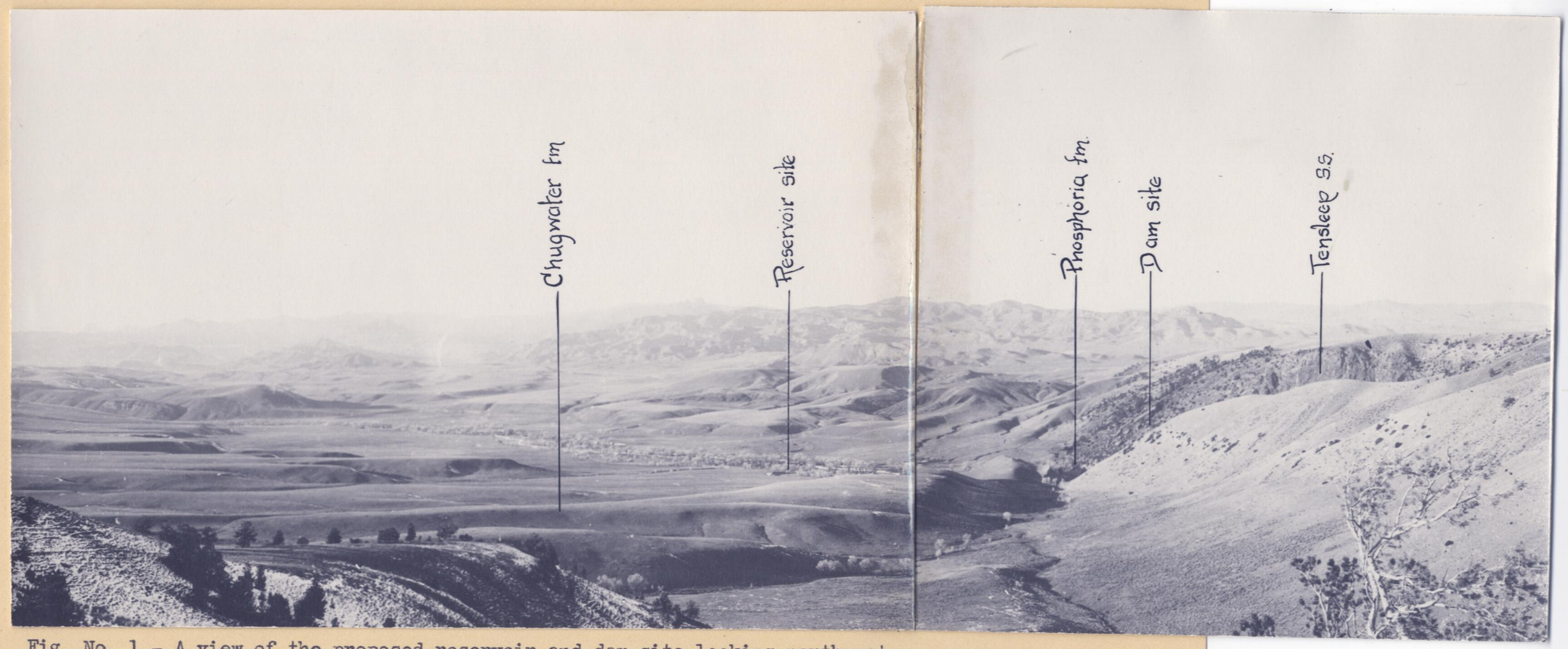
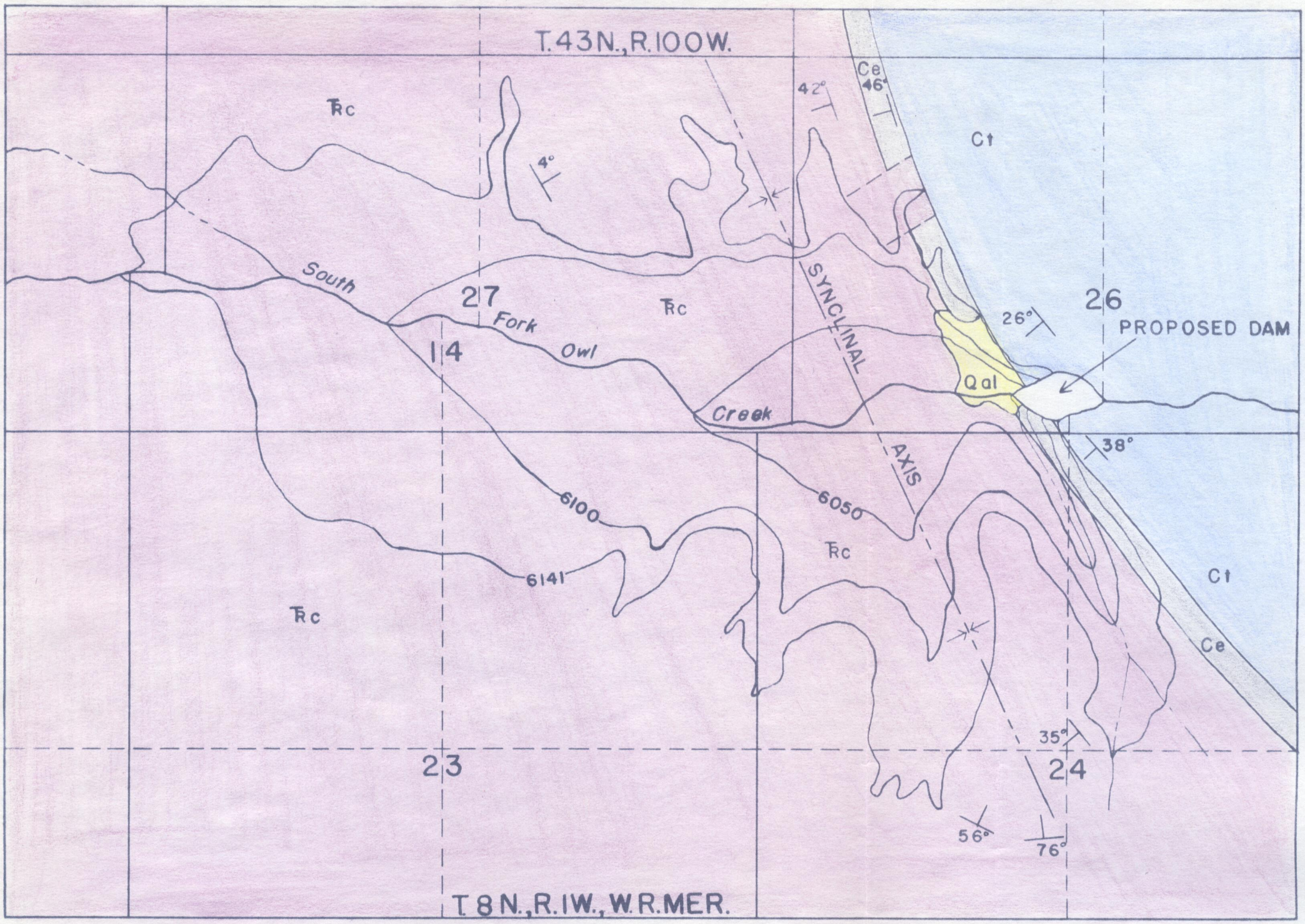


Fig. No. 1 - A view of the proposed reservoir and dam site looking northwest.

Fig. No. 2 - View of proposed dam site looking southwest.
The man is standing on the line of the axis of the dam. The upper portion of the Tensleep sandstone is exposed on the south wall of the canyon.

Fig. No. 3 - View of the dam site looking southeast from the reservoir basin.



GEOLOGIC MAP OF THE ANCHOR DAM SITE AND RESERVOIR

THE GEOLOGICAL SURVEY OF WYOMING

S.H.KNIGHT, STATE GEOLOGIST

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SCALE: 1 INCH = 1000 FEET

0 1000 2000 3000

GEOLOGY BY GARVIN HURWITZ
1935

TOPOGRAPHY TAKEN FROM MAP BY GEORGE DONNELL

LEGEND

QUATERNARY	Qal	ALLUVIUM
TRIASSIC	Trc	CHUGWATER
PERMIAN	Ce	PHOSPHORIA & DINWOODY
PENNSYLVANIAN	Ct	TENSLEEP