Department of Ecology

G E O H Y D R O L O G I C   E V A L U A T I O N

of

Aeneas Lake - Horse Springs Coulee Area

Okanogan County, Washington

Robert H. Russell, C.P.G.

October 1970

C O N T E N T S

GEOHYDROLOGIC EVALUATION

of

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INTRODUCTION

The project area occupies a north-south trending valley approximately 5 miles west of Tonasket, Washington, and which lies between Aeneas Mountain on the west and Cayuse Mountain on the east. The valley is bounded on the north by Spectacle Lake and by Aeneas Creek on the south. The area is about 11 miles long and averages about 4 miles in width. The site is served by a surfaced county road from Tonasket and by several gravel roads which traverse the area.

Horse Springs Coulee and the associated mountains comprise an area of mature topography of moderate relief with rolling hills and wide valleys, modified by the advance and recession of at least one, and perhaps two continental ice sheets which rode over the locale from Canada to the north. Horse

Springs Coulee ranges in elevation from about 1350 feet to 1600 feet from south to north, with mountainous areas of Aeneas and Cayuse Mountains ranging between 2000 and 5000 feet. Land surface gradient averages approximately 25 feet/mile from north to south.

PURPOSE AND SCOPE OF INVESTIGATION

Since prior to 1964, water levels in Aeneas Lake and wells located in Horse Springs Coulee have declined steadily, clearly pointing out that increased pumping for irrigation purposes was exceeding the annual recharge, and if permitted to continue, would eventually deplete the water in storage in the underground reservoir.

In February 1964 the Division of Water Resources of the Department of Conservation initiated a water level monitoring program designed to measure and record the rate of water level decline that was taking place in the Aeneas Lake - Horse Springs Coulee complex. On August 9, 1964, a meeting was held in Tonasket sponsored by the Chamber of Commerce for the purpose of reviewing the Aeneas Lake problem. In attendance were representatives of the Bureau of Reclamation, Washington State Department of Game, and local state legislators as well as property owners of Horse Springs Coulee and people interested in the recreational value of the lake. During the meeting I reviewed the water level decline that had taken place and projected probable future declines that would occur if withdrawals from the system were continued at the present rate without supplementing natural recharge by artificial means.

During the discussion that followed I mentioned several sources of water that may be available to supplement natural recharge to the system and recommended that pumping from the Okanogan River directly into Aeneas Lake seemed to be the most attractive.

In July 1968 Plateau Orchards Inc. of Oroville, Washington, submitted an application to the Department of Water Resources requesting a permit to appropriate 12 cfs, 2700 acre-feet per year from the Okanogan River to maintain the level of Aeneas Lake and irrigate 900 acres of land in the vicinity of the lake. A permit was issued and construction on the pipeline was completed in the summer of 1970. The project is now being operated by the recently formed Aeneas Lake Irrigation District.

On March 23, 1970, a request was received from the Water Management Division of the Department of Water Resources to provide the geologic and hydrologic data needed to define and designate a ground water subarea in hydraulic continuity with Aeneas Lake. This report is being prepared to satisfy that request.

Geologic interpretation is by the author based upon personal reconnaissance mapping in 1948 while on a graduate field course from the University of Washington, and personal observations made by the author during the week of July 28, 1970. A portion of the area was mapped as partial requirement for a Master of Science thesis by Robert W. Adams, University of Washington, 1962. Several rock outcrops were visited by the author to confirm Adams' mapping and were found valid. Therefore, his mapping was accepted for the part of the project covered by him.

PROJECT AREA

Watershed

The boundary of the area tributary to the subject aquifer is defined as that area between the crests of Aeneas Mountain and Cayuse Mountain. It lies north of a northeast-southwest trending line connecting the southern extension of Lemansky Mountain near the center of the SE 1/4 of Sec. 35 and the crest of the upland in the center of the E 1/2 of Sec. 25, Twp. 37 N., Rge. 26 E., and south of a westerly trending line connecting the northwest tip of Cayuse Mountain through several prominent bedrock outcrops in Horse Springs Coulee in Secs. 8 and 9, Twp. 38 N., Rge. 26 E., with the northeast tip of Aeneas Mountain near the west quarter corner of Sec. 8.

Other than water lost through three probable subsurface outlets, all precipitation falling in the project area migrates toward and contributes to the project aquifer.

Aeneas Lake - Horse Springs Coulee Aquifer

The aquifer is defined as that part of the project area in direct hydraulic continuity with Aeneas Lake and is in a position geologically to benefit directly or indirectly from artificial recharge through water pumped from the Okanogan River and discharged into Aeneas Lake.

The aquifer is outlined on Plate I and the perimeter boundary described as follows:

> Beginning at the intersection of the county road and the south line of Sec. 25, Twp. 37 N., Rge. 26 E., W.M., then west along said section line extended to its intersection with the 1600' contour as expressed on the U.S.G.S. quadrangle map Conconully, Washington, 1957, then follow the 1600' contour in a northerly direction through Secs. 26, 33, 22, 15, 10, 9 and 4, Twp. 37 N., Rge. 26 E., and Secs. 34, 27, 22, 21, 16 and 9, Twp. 38 N., Rge. 26 E., to its intersection with the project north boundary line connecting the southeast corner with the center of Sec. 9, Twp. 38 N., Rge 26 E., W.M., then southeasterly along said line to its intersection with the 1600' contour near the west wall of Horse Springs Coulee, then follow the 1600' contour in a southerly and easterly direction through Secs. 9, 16, 22, 27, 34 and 35, Twp. 38 N., Rge. 26 E., W.M., and Secs. 2, 11 and 14 to its intersection with the south line of Sec. 14, then east on the south line of said Sec. 14 approximately 1 1/2 miles to the southeast corner of Sec. 13, Twp. 37 N., Rge 26 E., W.M., then south on the east line of Secs. 24 and 25 a distance of approximately 1 1/4 miles to its intersection with the 1600' contour on the north slope of prominent bedrock (andesite) hill, then follow the 1600' contour in a westerly and southerly direction to a point 790 feet east of the county road in said Sec. 25, then south parallel to said county road a distance of about 2640 feet to its intersection with the south line of Sec. 25, then west 790 feet to POB. This covers an area of approximately 8.94 square miles. (Note: All reference points are from the U.S.G.S. 15' quadrangle maps "Conconully" 1957 and "Tonasket" 1957.)

GEOLOGY, GENERAL

During late Triassic or post Triassic time a thick series (7000 feet or more) of continental clastic and chemical sediments were laid down in a large geocyclinal basin lying generally between the Okanogan River and the Sinlahekin Valley and north of the town of Riverside. The series consisted of fine-grained clastic sediments with interbeds of volcanic rock followed by a thick succession of carbonate rocks.

Deposition of the marine sediments was followed by orogenic deformation which resulted in a series of north-south trending anticlinal and synclinal folds. During deformation the sediments were subjected to low grade metamorphism, which altered the sediments and volcanic rocks. The sediments are now phyllites, schists and metaconglomerates. The volcanics are now metavolcanics and greenstones. The limestones are impure dolamites and banded marble. The meta-sediments are referred to as the "Anarchist series." After a long period of quiet, Tertiary rhyolites and andesites were deposited locally.

During Pleistocene time the irregular bedrock surface was further altered by the advance and recession of at least one major continental glacier that rode over the area from the north. Upland areas were scoured by the advancing ice.

Valleys and depressions were subsequently filled with sand, gravel, clay and silt as the last of the ice ablated and wasted away. It is these recessional outwash deposits that serves as the aquifer in Horse Springs Coulee.

Anarchist Series

For this report the Tertiary andesites and rhyolites will be included with the meta-sediments and other rocks of the Anarchist series (R. A. Daley, 1912) (Watters and Krauskoph, 1941) since all are dense, fine-grained and impervious and do not serve as aquifers. Rather they serve as the impervious base and walls for the Horse Springs Coulee aquifer system.

Glacial Drift

Pleistocene glacial deposits of the project area include drift of Vashon age and perhaps one earlier continental ice sheet. These deposits range between 20 and 150 feet or more in thickness and probably average about 100 to 125 feet thick under most of the area below 1600' elevation and designated the "aquifer."

On the upland terraces between 1600 and 2000' elevation the bedrock of the Anarchist series is overlain by a relatively thin 10 to 25 foot thick deposit of glacial drift. In places, outliers of Anarchist rock appear as islands surrounded by the glacial drift.

HYDROLOGY.

Watershed Area

The project watershed is outlined on Plate I and consists of the area bounded on the east and west respectively by the crests of the Cayuse and Aeneas mountain ranges and by a somewhat arbitrary east-west line between Aeneas Lake and Aeneas Creek in the south and a line between Spectacle Lake and Horse Springs Coulee on the north.

Precipitation falling within that perimeter and not lost to evaporation or transpiration enroute will migrate toward and eventually provide recharge to the Aeneas Lake - Horse Springs Coulee aquifer. Ground water in the glacial drift overlying the Anarchist series (Qga) is in transit and not believed to be in direct hydraulic continuity with water stored in the aquifer. Water levels in wells on these uplands would be considerably above water levels in the project aquifer and would not be influenced by artificial recharge through Aeneas Lake.

Aeneas Lake - Horse Springs Coulee Aquifer

The aquifer may be described as that part of the drainage area lying below the elevation of 1600 feet MSL and which is underlain by glacial drift materials. It is outlined on Plate I.

Water levels in project wells 9J1 through 25P1 (see Plates I and II) show a ground water gradient from north to south at an average of 23 feet per mile. Gradient from well 9J1 to 27Q1 is 19 feet per mile; well 27Q1 to 10H1, 51 feet per mile; 10H1 to 23C1, 7.1 feet per mile; and 23C1 to Aeneas Lake and well 25P1, approximately 6 feet per mile. When platted as a profile, it shows a relatively flat water surface between wells 9J1 and 27Q1, and 10H1 and 25P1, with a quite steep gradient between wells 27Q1 and 10H1. It is quite possible that the bedrock constriction at the site of well 27Q1 serves as a partial ground water barrier and there may be a ground water "cascade" or sharp gradient steepening immediately south of the constricted area. Down grade from that area, the hydraulic gradient is probably less steep and coincides with the gradient between wells 10H1 and 25P1. This probability could not be confirmed since there are no known wells between wells 27Q1 and 10H1. (See geologic profile)

Project wells 9J1 and 27Q1 were drilled in April 1970 and are the only wells of record in the northern part of the project and for that reason there is no historical data available relative to water level changes in that part of the project. However, personal observations of water level changes in Stevens Lake (Twp. 38 N., Rge. 26 E., Secs. 22 and 27) over the past 6 years indicate that it has experienced a water level decline similar to Aeneas Lake but not in the same magnitude.

From this study it appears to the writer that the area designated "the aquifer" is a single hydraulic unit and is influenced directly or indirectly by precipitation falling within the total watershed. The bedrock constriction near well 27Q1 nearly divides the aquifer into two separate systems and at first blush it would seem prudent to manage it as two separate ground water subareas. However, after an objective evaluation, it is clear that it would not be the better course to follow since the area north of well 27Q1 constitutes about one-third of the total project watershed and precipitation falling on this area contributes recharge to the aquifer south of well 27Q1 through both surface and subsurface flow. Water right holders residing in the southern one-third of Horse Springs Coulee enjoy a legal interest in this natural recharge water.

Ground Water Discharge

Water is lost from the ground water system by three primary ways; they are:

1. Evapotranspiration directly from Aeneas Lake, cropland and the crops being grown;
2. Pumping through wells to irrigated land; and
3. Subsurface outflow.

Aeneas Lake, a glacial kettle, has existed in its present state as a fresh water lake since the close of the last continental glaciation approximately 12,000 years ago. The fact that the lake has not become highly mineralized over that period clearly indicates that there are subsurface outlets in addition to the pumping and evaporation losses.

From this study, it appears that there are two significant subsurface outlets through glacial drift materials; they are:

1. South from Aeneas Lake to Aeneas Creek (outflow from this outlet is being monitored to detect any change in flow due to artificial recharge of Aeneas Lake); and
2. Northeast from Aeneas Lake between the county road and the bedrock hill in the E 1/2 of Sec. 25. The miscellaneous station is located at the SW 1/4 of Sec. 31, Twp. 37 N., Rge. 27 E.

A third possible subsurface outlet exists at the north end of Horse Springs Coulee in the SW 1/4 of Sec. 9 near project well 9J1. A review of geologic and hydrologic data of the area indicates that if subsurface discharge does occur here, it would be insignificant.

CONCLUSIONS

1. Prior to man's appearance, Aeneas Lake was in a state of equilibrium, annual outflow was equal to annual

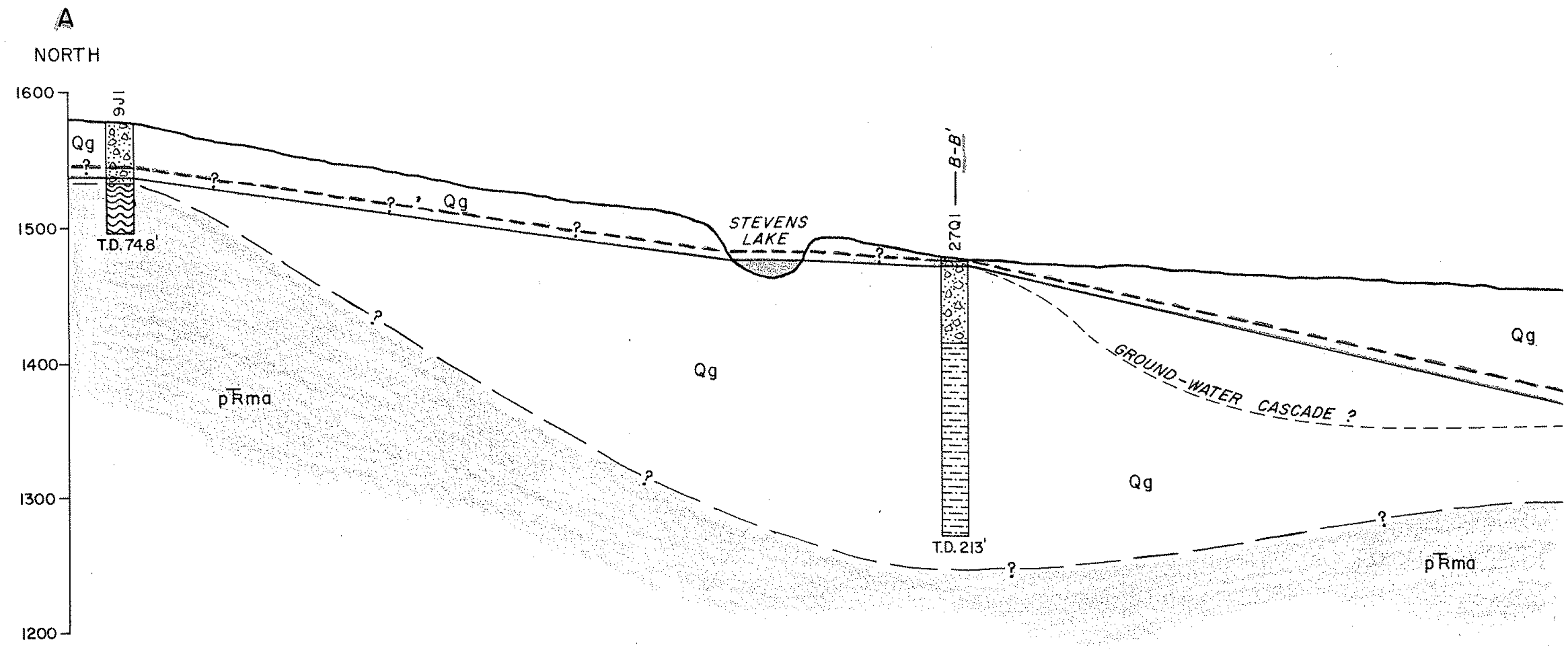
inflow. Now water is being removed from the Aeneas Lake - Horse Springs Coulee aquifer at a rate which greatly exceeds the annual natural recharge.

2. Water levels in observation wells and Aeneas Lake have declined at an average rate of 2.66 feet per year during the 6-year period of observation, 1964-1970.
3. Personal observations by the writer indicate that a similar rate of decline extends back to 1955 or before.
4. Continued pumping at the present rate without importing outside water would result in continued "water mining" which will eventually destroy Aeneas Lake and Horse Springs Coulee as an important renewable water resource.
5. Any increase in annual withdrawal from the Aeneas Lake - Horse Springs Coulee aquifer would be at the expense of artificially stored ground water.

RECOMMENDATIONS

1. The Aeneas Lake - Horse Springs Coulee ground water subarea should be established. This would be a subarea of the "proposed" Okanogan Ground Water Area.
2. The subarea should include that part of the watershed which lies below the 1600' contour as shown on Plate I and as described in the text.
3. Artificially stored ground water should be monitored on a quantitative basis.

4. Geophysical work in certain critical areas of the project could help to better define the geohydrology of the aquifer system, but this would be expensive and in my judgment the end would not justify the means.



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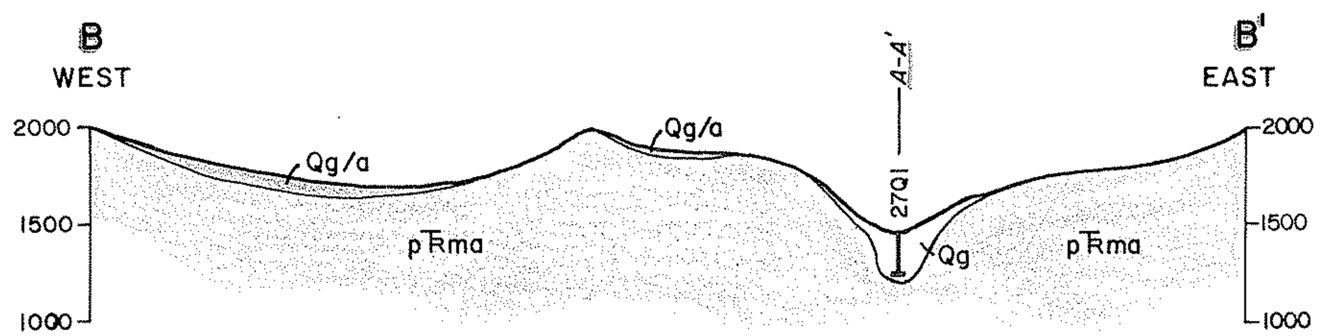

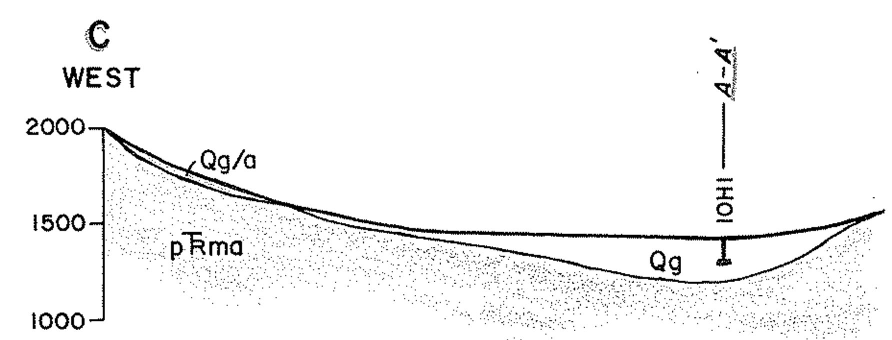

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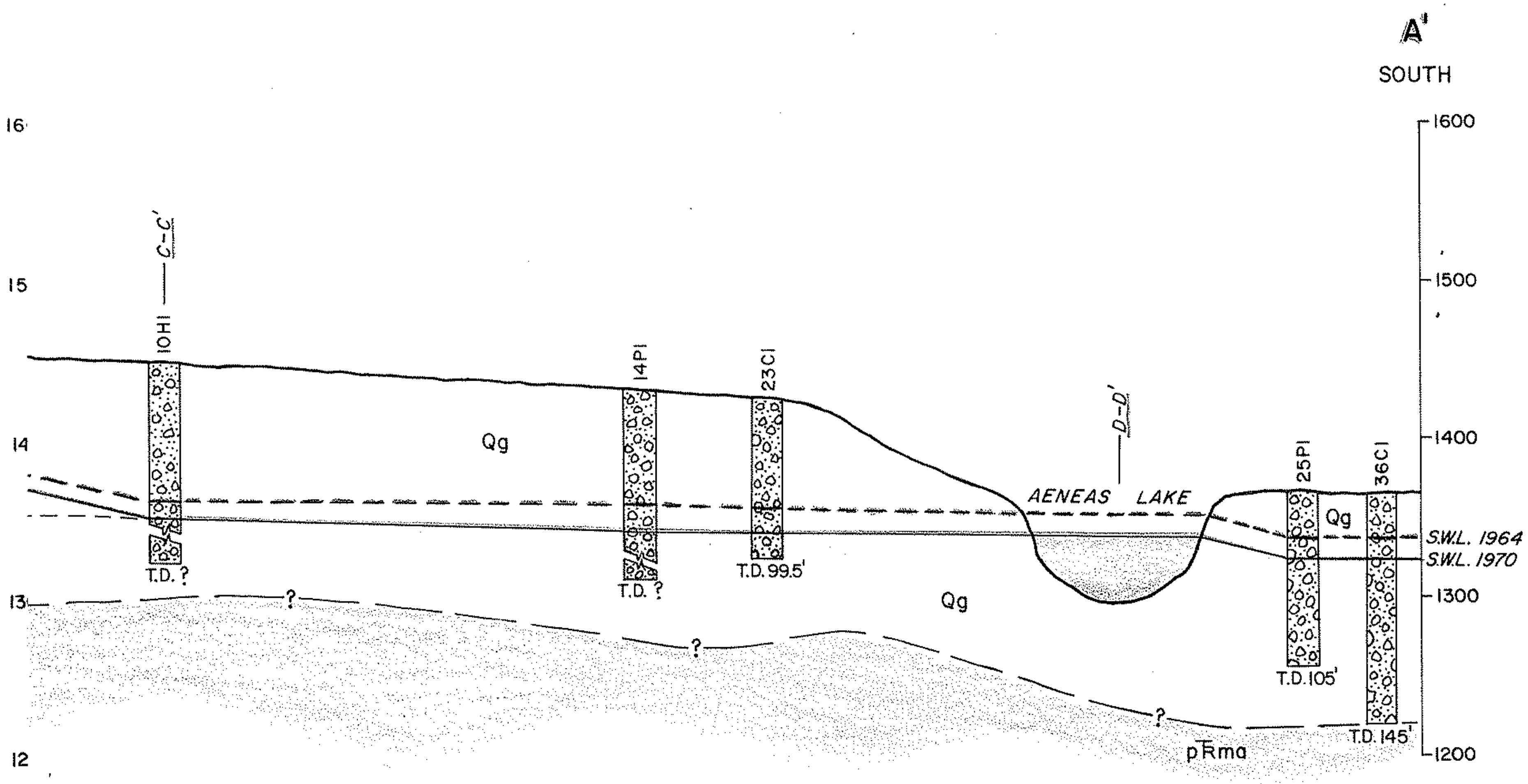

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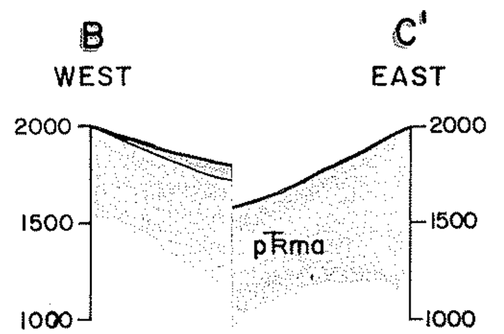
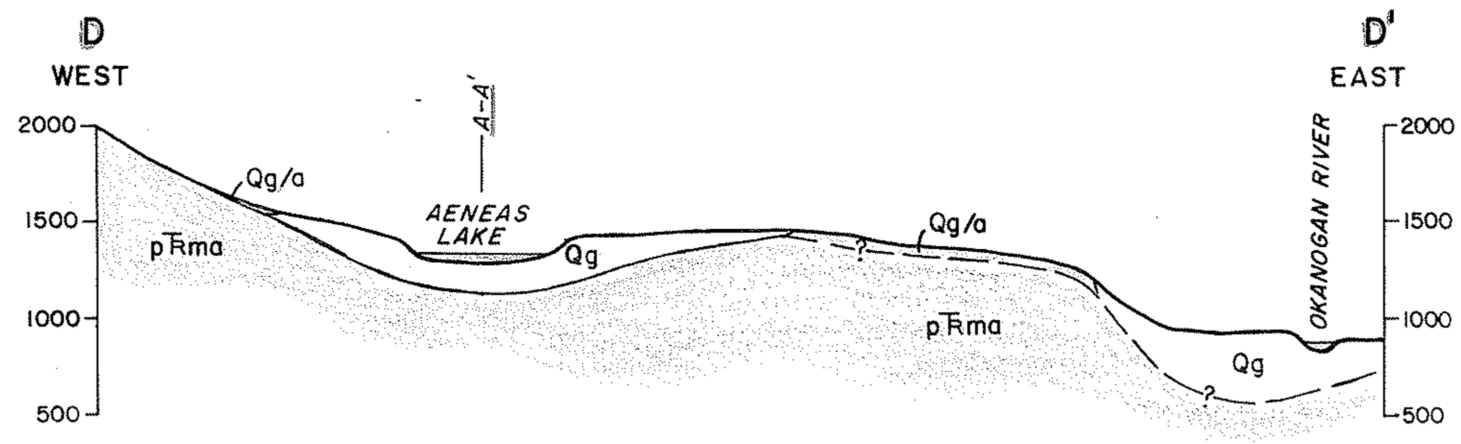
1" = 100' (ELEVATION ABOVE MEAN SEA LEVEL)

EXPLANATION

- Glacial drift, sand and gravel
- Glacial drift, compact clay
- Anarchist series, bedrock

NOTE: For an explanation of the geologic symbols see the Geohyrologic Map, plate 1.





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CROSS SECTIONS
OF
AENEAS LAKE-HORSE SPRINGS COULEE
OKANOGAN COUNTY, WASHINGTON
BY
DEPARTMENT OF ECOLOGY

SCALE AS DEFINED UNDER CROSS SECTIONS

ROBERT H. RUSSELL – GEOLOGIST	OCTOBER
JOHN C. MILHOLLIN – CARTOGRAPHER	1970

PLATE 2