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AN INVESTIGATION OF BEACH
EROSION ALONG LAKE HURON
NEAR LEXINGTON, MICHIGAN

Thesis for the Degree of B. S.

MICHIGAN STATE COLLEGE

Ernest V. Keckonen - Robert C. Patterson

1948



THESIS

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**An Investigation of Beach Erosion
along Lake Huron near Lexington, Michigan**

**A Thesis Submitted to
The Faculty of
MICHIGAN STATE COLLEGE
of
AGRICULTURE AND APPLIED SCIENCE**

by

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Candidates for the Degree of

Bachelor of Science

July 1948

Thesis

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We are very grateful to our wives who served as, note takers, leadsmen, and rodmen in surveying for this thesis.

E.V.K.
R.C.P.



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INTRODUCTION

In former years the need for beach erosion studies was not realized by beach property owners. The rapid growth of seaside resorts, whose value as a tourist attraction often depends on the condition of the beach, have brought about the sharp realization of the need for beach erosion studies.

The average summer vacationer spends his time and money at those beaches that appeal to him, leaving the damaged ones to the owners. The owner therefore has a very real interest in the preservation of his property against erosion, when his income is derived from the summer tourist. The amount of income is often reflected by the condition of the beach. The shore phenomenon of erosion may therefore easily wash away his investment.

Preserving the beaches necessitates investigation to determine the trend, rate, and manner of erosion or accretion. Predictions may then be made as to when and where protective measures are needed, and the type that will solve the problem in the most economical way.

This investigation of the Lexington area was made because the lake property there is primarily devoted to summer cottages and resorts, and unabated erosion could seriously threaten the value of the property as a tourist attraction. In the last few years erosion has been very rapid at some of the portions of this area, in fact one resort owner who proudly boasted of the finest sand beach in Sanilac County



only four years ago, now has a beach that is almost entirely washed away.

DESCRIPTION OF THE AREA

The Lexington area has a narrow sandy or sandy-gravel beach, usually about twenty to two hundred feet wide, which terminates at the foot of a wave cut clay cliff that rises very steeply thirty to fifty feet. The summer homes and cottages are located at the top of this clay cliff. A view of this cliff is shown in Fig. 1.

METHODS OF COLLECTING DATA

To determine the changes which have taken place in the shoreline, historical investigation of old and new topographic maps and surveys were made. Comparison of these shorelines made over a period of years indicate the progressive changes that have taken place.

The old maps and surveys used to compare with the present shoreline are the Michigan State Land Office Survey of 1833, and the United States Lake Survey charts of 1859 and 1914.

These charts were enlarged to a scale of 1:10,000 and superimposed upon the 1833 shoreline so that the progressive changes that have taken place over the last one hundred and fifteen years could be seen easily.

The survey to determine the present shoreline was made in June, 1948. The west boundary of Range 17 East was chosen as a reference line. The distance from this line to Lake

Fig. 1- Eroded cliff, southern end of Lexington village limits



Huron was taped along the section lines of section 6 in T9N R17E and sections 30 and 31 in T10N R17E. Posts were then established on the intersection of the shoreline and these section lines. A meander line following the shoreline was made between the section posts by a transit and stadia survey.

Offshore depth changes also have a bearing upon the probable changes to be expected in the future.

Offshore profile lines were established perpendicular to the shore at selected locations along the beach. These profiles extended from the shoreline to about 1500 feet seaward. The depths were measured to the nearest quarter foot by sounding from a small boat at the same time that the distances were determined by stadia. A transit on a shore station controlled the position of the boat along the profile line and determined the distances.

The stadia method of determining the distance is limited by weather conditions as results can be obtained on only the calmest days. The profiles in section 30 are incomplete because windy weather interrupted the survey. A better method that would not be limited by weather requires two transits to measure angles, the distances are then calculated by triangulation. The stadia method also required targets for the more distant shots which slowed the work considerably.

SHORELINE AND OFFSHORE DEPTH CHANGES

A study of the surveys of this area from 1833 to 1948 shows erosion of about two hundred feet in a few portions of

the beach and accretion of about two hundred and fifty feet in other portions.

A greater change in the shoreline in section 30 and 31 took place between 1833 and 1859, while the greater change in section 6 was between 1914 and 1948. Changes were slight during the 1859-1914 period.

These changes in the shoreline are a guide as to the trend of changes that may be expected in the future.

The offshore depth changes as shown by the profiles and in Table 1. Shoreline and depth contour changes, show that the offshore depth has increased at all points, indicating that storm waves have swept much of the beach away.⁽¹⁾ This is corroborated by residents of the area who attest to the fact that most erosion takes place during storms. A storm in July, 1945, caused the greatest erosion in recent years, scouring the beach and moving the shoreline back about sixty feet.

EROSION CONTROL

The existence, direction, and approximate volume of littoral drift are important elements in determining erosion control methods.

This littoral or beach drift is caused by waves breaking obliquely on the shore. A wave breaking on the beach that is advancing obliquely up the shore, continues in that direction

(1) William Shield in "Principles and Practice of Harbor Construction" says that during the first few hours of a gale enough material may be removed from the shore-face to deepen the water there from five to ten feet.

but the backwash tends to run perpendicular to the shore down the steepest slope. Thus a particle carried by such a wave would advance obliquely along the shore and then roll down, continuing on a stepped or zig-zag path. According to D.W. Johnson in "Shore Processes and Shoreline Development" this path is not sharply zig-zag, but is a parabolic curve due to the control of gravity which makes the change in direction of the particle gradual instead of abrupt as shown in Fig. 2.

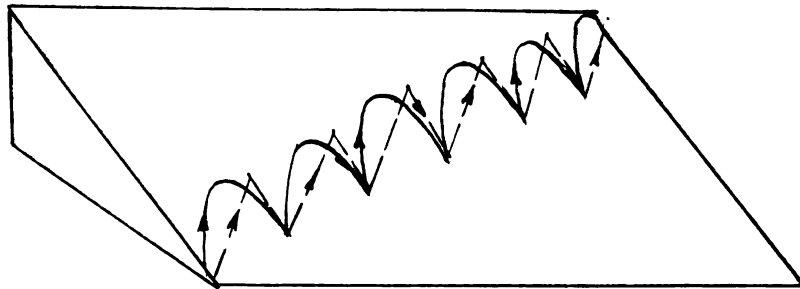


Fig. 2- Section of beach slope showing by dotted lines the so-called zig-zag path of debris particles during beach drifting and by solid lines the parabolic paths actually followed. (Shore Processes and Shoreline Development)

The waves therefore bring about this important longshore transportation of debris along the beach.

A longshore current combined with the movement of debris caused by waves breaking on the shore give a very pronounced littoral drift in the direction of the current.

The direction of littoral drift depends on many factors, among these are the direction of prevailing wind and the direction of the greatest stretch of open water (weak winds blowing over a great expanse of water may develop larger waves than strong winds over a limited amount of water).

Both the prevailing wind and greatest stretch of water for the Lexington area are from the northeast causing the waves to strike the shore obliquely from this direction so that the beach drift is to the south. This southerly drift is shown by existing groins which have trapped sand on the north side and allowed erosion to take place on the south side. See Fig. 3.

EXISTING PROTECTIVE DEVICES

The few existing protective devices are groins, built perpendicular to the shoreline with the function of trapping or retarding littoral drift. These groins are forty to sixty feet long, extending twenty to thirty feet into the lake to a depth of two or three feet. They have been effective in building up the beach to some extent, but their effectiveness is not fully realized.

Most of the groins are made of two rows of piling about four feet apart with three inch planks forming a wall along each row of piling. The space between the sheeting walls is filled with large stones, and the surface is finished with concrete. See Fig. 4

Another type of groin used in this area is made of

unfinished timber and stones. A frame of timber about four feet wide and the desired length of the groin is constructed, with woven wire fencing nailed to the bottom to form a basket. The frame is floated into position perpendicular to the shore then filled with stones. The shore end of the groin is firmly anchored with piling but there is no anchoring of the other end. Desirable qualities of this type of groin are: the piling is not undermined by action of the water, can be built with little equipment and of cheaper materials, therefore is less costly to construct. An example of this type of groin is shown in Fig. 5 which was built by one man and his two sons a few days before the picture was taken.

RECOMMENDATIONS

Groins have proved to be the most effective means of stabilizing beaches where there is sufficient littoral drift. As about 80 per cent of the littoral drift occurs shoreward of the six foot depth under normal weather conditions, groins should normally extend to this depth. (1) The Lexington area has sufficient littoral drift as observed at existing groins, but the groins do not extend far enough into the lake for maximum effectiveness.

At point 12 on the shoreline chart a pier was built that extended 200 feet into the lake, but the pier began to

(1) Engineering Manual for Civil Works, Part CXXXIII, Beach Erosion Studies, War Department.



Fig. 3- North side (top) and south side of a groin, showing littoral drift trapped on north side of groin.



trap littoral drift and therefore acted as a groin. There has been an accretion of 200 feet on the north side of this pier. This example shows that much more beach stabilization could be obtained by building groins that extended to a greater depth than is now practised.

Protective devices in this area must also be built to resist the destructive effect of ice. Spring breakups and ice jams are particularly destructive to beach structures.

A groin of the type shown in Plate 10 is recommended for this area. Less material per foot of groin is required than is now normally used in the Lexington area thereby ~~making~~ this type of structure less costly. Because piers supported by wooden piling have withstood many years of ice forces so groins made of timber should similarly withstand these forces.



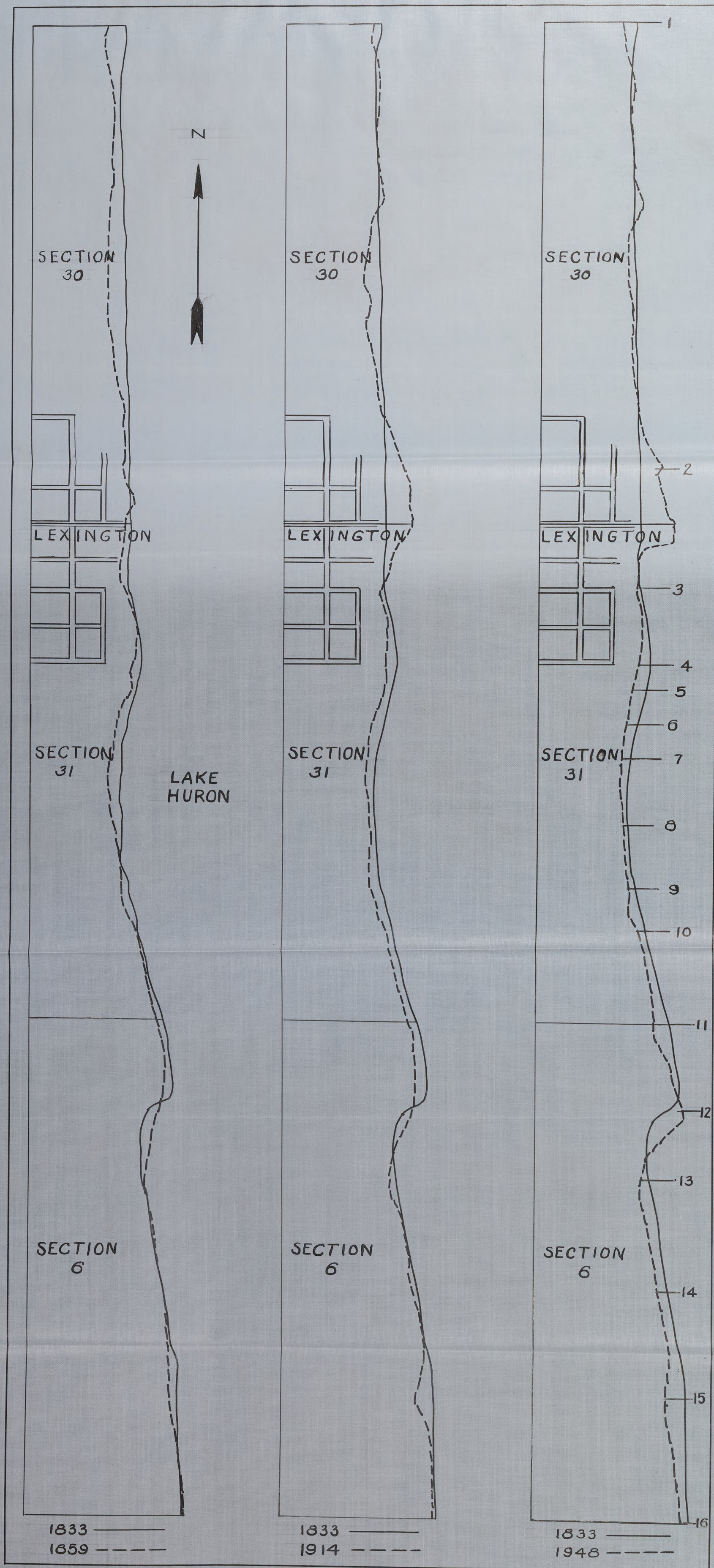
Fig. 4- Typical groin of Lexington area.

Fig. 5- Timber-stone groin shortly after completion.

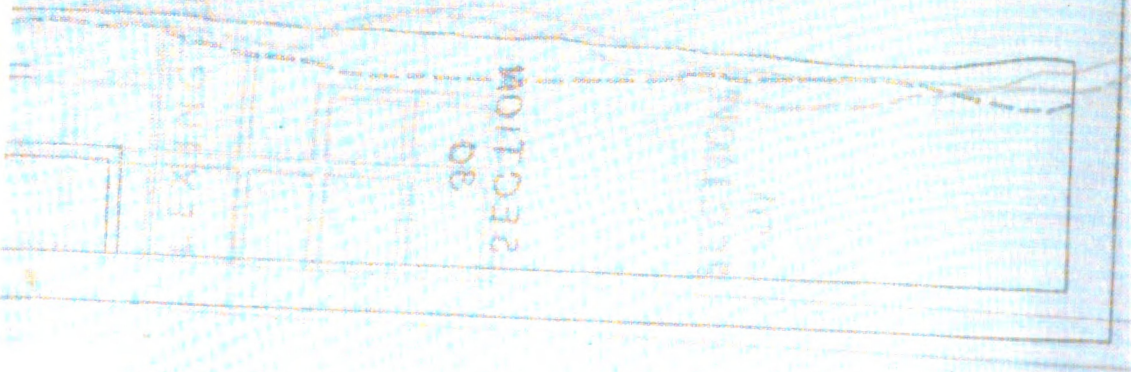


Table 1-SHORELINE AND DEPTH CONTOUR CHANGES

Station	Standard Low Water Datum	6' Depth	12' Depth	16' Depth	Remarks
1	-90	-15	-195	-270	Depth increased
2	-55	-85	-410	-530	" "
3	-10	-175	-310	----	Groin
4	-60	-40	-295	----	Depth increased
5	-40	-110	-190	----	Cliff eroded
6	-25	-165	-220	-615	Depth increased
7	-125	-65	-50	-260	" "
8	-10	-40	-250	-670	" "
9	-25	-245	-280	-660	" "
10	-35	-270	-235	-485	" "
11	-100	-55	-175	-455	" "
12	-195	-180	-45	-590	" " Pier acted as groin
13	-70	-455	-115	-650	Depth increased
14	-70	-110	-225	-670	" "
15	-105	-50	-220	-700	" " Offshore bar formed
16	-55	-140	-265	-640	Depth increased



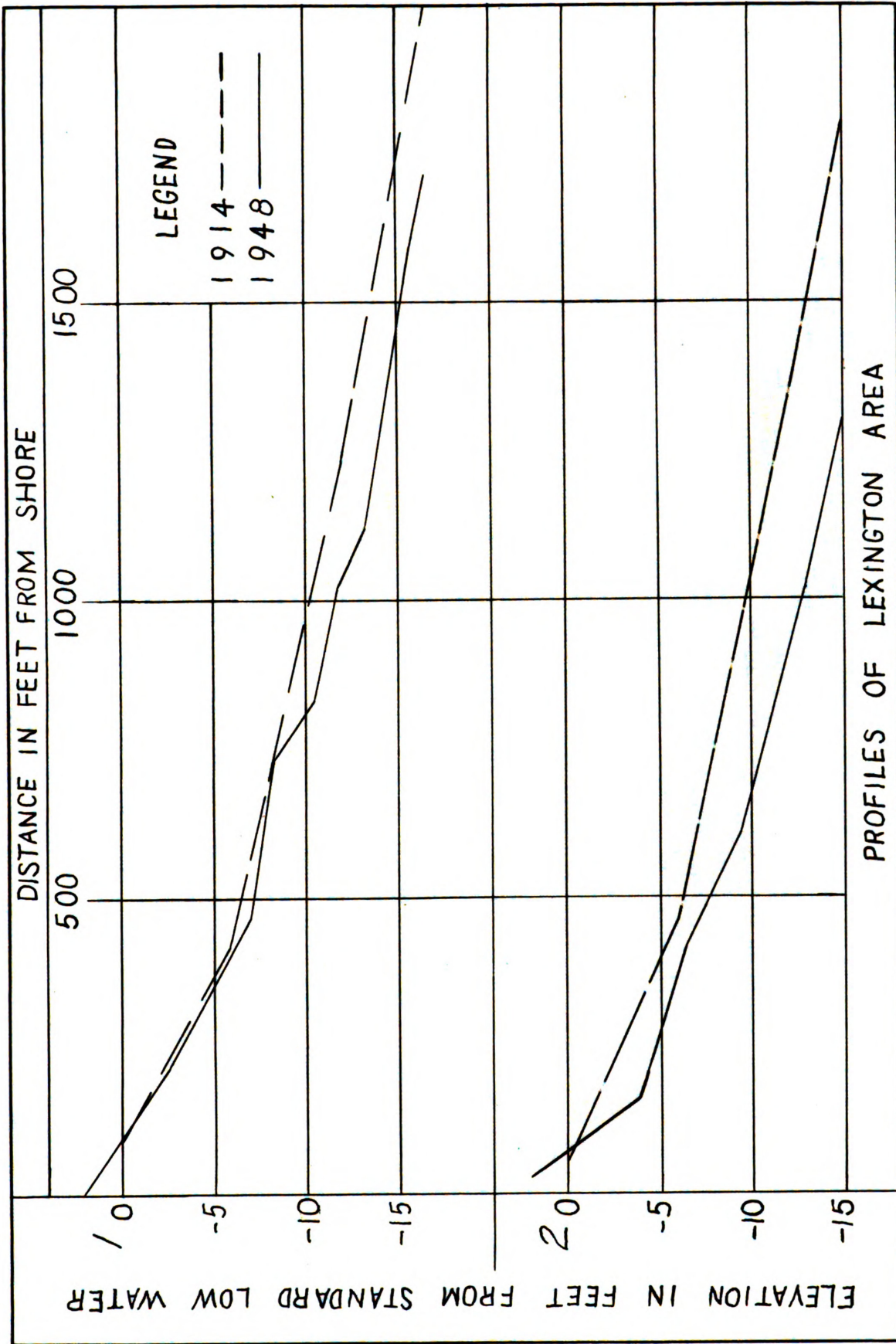
SHORELINE PLAN OF LEXINGTON AREA
 T9N R17E
 TION R17E
 SCALE ~ 1:10,000

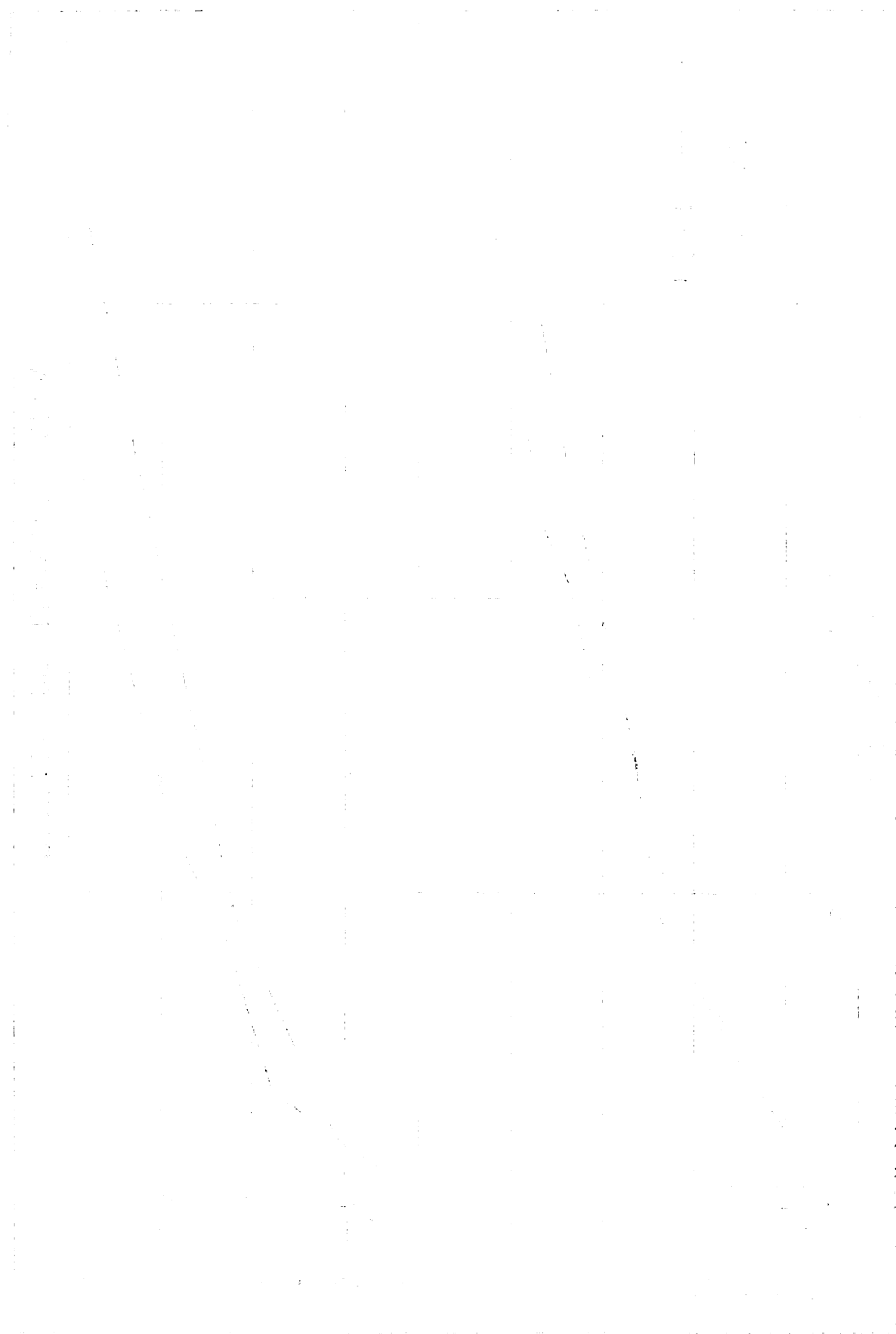


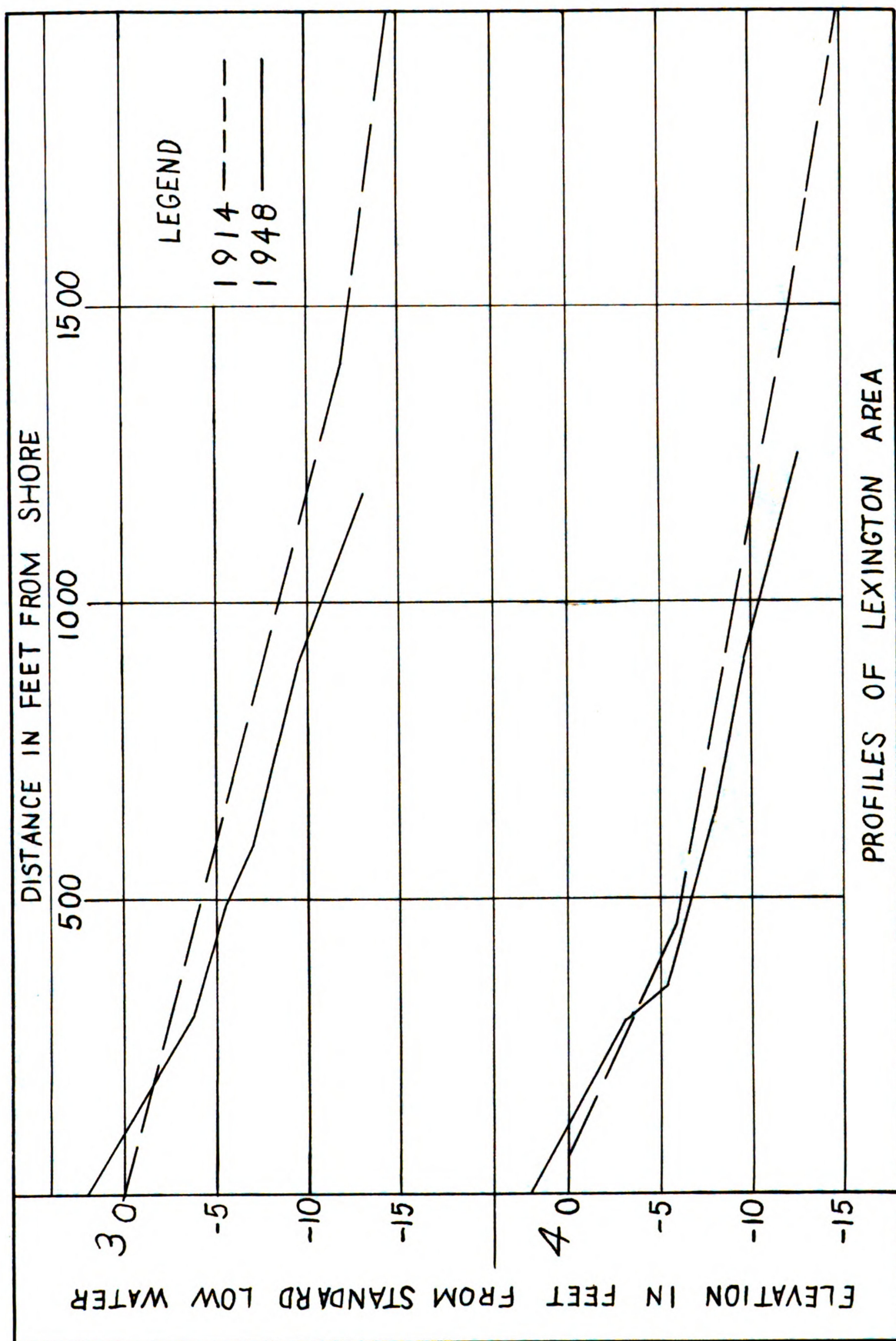
LAKE
HOBAN

DEPT

1230







PROFILES OF FLEXION AREA

ELEVATION IN FEET FROM STANDARD LOW WATER

DISTANCE IN FEET FROM SHORE

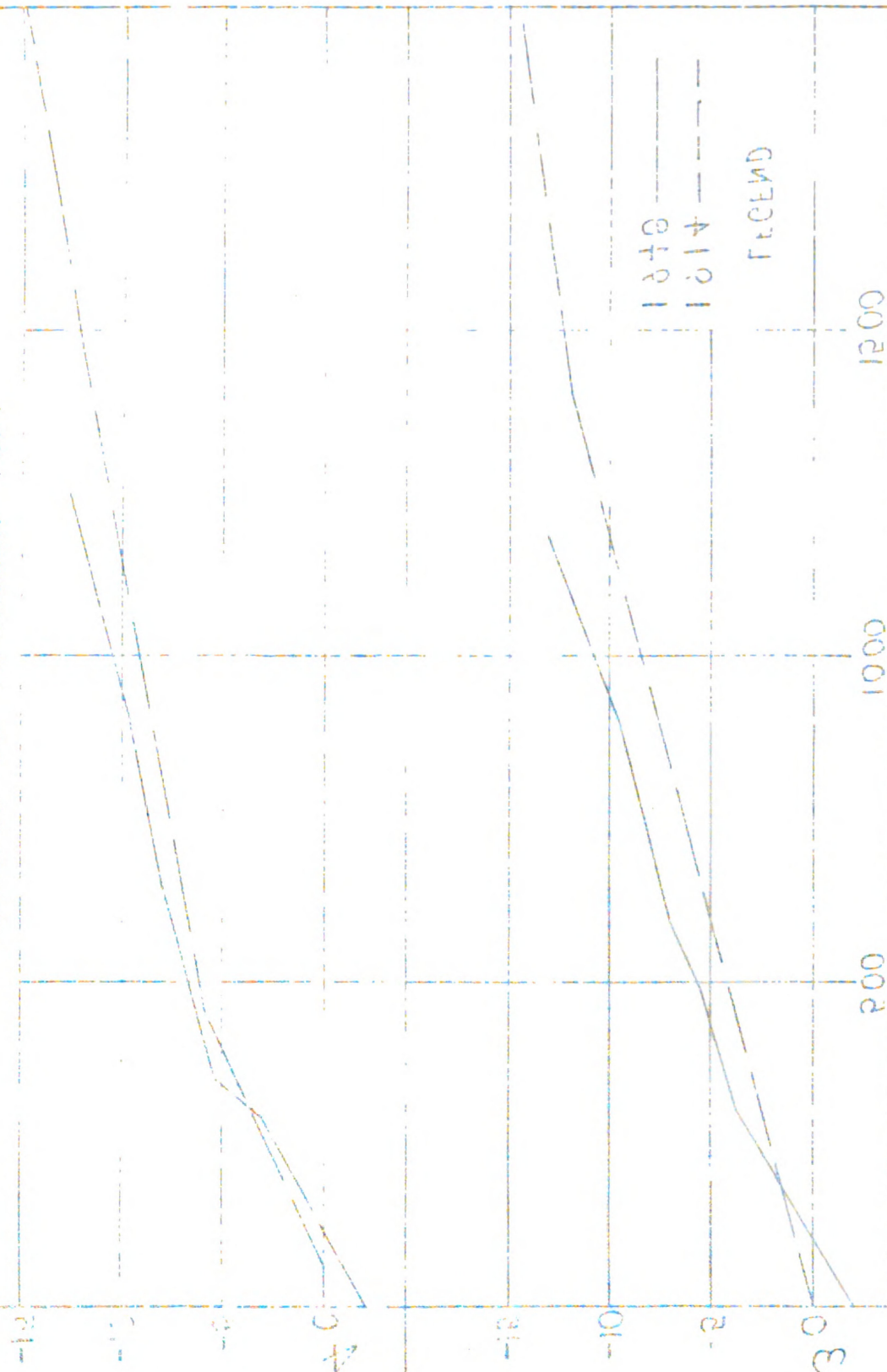
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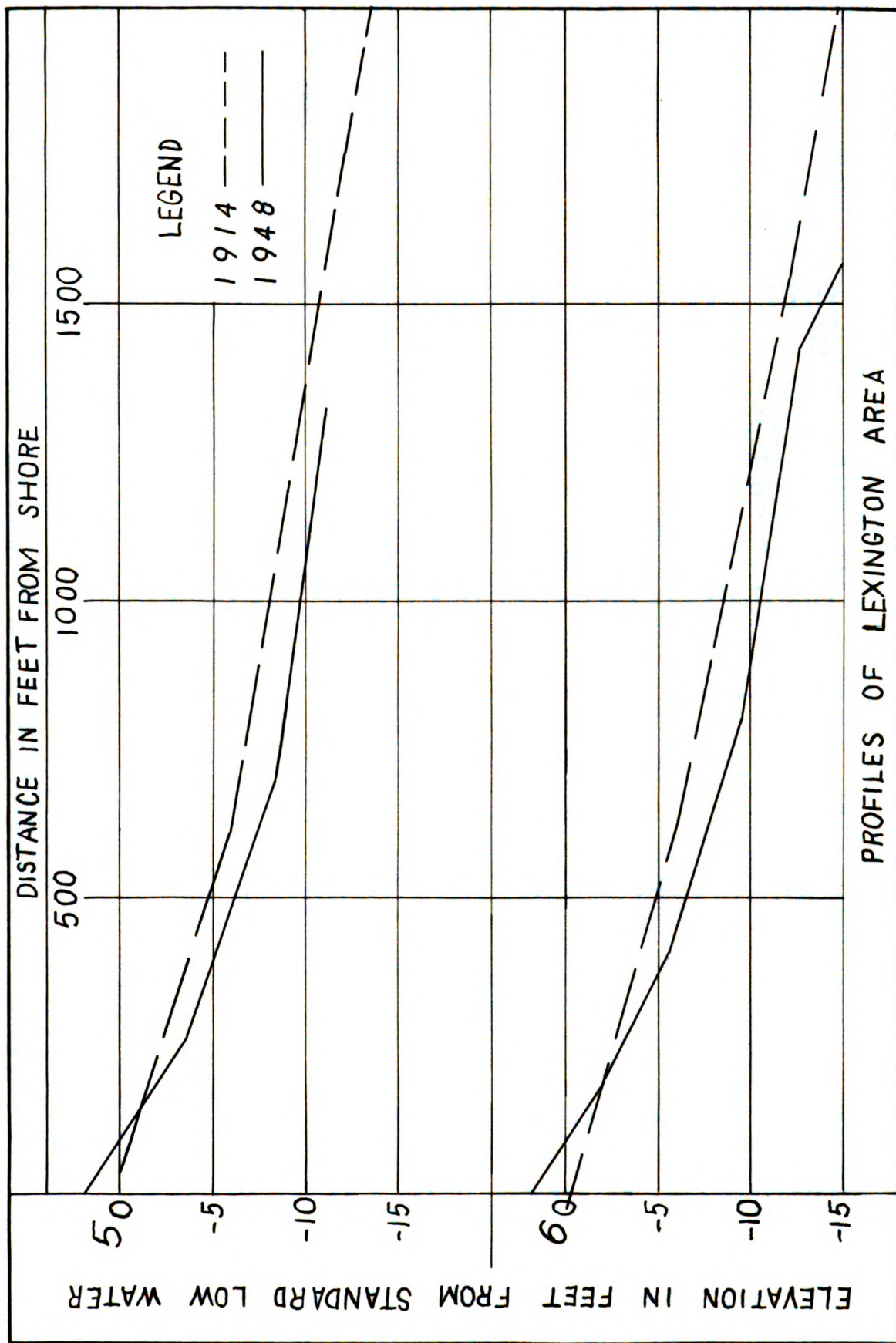
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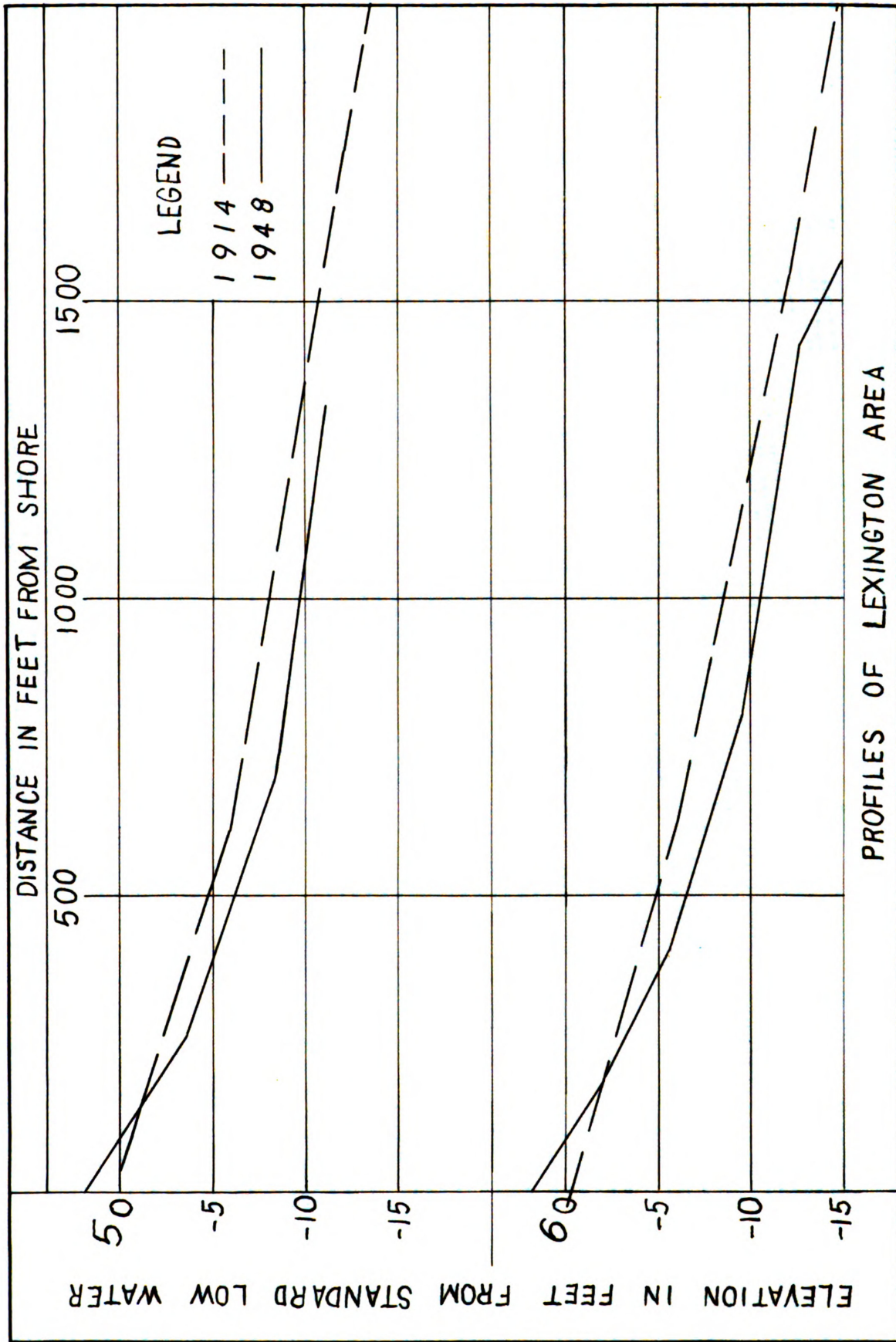
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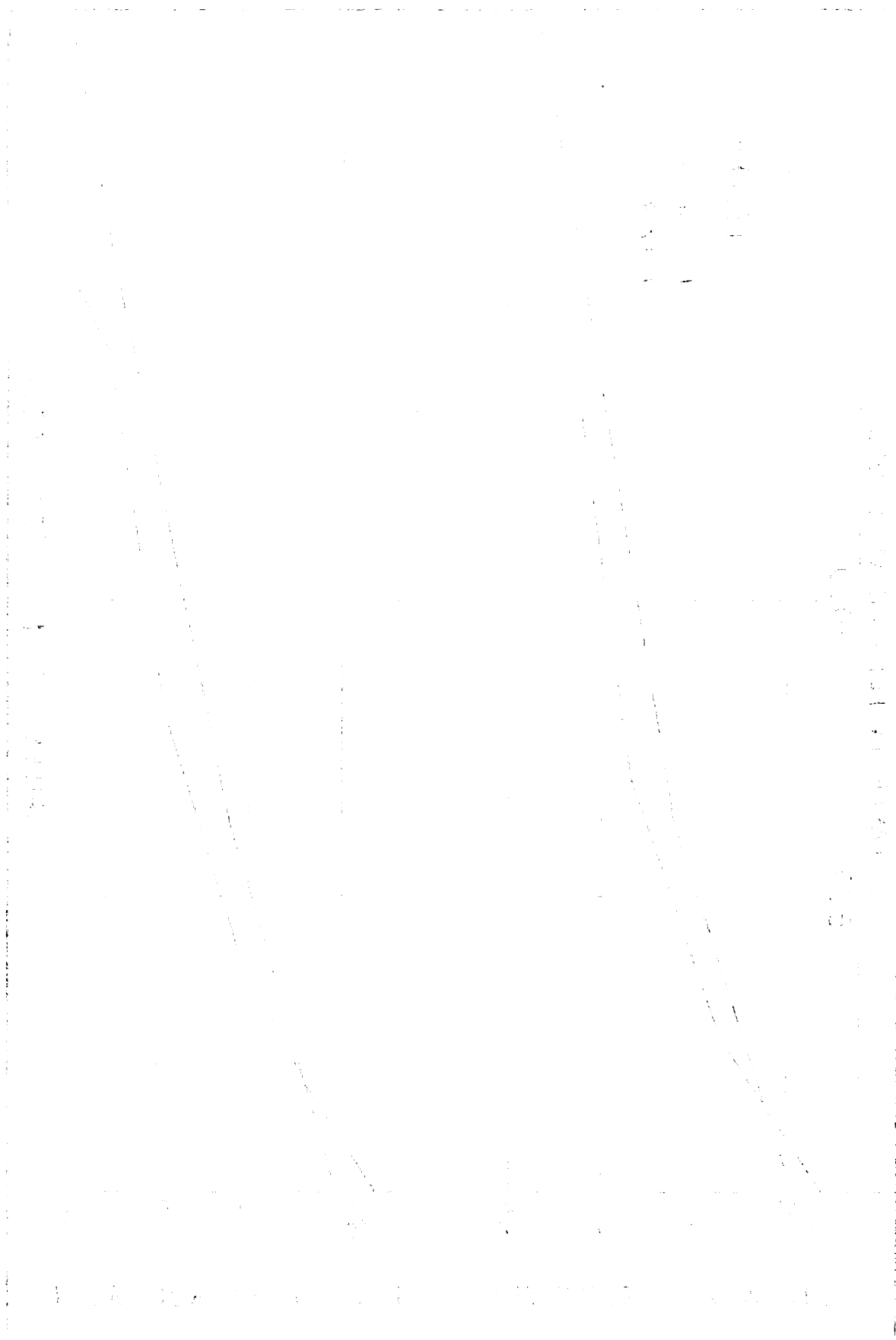
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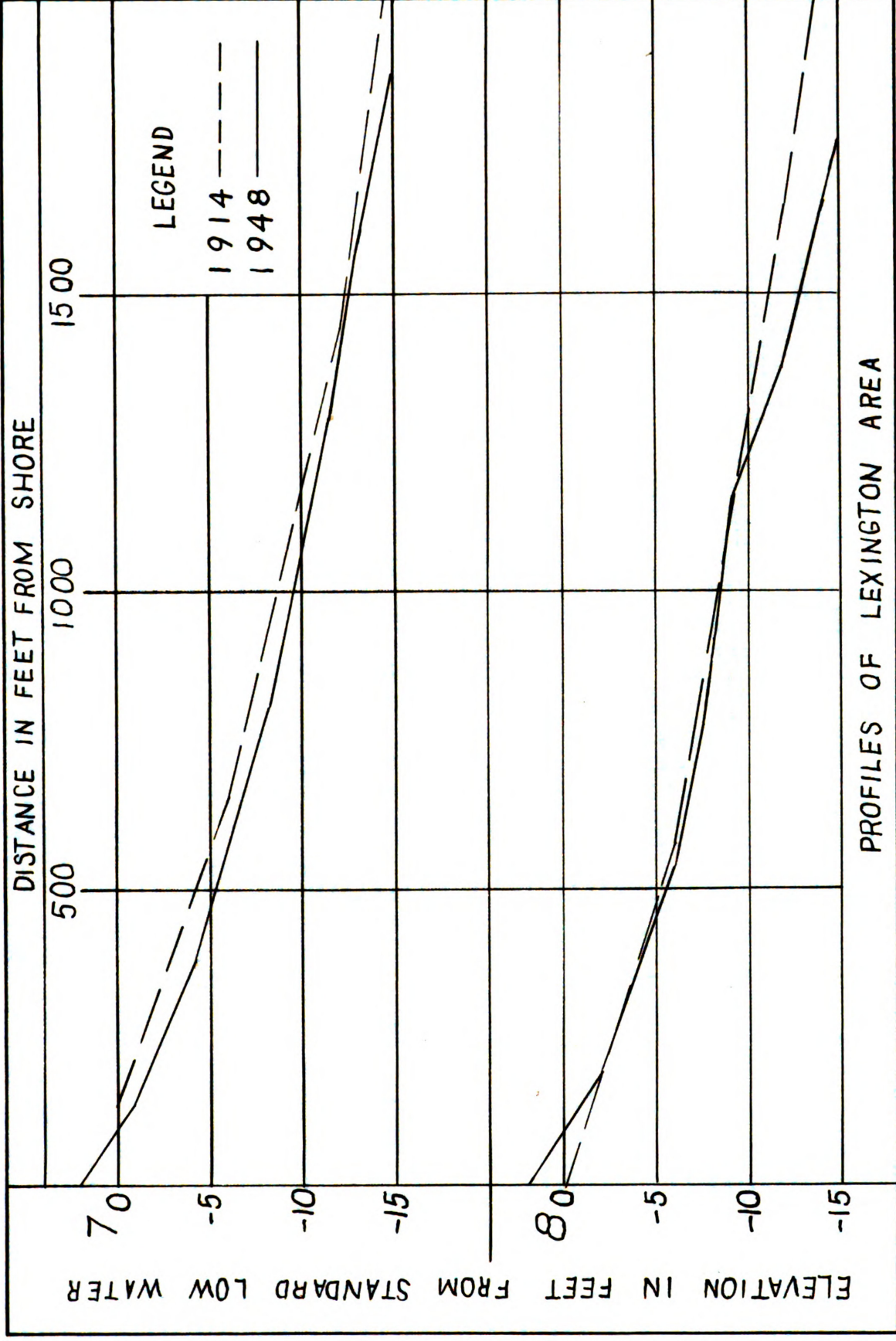
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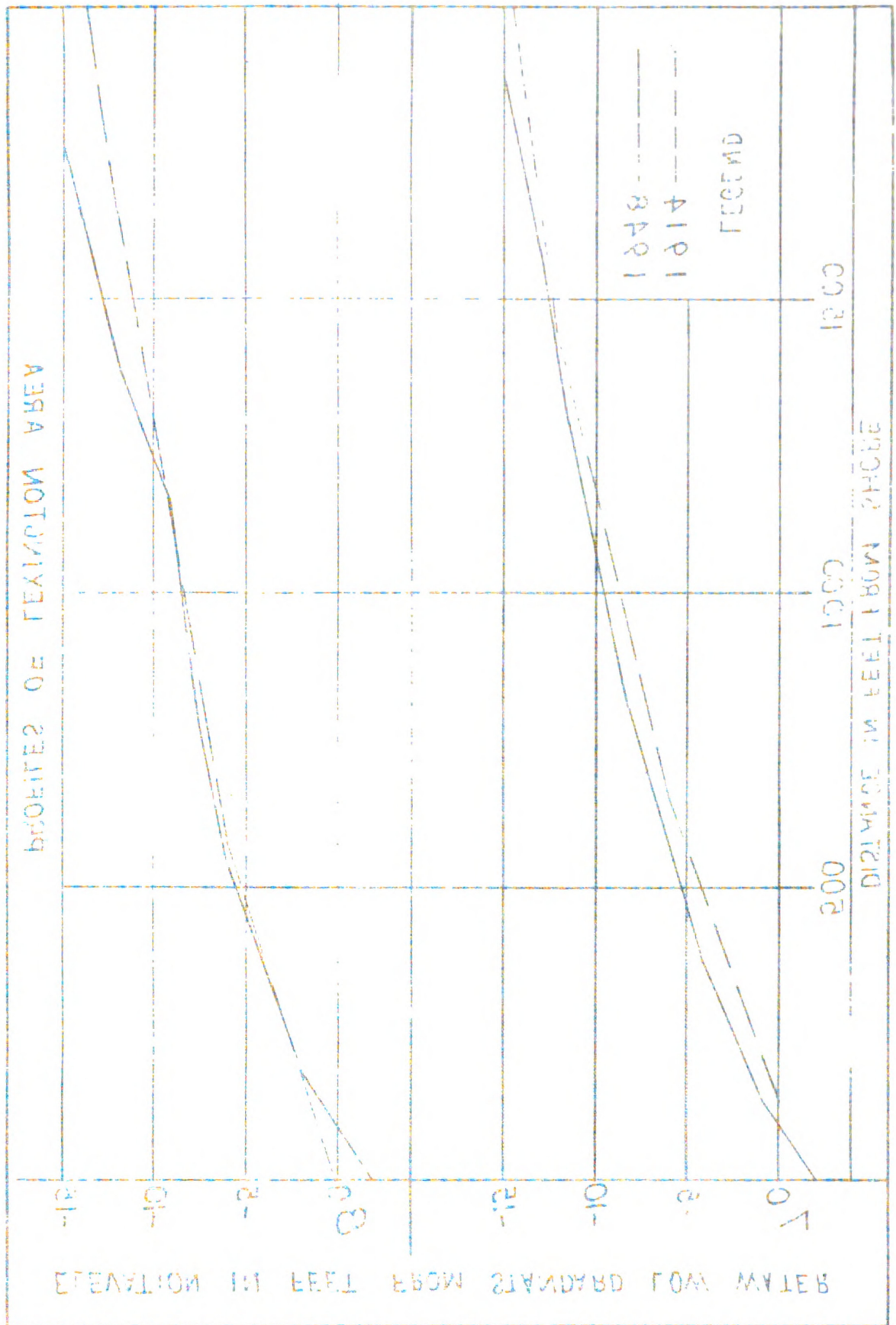


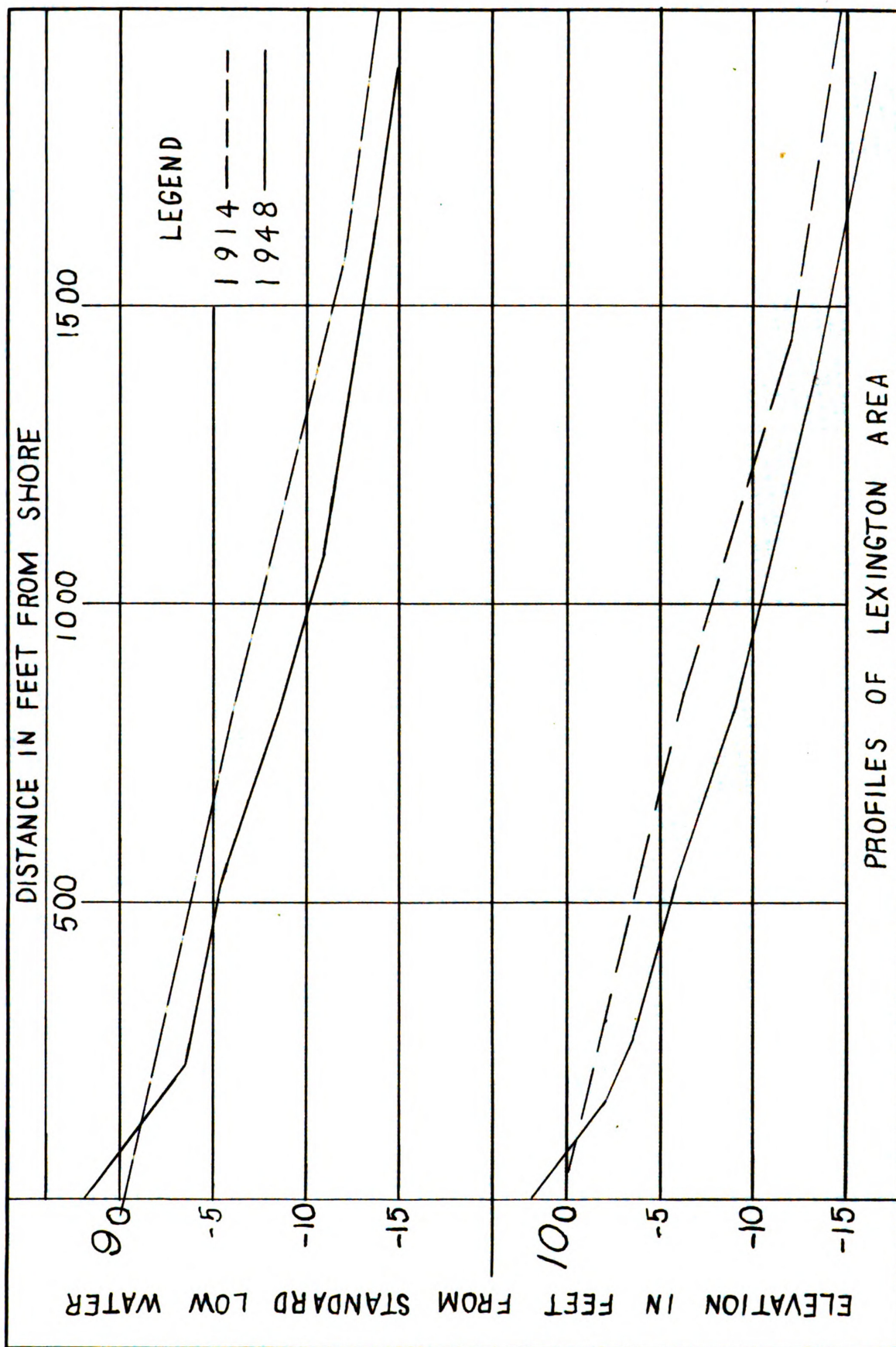


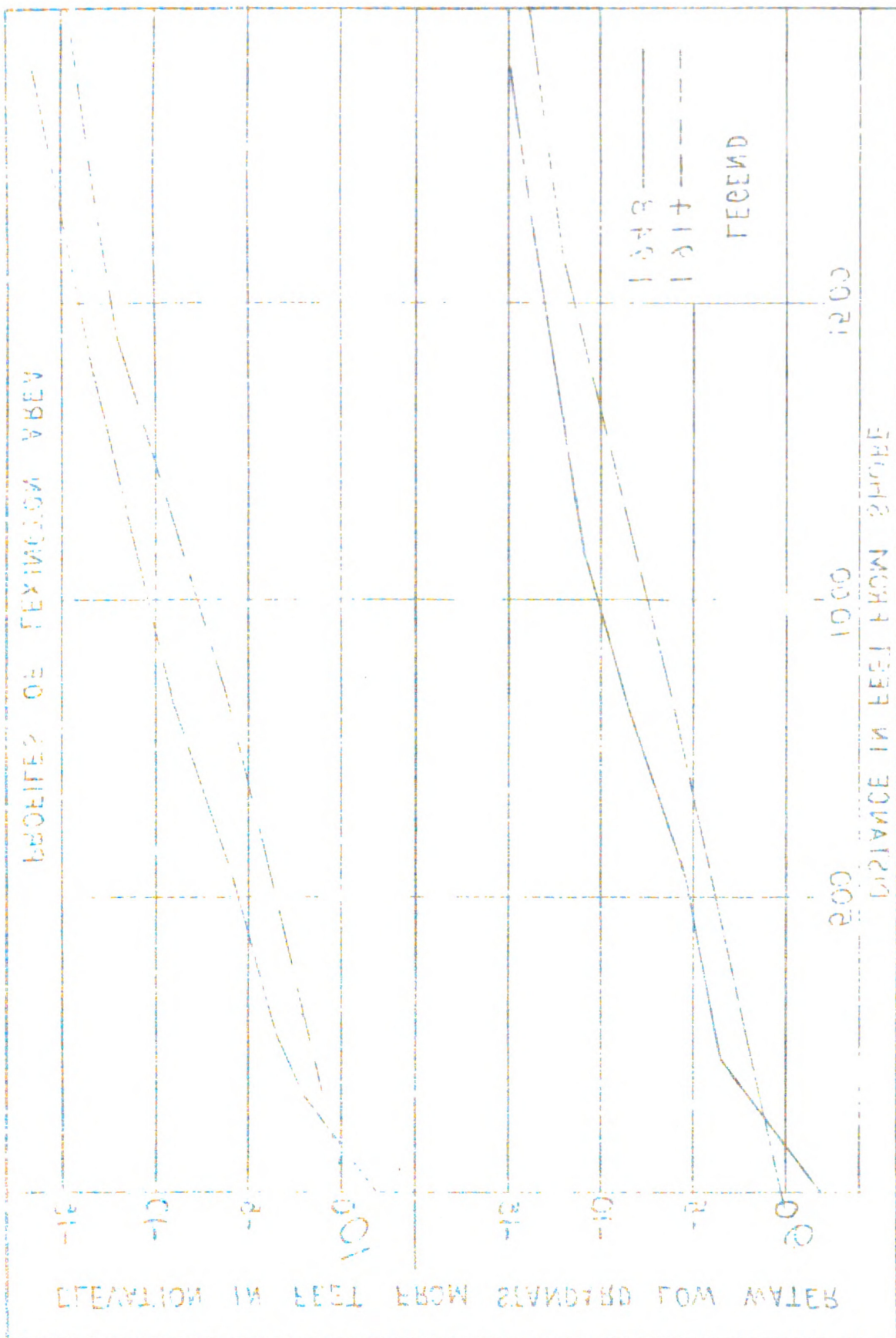


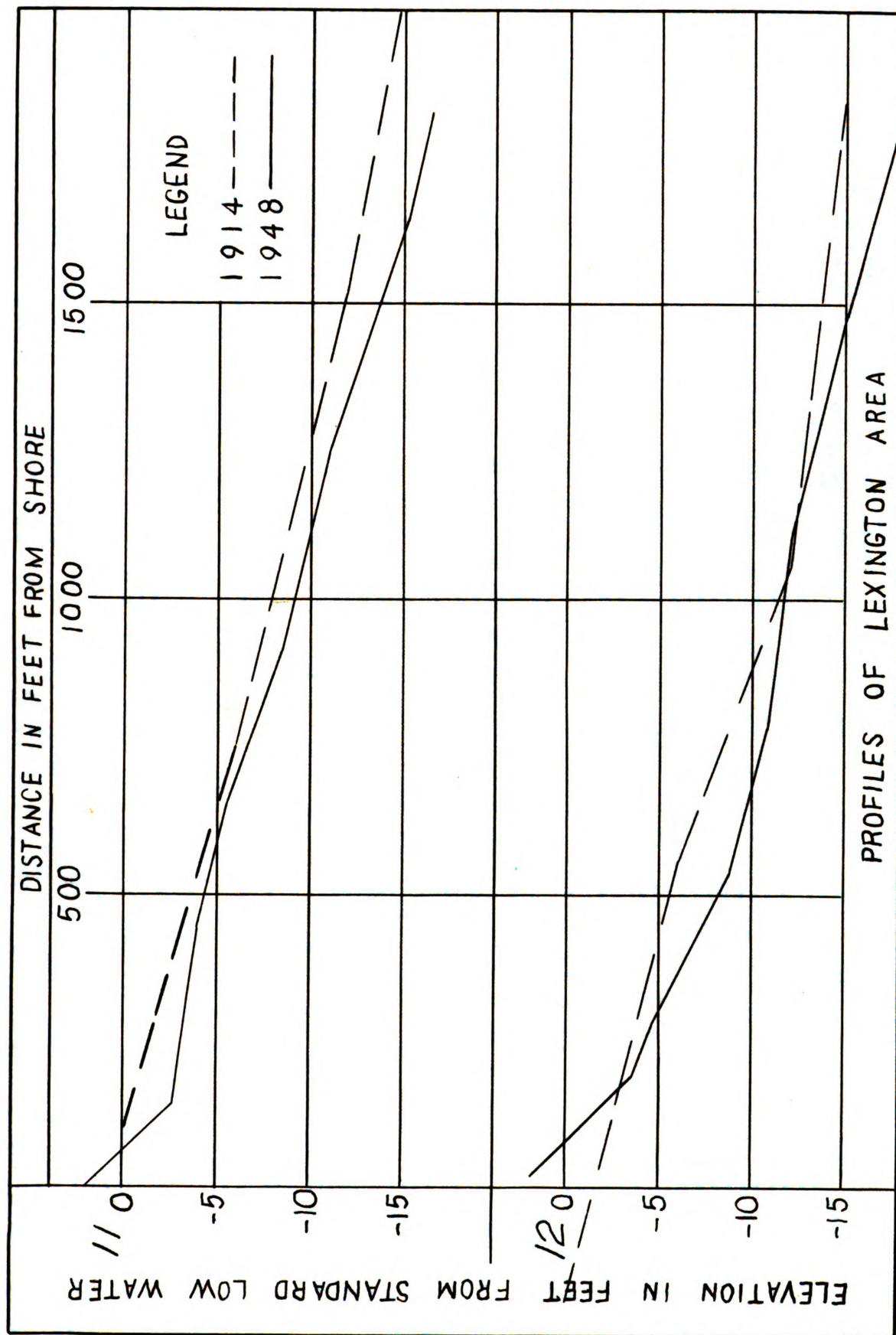


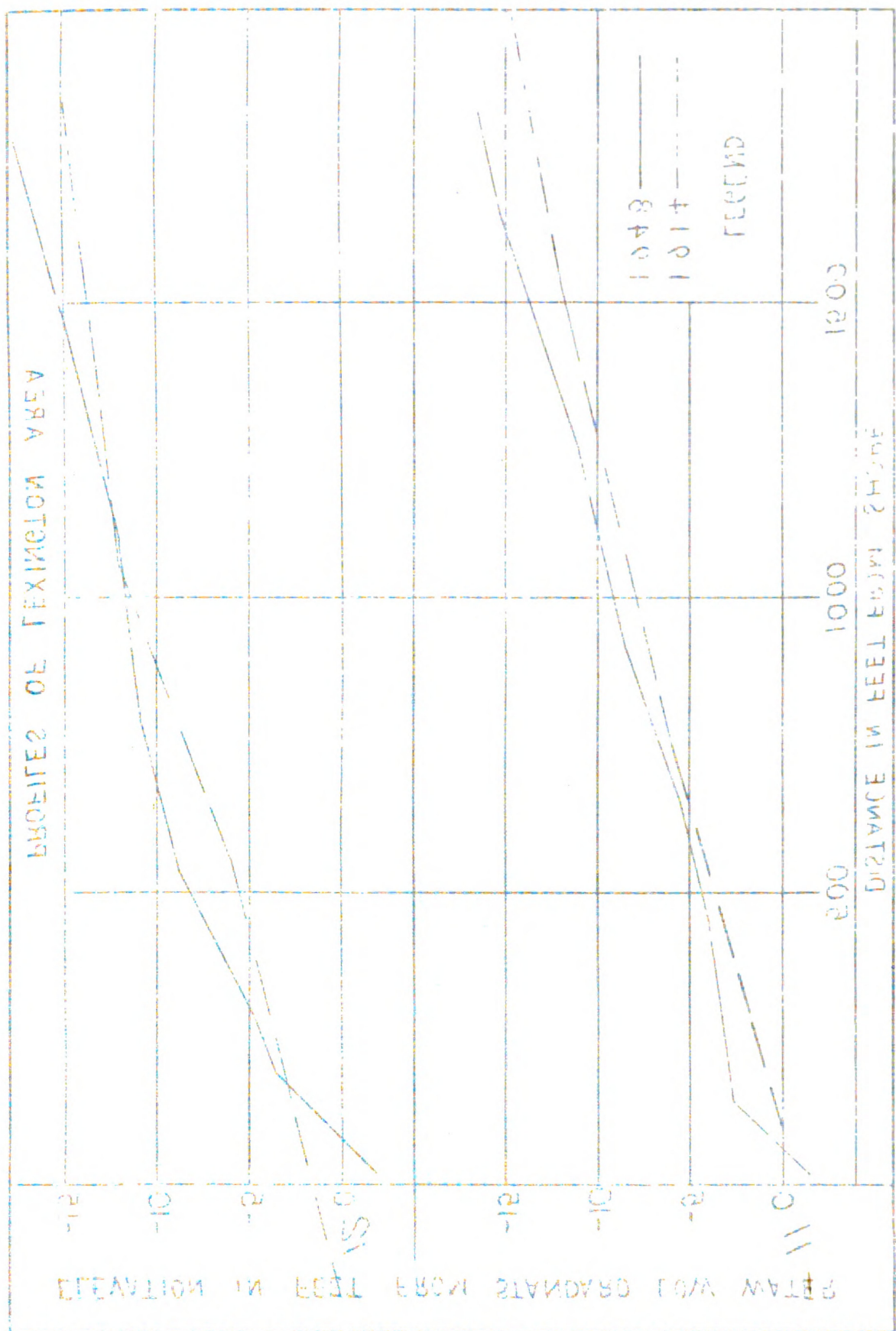


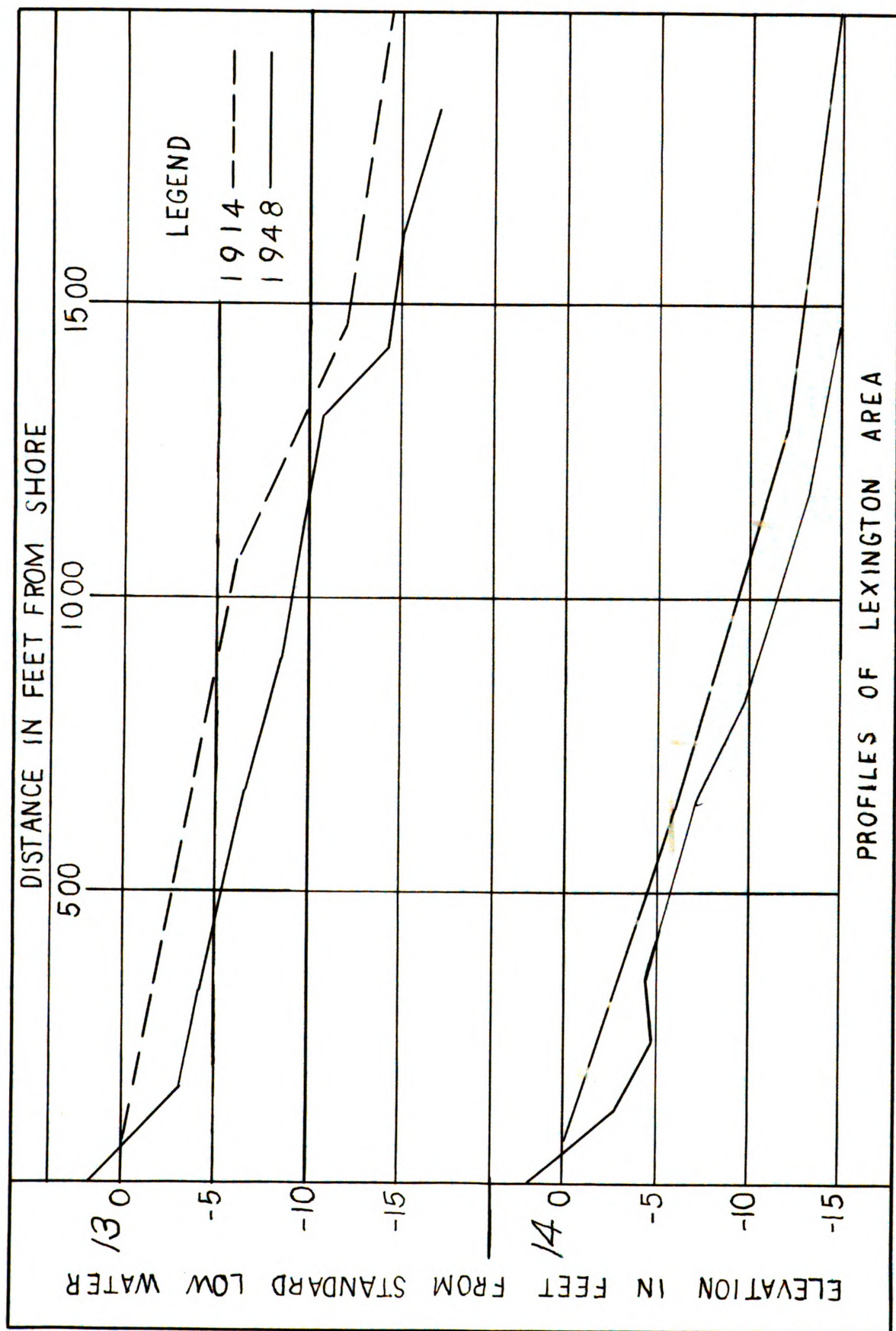


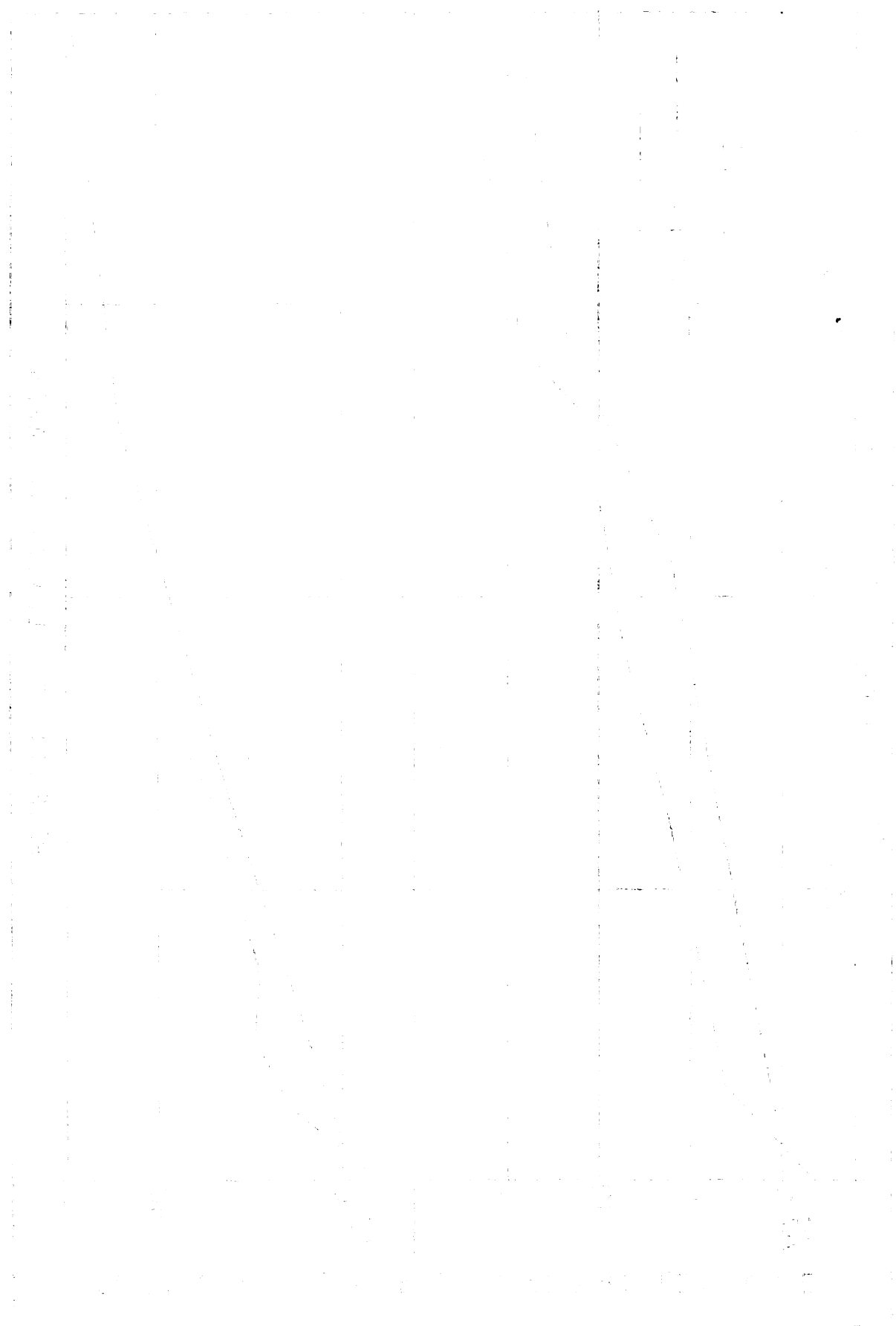


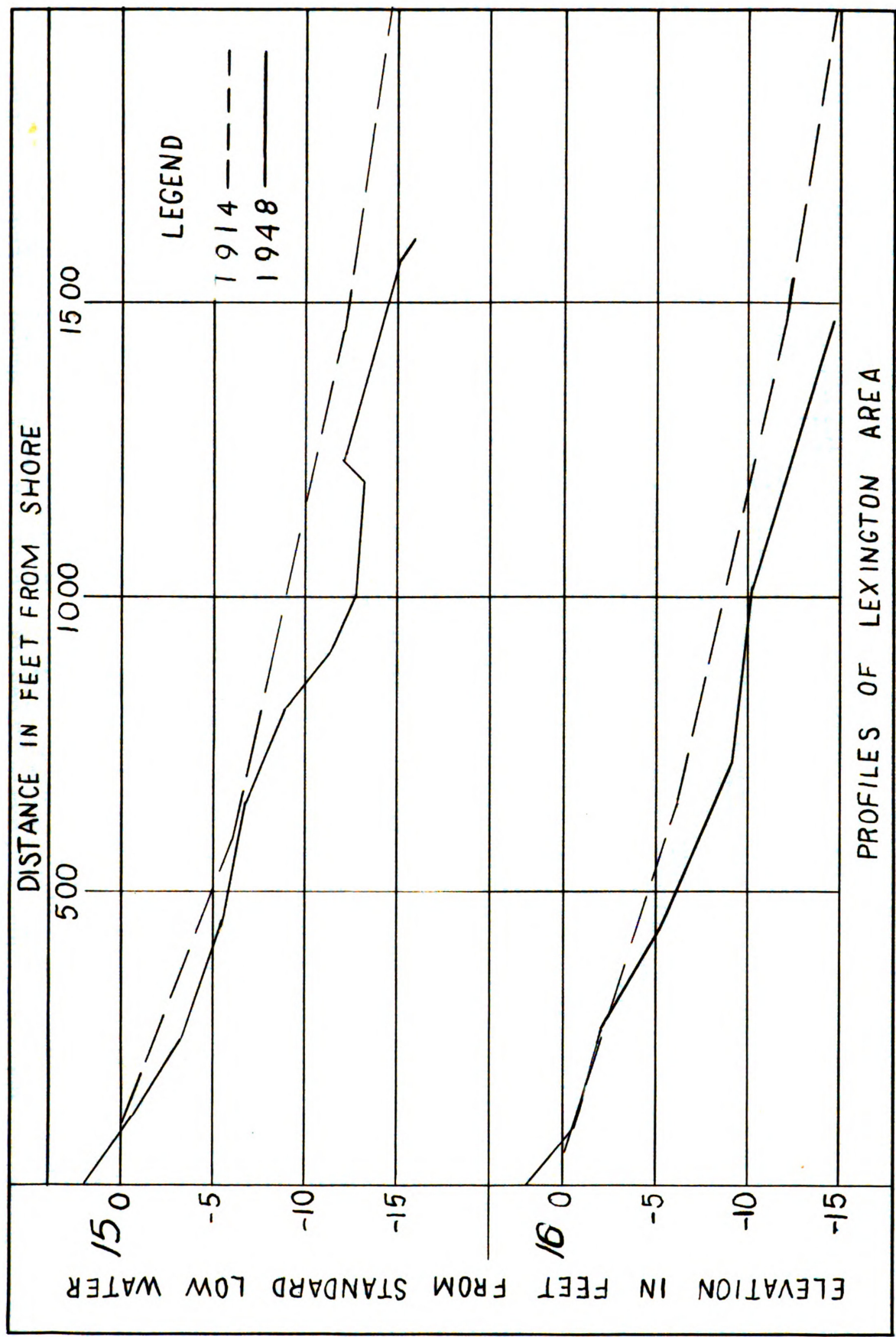


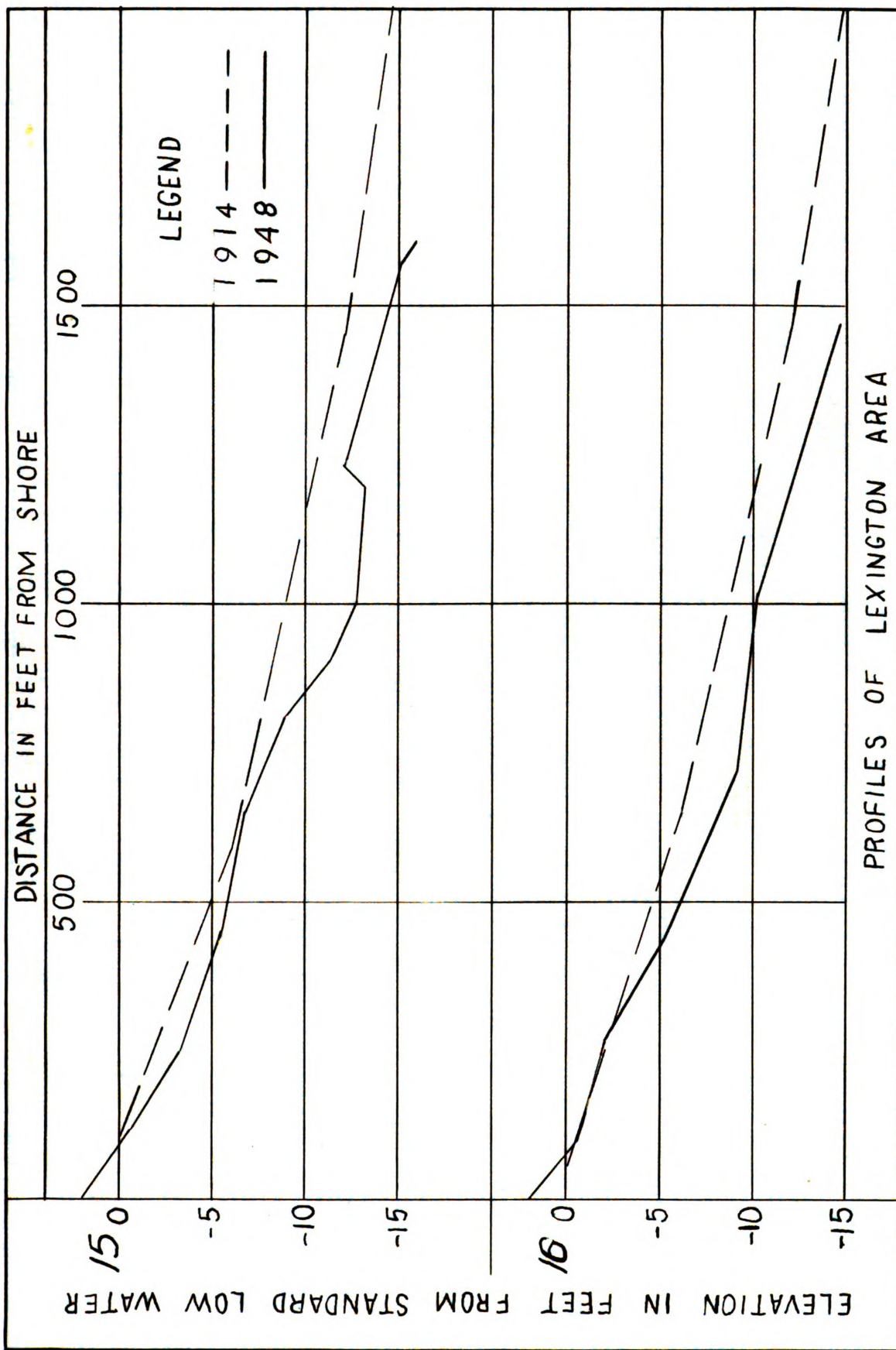


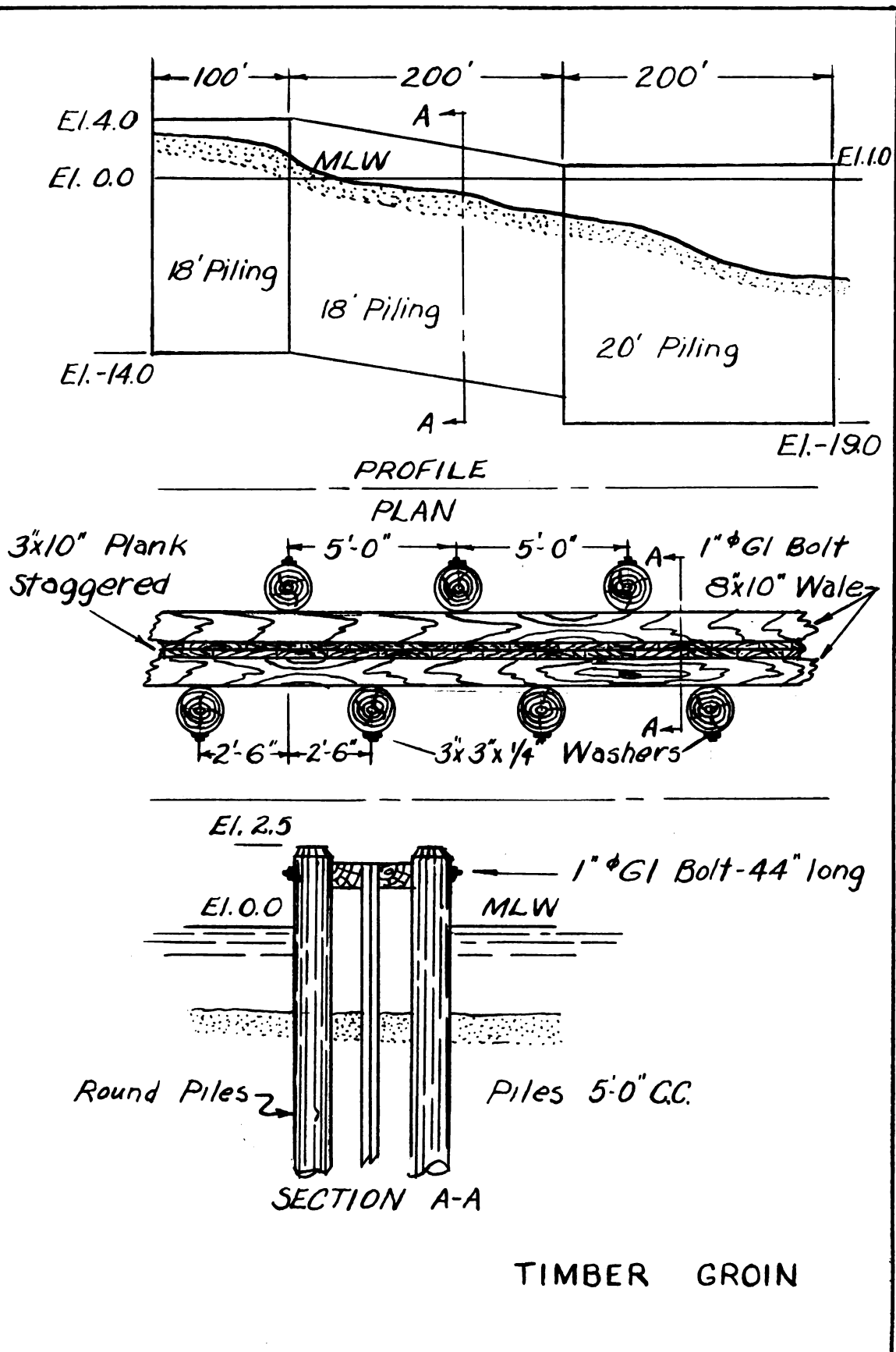












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Vol. 2 No. 1-2

C.E. Feltner

Beach Erosion in North Carolina

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