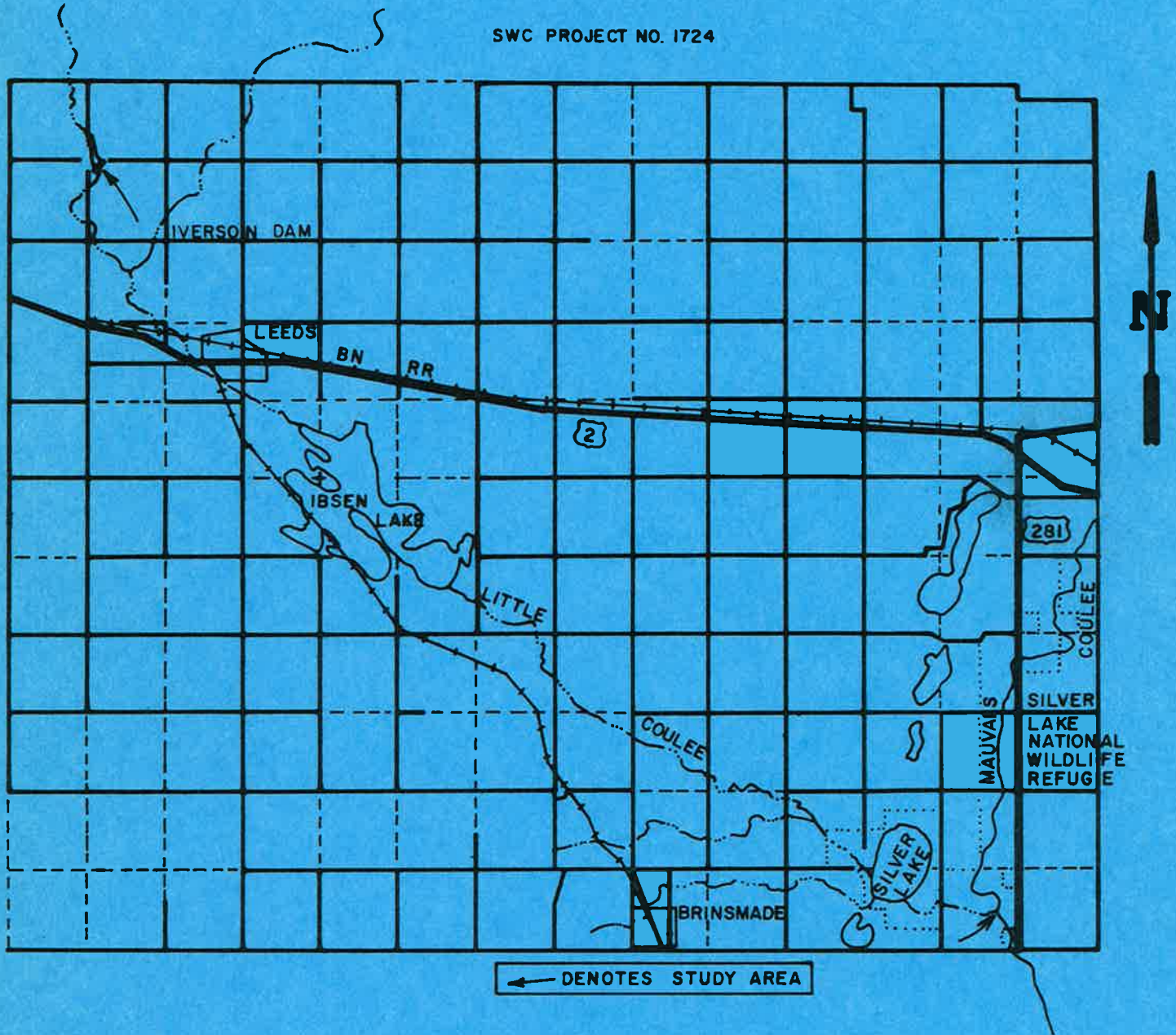
1724

PRELIMINARY ENGINEERING REPORT

LITTLE COULEE
WATER SURFACE PROFILE STUDY

SWC PROJECT NO. 1724



NORTH DAKOTA
STATE WATER COMMISSION
JULY 1981

SWC NORTH DAKOTA
STATE WATER COMMISSION
900 east boulevard
701-224-2750
bismarck 58505
north dakota

December 14, 1981

TO: Holders of the Preliminary Engineering Report for the Little Coulee Water Surface Profile Study

RE: SWC Project #1724

Gentlemen:

This letter is to correct a typing error in the Preliminary Engineering Report for the Little Coulee Water Surface Profile Study and to further explain the hydraulic analysis section, with reference to the water level increases at the structures.

A typing error was made on page 9, line five. The maximum outlet capacity of Iverson Dam should be changed from 00 cfs to 400 cfs.

In the hydraulic analysis of the 19 structures, starting on page 10, some of the water level increases are greater for a 25-year event than for the 100-year event. The increases are correct as written. The reason for the greater increase for the 25-year event is due to the fact that the increases are measured from the downstream flow elevation. Since the 25-year flow is considerably less than the 100-year flow, the downstream elevation for the 25-year event will be much less than the 100-year event. Once the structure is overtopped, the increase due to the added 100-year flow is very little since the top of the structure or road can handle large flows easily.

Sincerely,

David A. Sprynczynatyk

David A. Sprynczynatyk, P.E.
Director of Engineering

DAS:sh

PRELIMINARY ENGINEERING REPORT

Little Coulee
Water Surface Profile Study

SWC Project #1724
July, 1981

North Dakota State Water Commission
State Office Building
900 East Boulevard
Bismarck, North Dakota 58505

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PLATES

I. INTRODUCTION

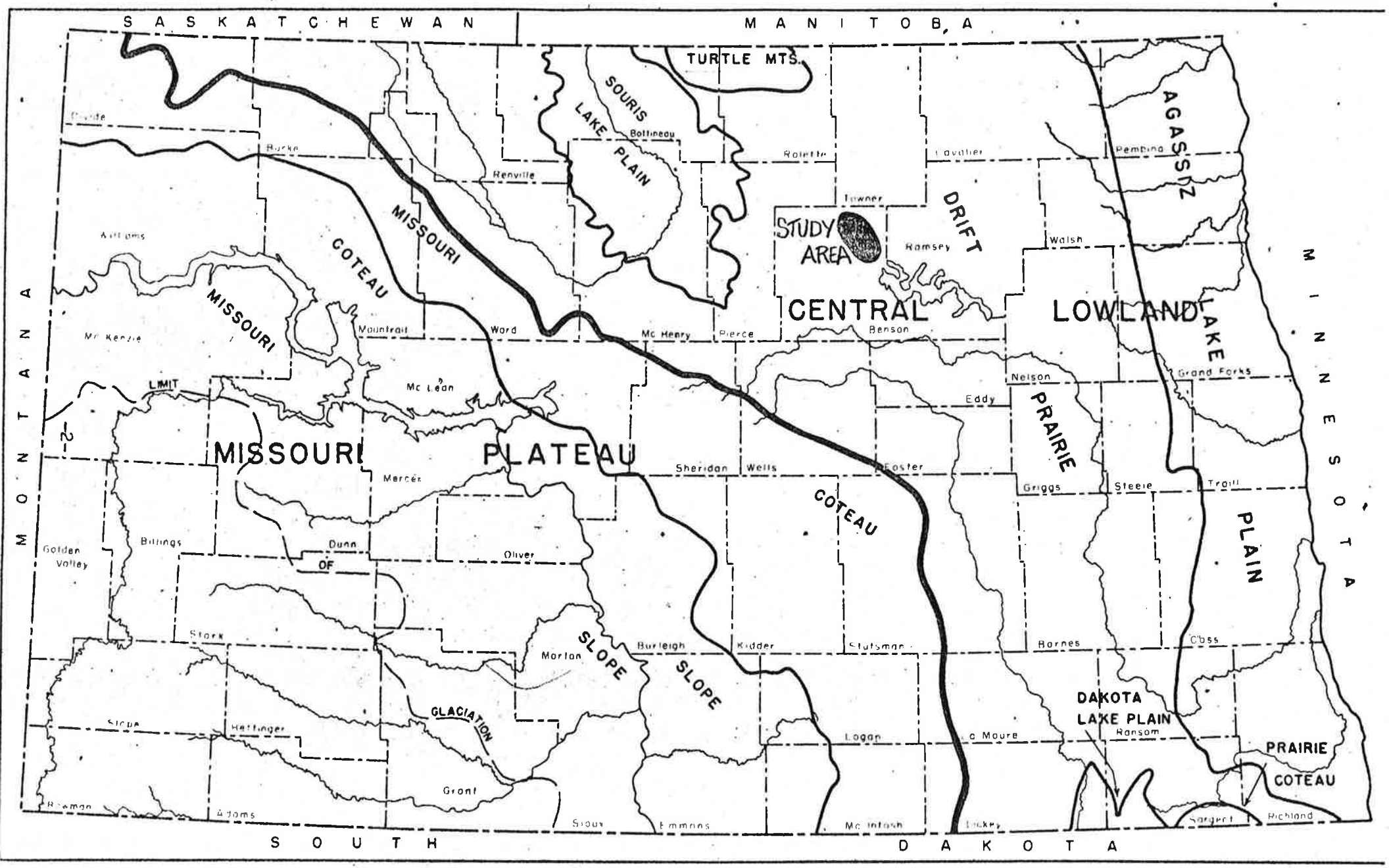
This report on the flooding of Little Coulee near Leeds contains the results of a study conducted by the State Water Commission in cooperation with the Devils Lake Basin Joint Water Management Board. A preliminary Investigation Agreement with the Joint Board was made on April 23, 1980. A copy of the Agreement may be found in Appendix A. Figure 1 shows the general location of the study area. Study area limits are shown in Figure 2. The study's major objective was to analyze the flow of the coulee during flooding conditions. It also looked at the effects of additional flows due to possible discharges from Hurricane Lake. These were estimated to be 100 c.f.s. From this analysis, structures affecting the flow of the water were identified and recommendations as to what could be done to improve the flood flow were presented along with an estimated cost for their implementation.

The engineering analysis of Little Coulee included a hydrologic study. Water surface elevations at various structures and crossings were calculated and from this information, water surface profiles were developed. They were used to determine the effect of existing channel conditions and structures on selected flows.

II. DESCRIPTIONS OF STUDY AREA

Study Area Location

Little Coulee is the major tributary to Lower Mauvais Coulee with a drainage area of approximately 400 square miles and consists of approximately 19.4 miles of river channel. Starting at the outlet of Iverson Dam in Section 24, Township 156 North, Range 69 West, the study area extends southeast through Lake Isben and Silver Lake. It ends at the confluence with Lower Mauvais Coulee in Section 2, Township 154 North, Range 67 West; all in Benson County (See Figure 2).



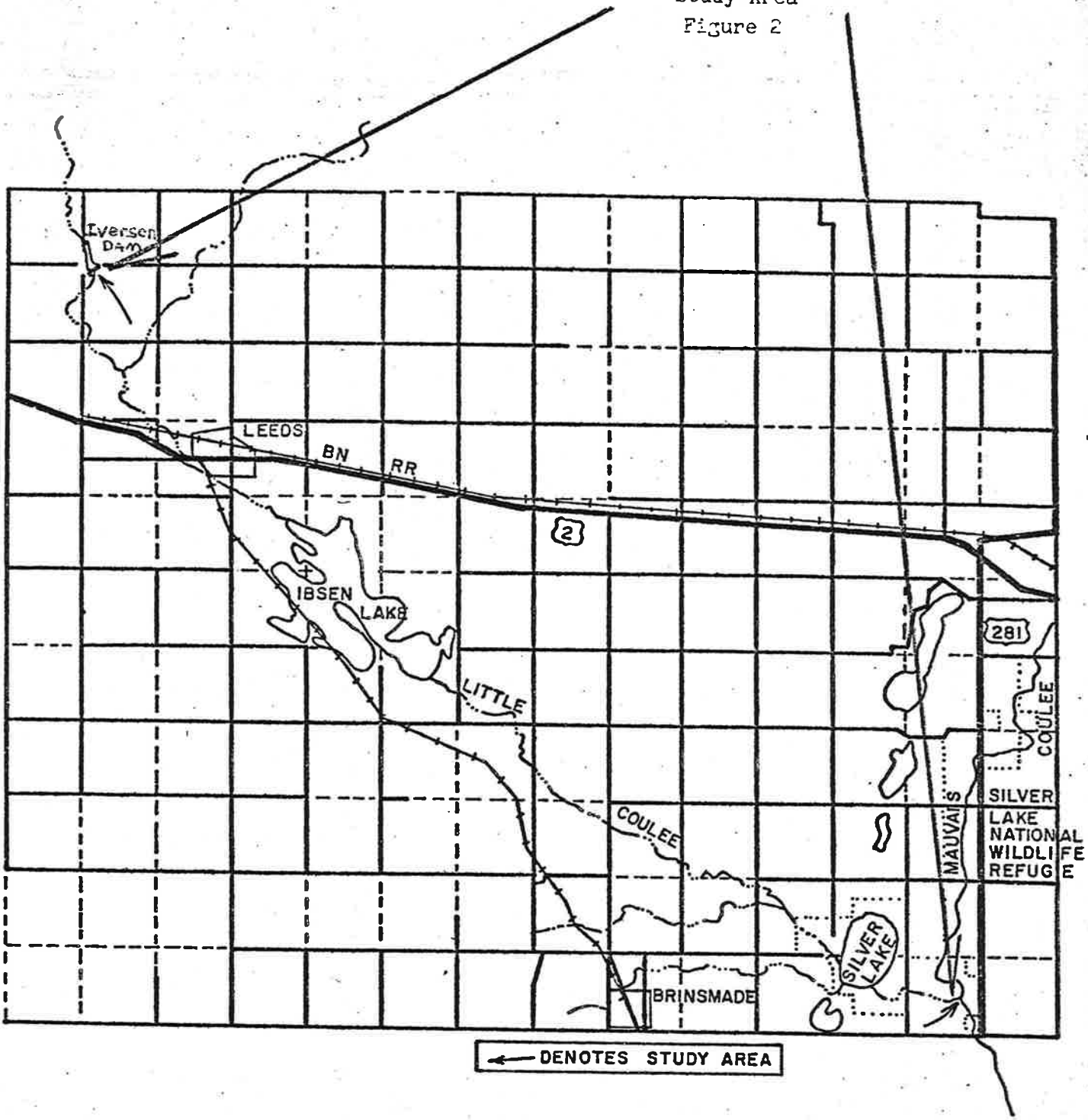
(Modified from Clayton-1962)

SCALE

Location Map

Figure 1

Study Area
Figure 2



Watershed and Stream Characteristics

Average channel cover is medium grass one to three feet tall with a few areas of heavy grass and brush three to six feet tall. On the average, the channel slopes at a rate of 5.2 feet per mile. There is a steep drop of 40 feet in 2.9 miles from Iverson Dam to structure five, approximately 1.0 mile northwest of Leeds. From Leeds to structure 13 the slope is gentle, but it increases along the reach to Silver Lake.

III. ENGINEERING ANALYSIS

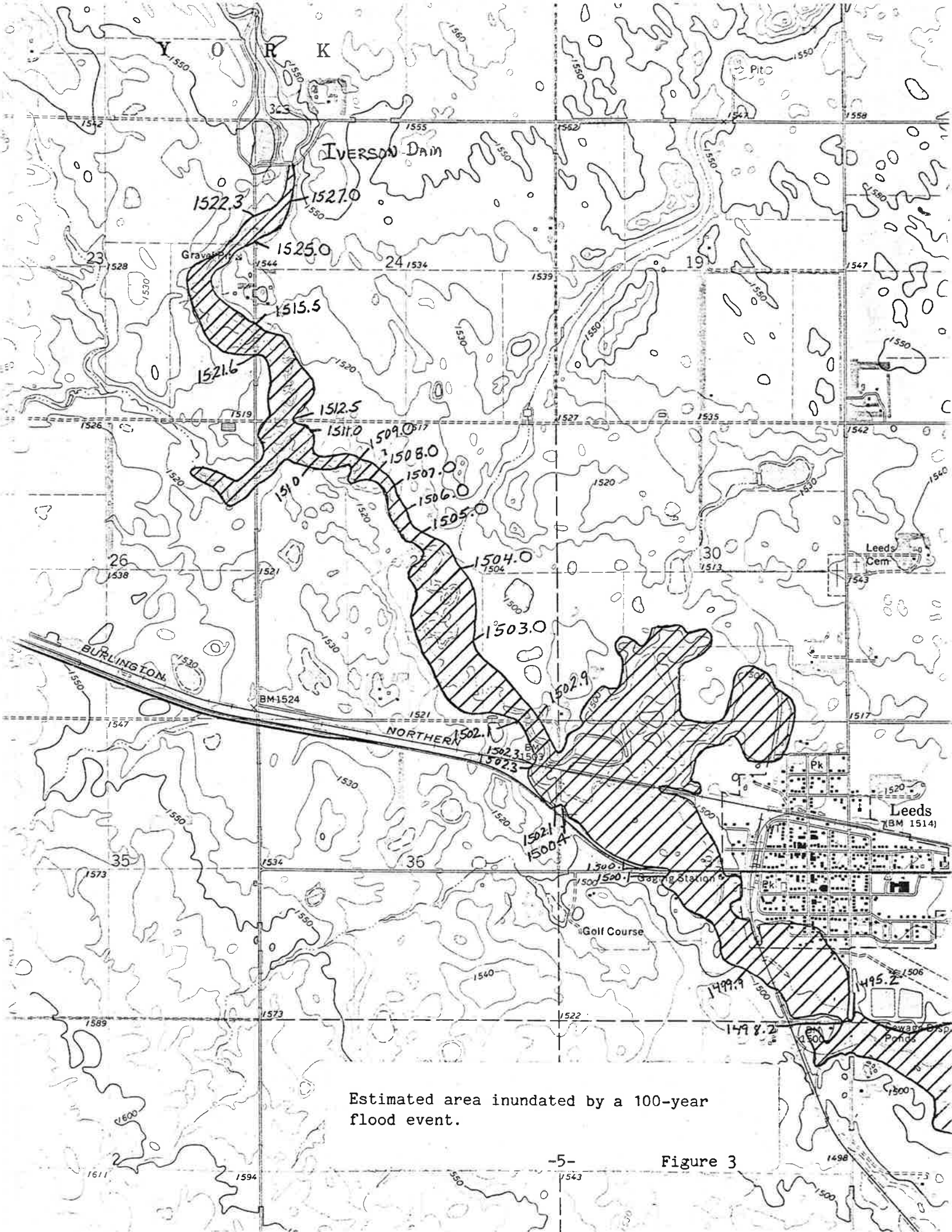
Study Procedures

Water surface elevations were calculated for a 25-year flood, 100-year flood, and 100 cfs above the 100-year flood. These flows were determined from stage gage data of 1979. A U.S. Geological Survey stream gage is located on the section line road between Section 2 and 3, Township 154 North, Range 67 West. This information, combined with a topographic survey consisting of stream profiles, cross sections, and structure details, was used to determine water surface elevations for flood flows along the study area. These water surface elevations were used to plot a water surface profile along Little Coulee for existing conditions. From this information, problem areas can be identified and alternatives for improvements selected.

The area along the coulee inundated by a 100-year event was outlined on topographic maps. (See Figures 3 through 8) These areas were determined by using the water surface profiles and comparing them to the contours of the adjacent land. Water surface elevations of the 100-year event were plotted without considering floodplain encroachments. Therefore, the area delineated on the maps cannot be considered a floodway.

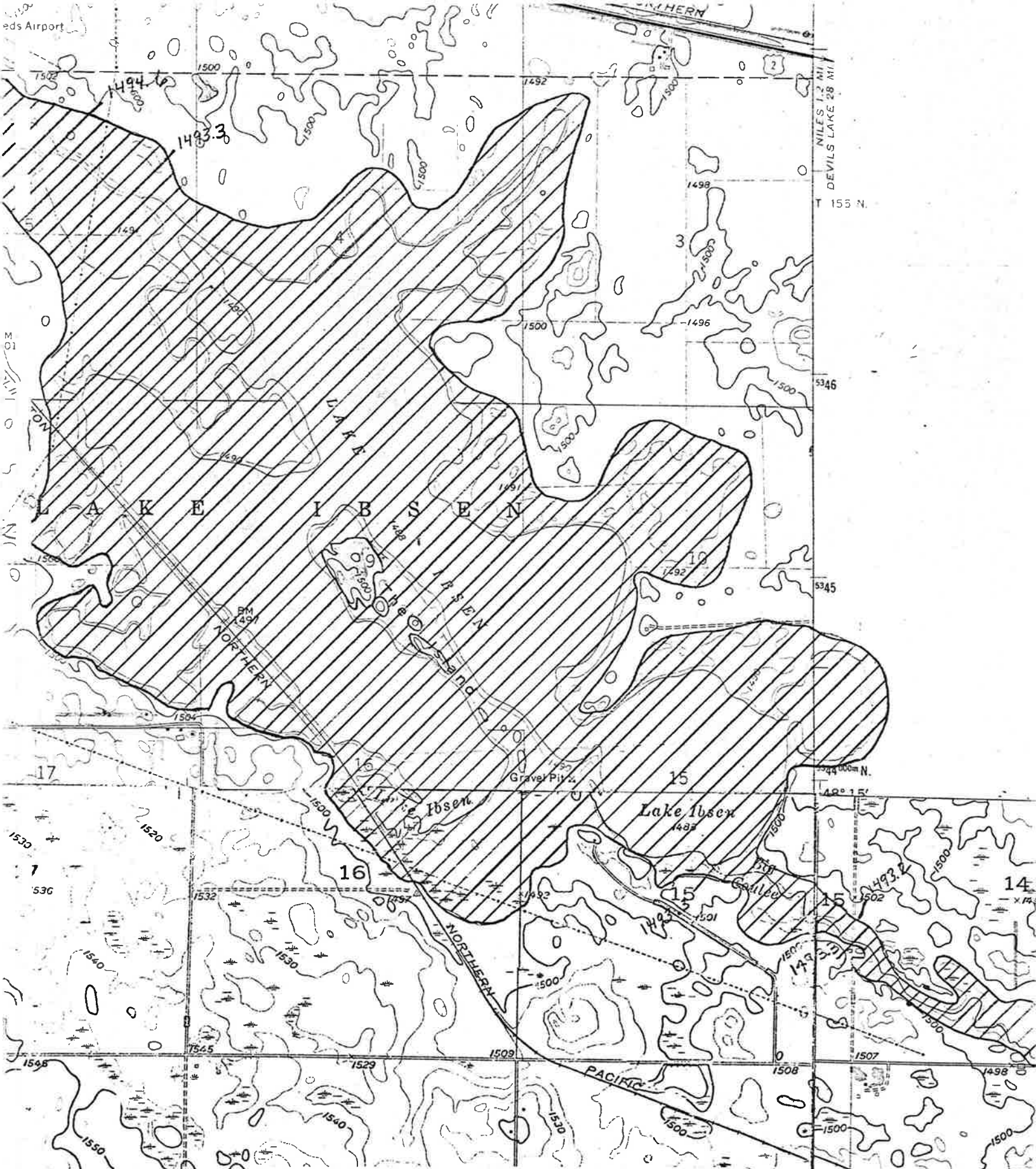
Base Flood

Over the years, the Devils Lake Basin has undergone many changes which makes it difficult to accurately determine a 25-year or 100-year flood discharge.



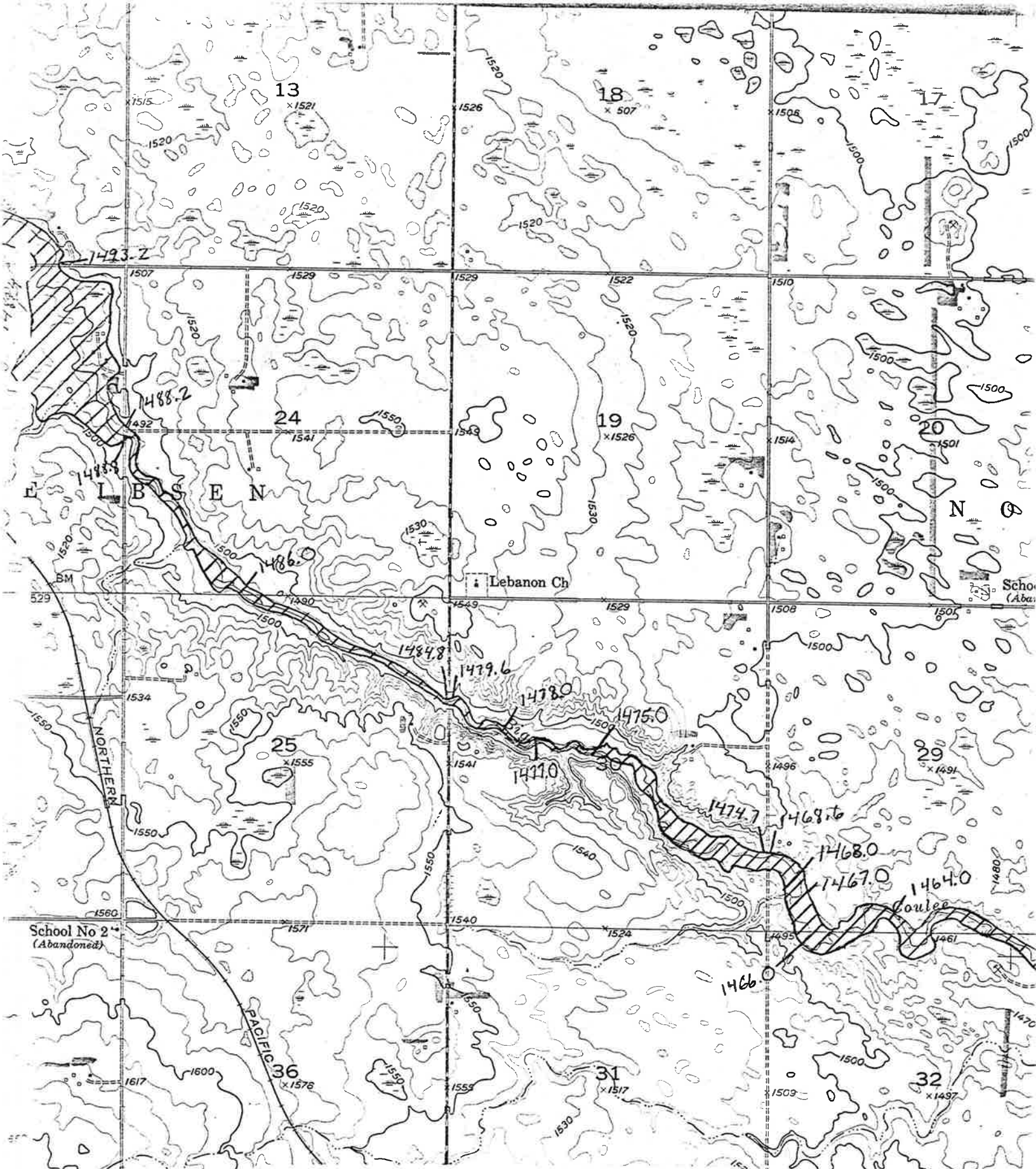
Estimated area inundated by a 100-year flood event.

Figure 3



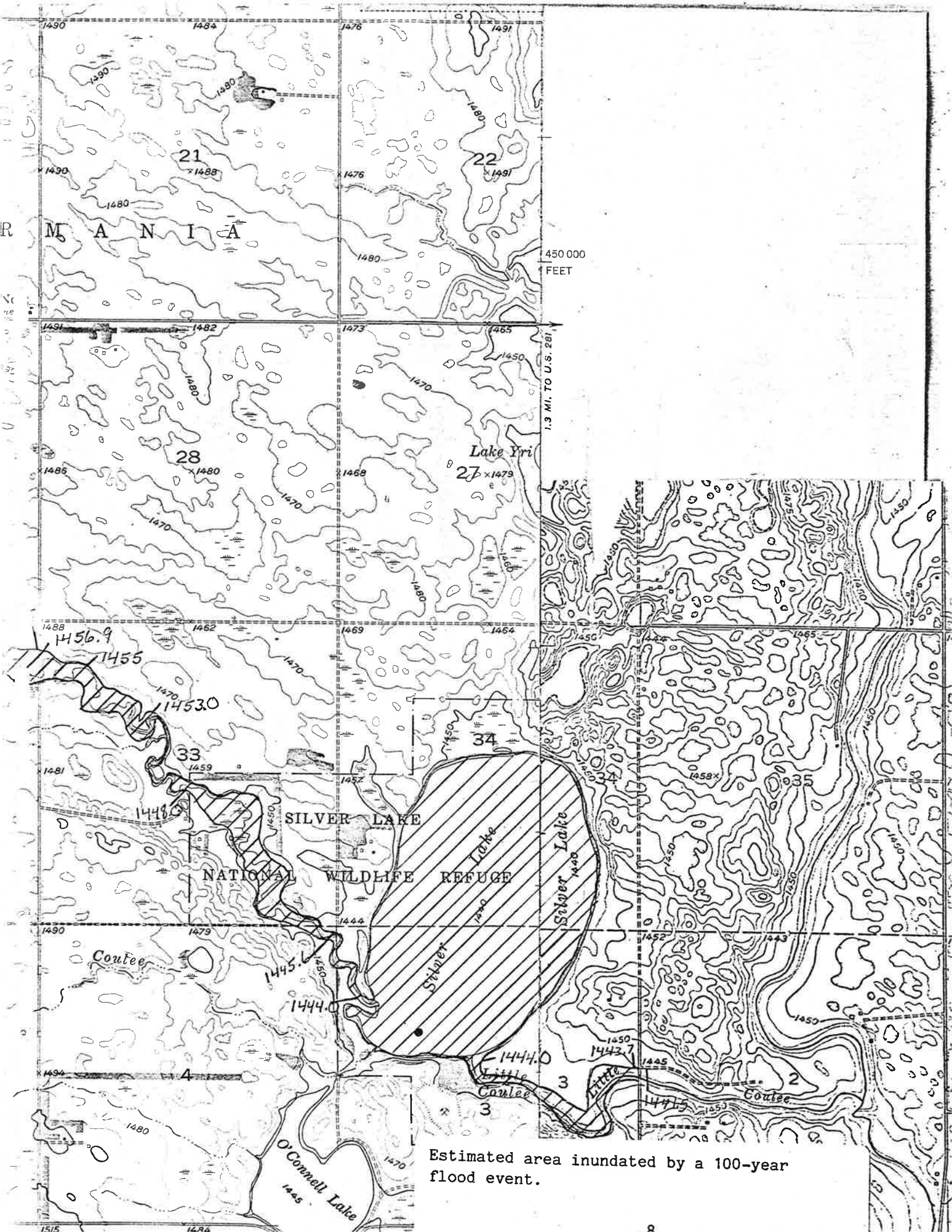
Estimated area inundated by a 100-year flood event.

Figure 4



Estimated area inundated by a 100-year flood event.

Figure 5



Estimated area inundated by a 100-year flood event.

A significant alternation in the Little Coulee Watershed was the modification made to Iverson Dam in the early 1970's. Iverson Dam previously had a weir type spillway. This old weir was replaced by three 48-inch CMP culverts. The discharge capacity of Iverson Dam was reduced 40 to 50 percent. The maximum outlet capacity of Iverson Dam is about 400 c.f.s. Greater flow will cause the structure to be overtopped.

It is unlikely that the dam would withstand a 100-year event. The discharges, however, used in this analysis assumed the 100-year discharge at Iverson Dam to be 400 c.f.s. If the dam would fail during a 100-year event, the resulting discharge would be considerably higher.

Table 1 summarizes the flows used to evaluate the structures and channel capacity in the study.

Table 1 - Flood Flows

	25 year (cfs)	100 year (cfs)	100 year + 100 cfs
Iverson Dam Discharge	250	400	-
Below Iverson Dam to Lake Isben	360	725	825
Lake Isben to Silver Lake	225	450	550
Silver Lake to Confluence with Lower Mauvais Coulee	190	375	475

Hydrologic Analysis

After the stream characteristics and water levels were evaluated, the water surface profile was developed. This was done by using the HEC 2 water surface profile program created by the U.S. Army Corps of Engineers. From this information the impacts of the water levels on the existing conditions were studied. Alternatives to improve problem areas were evaluated and their costs were estimated. Recommendations for Little Coulee were arrived at based on flood levels, flood impacts, and costs.

Nineteen crossings exist along Little Coulee from Iverson Dam to the confluence with Lower Mauvais Coulee. Iverson Dam is structure number one. Plate 1 is a map of the study area showing the structure locations. Structure six, a railroad trestle northwest of Leeds, is the only structure between Iverson Dam and Highway #2 that is adequate to handle a 25-year flood. Others adequate to handle the flows are structures 8, 9, 10, 13, 14 and 19. The remaining structures are inadequate.

Plates 2, 3, 4, and 5 show the water surface profiles for the 25-year flood, and 100-year flood. They also list the elevations for a flow 100 c.f.s. above the 100-year flood. The profile shows a number of roads overtopped by flooding. Table 2 is a summary of the crossings along Little Coulee. It includes structure descriptions, low point of the roadway, invert elevations and other general information.

In Table 2, structures have a road-type associated with them. These are the same as the road types described on county road maps. This information is useful in evaluating the feasibility of a design which would improve the roadway's ability to handle the flood flows. The following is a general description of the structures listed in Table 2.

1. Structure two is a four-foot culvert through a roadway which is graveled, graded, and drained. During the 100-year event, the roadway was overtopped by 1.6 feet and caused a water level increase of 4.4 feet. During a 25-year event, the roadway will be overtopped by 1.1 feet with a water level increase of 4.8 feet.
2. Structure three is two four-foot culverts through a graveled, graded, and drained roadway. During the 100-year event, the roadway was overtopped by 1.3 feet and caused a water level increase of 6.1 feet. During a 25-year event, the roadway will be overtopped by 0.9 feet with a water level increase of 6.3 feet. Water elevations are affected by the channel slope in this area.

TABLE 2.--STRUCTURE DESCRIPTIONS

Structure Number	Legal Description S - T - R	Description	Roadway Elv. msl	25 yr. Flood Water Level msl	100 yr. Flood Water Level msl	100 yr. Flood +100 cfs msl	Invert Elv. msl
1	24-156-69	Iverson Dam 3-4' CMP T.C. 1537.5	1542.3	---	---	---	1533.5
2	23,24-156-69	Type 3 Rd. 1-4' CMP T.C. 1522.3	1525.1	1526.2	1526.7	1526.9	1518.3
3	23,24-156-69	Type 3 Rd. 2-4' CMP T.C. 1515.7	1520.3	1521.2	1521.6	1521.7	1511.7
4.	24,25-156-69	Type 6 Rd. 1-4" CMP T.C. 1511.0	1511.0	1512.1	1512.5	1512.5	1507.0
5.	25,36-156-69	Type 4 Rd. 14'Wx21'L Bridge L.C. 1499.6	1500.4	1502.2	1502.9	1503.1	1493.5
6.	36-156-69	Railroad 77' wide Bridge L.C. 1500.1	1504.6	1502.0	1502.3	1502.5	1495.8
7.	36,31-156-69,68	Type 4 Rd. 2-4" CMP T.C. 1497.4	1501.4	1501.9	1502.1	1502.2	1403.4

TABLE 2 (cont'd).--STRUCTURE DESCRIPTIONS

Structure Number	Legal Description S - T - R	Description	Roadway Elv. msl	25 yr. Flood Water Level msl	100 yr. Flood Water Level msl	100 yr. Flood +100 cfs msl	Invert Elv. msl
8	31-156-68	Type 1 Rd. Highway #2 2-12'x66' Concrete Cul. T.C. 1498.7	1500.7	1497.0	1500.1	1500.9	1493.4
9	31-156-68	Abandoned Railroad Trestle 14'x45' L.C. 1498.0	1500.00	1496.9	1499.9	1500.7	1490.6
10	31,32-156-68	Type 3 Rd. 2-14'x9' Elip. CMP T.C. 1499.6	1500.0	1495.9	1498.2	1498.7	1490.6
11	15,14-155-68	Type 4 Rd. 12.5'x21.5' Bridge L.C. 1492.8	1493.8	1489.9	1493.3	1494.2	1483.4
12	14,23-155-68	Type 3 Rd. 4-4' CMP T.C. 1487.6	1493.0	1489.8	1493.2	1493.7	1483.6
13	23,24-155-68	Type 3 Rd. 18'x21'Bridge L.C. 1490.5	1491.5	1487.3	1488.8	1489.5	1483.1

TABLE 2 (cont'd) --STRUCTURE DESCRIPTIONS

Structure Number	Legal Description S - T - R	Description	Roadway Elv. msl	25 yr. Flood Water Level msl	100 yr. Flood Water Level msl	100 yr. Flood +100 cfs msl	Invert Elv. msl
14	25,30-155-68,67	Type 3 Rd. 14.5'x15.5' Elip. CMP T.C. 1492.1	1504.0	1482.9	1484.8	1485.5	1477.6
15	30,29-155-67	Type 4 Rd. 1-6' CMP T.C. 1472.7	1474.0	1474.2	1474.7	1475.7	1466.7
16	32,33-155-67	Type 3 Rd. 2-5' CMP T.C. 1459.3	1463.2	1460.4	1463.7	1464.3	1454.3
17	33-155-67	Texas Crossing	1446.7	1447.4	1447.6	1447.9	1446.7
18	33,4-155,154-67	Seldom Used Trail Culvert Washout	1438.7	1444.6	1445.7	1446.2	1438.7
19	32-154-67	Type 3 Rd. 14'x22' Bridge L.C. 1443.4	1444.4	1442.1	1443.7	1444.8	1438.3

ROAD CLASSIFICATION
1 Paved Road - Including High Type Bituminous
2 Bituminous Road - Low Type
3 Gravel Graded and Drained Road
4 Graded and Drained Road
5 Unimproved Road
6 Primitive Road

L.C. Low Chord
T.C. Top Culvert

3. Structure four is a four-foot culvert through a primitive roadway. During the 100-year event, the roadway was overtopped by 1.5 feet and caused a water level increase of 0.8 feet. During a 25-year event, the roadway will be overtopped by 1.1 feet with a water level increase of 1.2 feet.

4. Structure five is a 14 x 21 foot bridge through a graded and drained roadway. During the 100-year event, the roadway was overtopped by 2.5 feet and caused a water level increase of 0.1 feet. During a 25-year event, the roadway will be overtopped by 1.8 feet with a water level increase of 0.1 feet.

5. Structure six is a railroad trestle northwest of Leeds. It handled both the 25-year and 100-year event with more than two feet of clearance below the railroad embankment.

6. Structure seven is two four-foot culverts through a graded and drained roadway. During the 100-year event, the roadway was overtopped by 0.7 feet and caused a water level increase of 1.7 feet. During a 25-year event, the roadway will be overtopped by 0.5 feet with a water level increase of 2.7 feet.

7. Structure eight is Highway #2. It has a double 4 x 12 foot concrete box culvert. The roadway is a paved road with high type bituminous pavement. It handled the 25-year and 100-year event. Water elevations here are affected by downstream conditions.

8. Structure nine is an abandoned railroad trestle located south of Leeds. It was not overtopped by the 25-year or the 100-year event. The trestle does not have a significant effect on the water surface elevations.

9. Structure ten consists of two 14 x 9-foot ecliptical culverts through a graveled, graded, and drained roadway. It was not overtopped by

the 100-year event but did increase the water level by 3.0 feet. It will not be overtopped during a 25-year event but will increase the water level 1.8 feet.

10. Structure eleven is a 12.5 x 21.5-foot bridge through a graded and drained road. The roadway was not overtopped by the 100-year event but did increase the water level 0.1 feet. It will not overtop during a 25-year event and will not increase the water level.

11. Structure twelve consists of 4 four-foot culverts through a graveled, graded, and drained roadway. It was overtopped by 0.2 feet with a water level increase of 3.8 feet during the 100-year event. A 25-year event will pass through the structure with a water level increase of 1.1 feet.

12. Structure thirteen is a 18 x 21-foot bridge through a graveled, graded, and drained roadway. The 100-year event passed through the structure with a water level increase of 0.6 feet. The 25-year event will pass through the structure with a water level increase of 0.2 feet.

13. Structure fourteen is 14.5 x 15.5-foot eclipitical culvert through a roadway which is graveled, graded, and drained. On the 100-year event, the flow passed through the structure with a water level increase of 5.2 feet. During a 25-year event the flow will pass through the structure with a water level increase of 4.3 feet.

14. Structure fifteen is a six-foot culvert through a graded and drained roadway. Water overtopped the roadway during the 100-year event by 0.7 feet and the water level increased 6.1 feet. Water will overtop the roadway during a 25-year event by 0.2 feet with a water level increase of 6.6 feet. Water elevations are particularly influenced by channel slope and elevation.

15. Structure sixteen consists of two five-foot culverts through a graveled, graded, and drained roadway. During the 100-year event, the roadway was overtopped by 0.5 feet and caused a water level increase of 6.8 feet. During a 25-year event, the roadway will pass the flow with a water level increase of 4.2 feet. Channel slope has some effect on the increase of water level.

16. Structure seventeen is a Texas crossing which does not have any significant influence on the water surface elevations.

17. Structure eighteen's culvert washed out. The roadway is a seldom used trail, located northwest of the Silver Lake inlet. In this area there is thick grass and brush. Water elevations here are influenced by Silver Lake.

18. Structure nineteen is a 14 x 21-foot bridge through a graveled, graded, and drained roadway. It passed the 100-year event with a water level increase of 2.2 feet. It will pass the 25-year event with a water level increase of 0.8 feet. This is the only structure between the Silver Lake outlet and the confluence with Lower Mauvais Coulee.

IV. ALTERNATIVES

Standard State Water Commission design criteria assumes a design flow equal to the 25-year flood event to determine the size of a structure needed at a road crossing. For culverts, the water level is allowed to back up to a foot below the road surface. This produces the head needed for flow through the pipe. Bridges must pass the design flow with the water surface below the beams. Table 3 is a list of structures that are inadequate to pass the 25-year flood:

Table - 3

Roadway Flooding - 25 Year Event							
Structure Number	2	3	4	5	7	15	17
Depth of water over road (feet)	1.1	0.9	1.1	1.8	0.5	0.2	0.7

Alternatives were studied which would improve the channel and crossing capacities so they would be able to pass the 25-year event. Alternatives to improve flow were looked at along the study area. They included vegetation removal, and the installation of new culverts or bridges. Also included is a discussion on the capacity of Iverson Dam.

Vegetation Removal

Dense growths of vegetation in a channel reduce its efficiency and can cause water to back up. Throughout the study area, the cover in the channel generally consists of medium grass one to three feet tall with spots of heavy grass and brush. Above the Lake Isben inlet there is approximately 200 feet of heavy cattails and slough grass. Vegetation in the channel could be removed during low water levels, but due to the type of cover, the effect would only last about two or three years. After this amount of time, the cover would grow back. The cost of the alternative would be approximately $200.00.

In Section 33, Township 155 North, Range 67 West, there are thick grass and cattails three to five feet tall for approximately 3000 feet of channel. This location is a permanent slough with the channel slope being the controlling factor. Vegetation removal in this area would have a short-term effect due to the cover type. Removing this cover would not reduce the water level enough to justify the vegetation removal.

Culverts

Roadways that were overtopped by a 25-year event vary in type and area flooded by backwater. The following paragraphs discuss the recommended improvements to crossings having culverts. Included is an estimate of costs for the improvements.

1. Structure fifteen is a 6.0-foot culvert through a graded and drained road. The roadway would be overtopped by 0.2 feet on the 25-year event. Installation of one four-foot CMP culvert, with end sections matching the embankment slope, would enable the crossing to meet the design criteria for a 25-year flood event and have a capacity of 250 c.f.s. The cost would be approximately $4,500.

2. Structure seven is two four-foot culverts through a graded and drained road. It would be overtopped by 0.5 feet and increase the water level 2.7 feet during a 25-year event. A field survey indicated the west culvert was 3/4 plugged. This needs to be cleared. Installation of two additional five-foot CMP culverts with end sections matching the embankment slopes would pass the 25-year event. The roadway would have to be raised 0.5 feet to elevation 1501.9 for approximately 350 feet. This would cost approximately $2000 for gravel fill. Total cost would be $14,300. Crossing capacity would be 368 c.f.s. with the new culverts.

3. Structure four would be overtopped by 1.1 feet during a 25-year event. There is one four-foot culvert in place through a primitive road. Making an improvement that would reduce water levels is not feasible due to the road type and the small effect it would have on the upstream water level. Because of this, it is recommended that nothing be done at this crossing.

4. Structure three would be overtopped by 0.9 feet, with 3.4 feet of tailwater during the 25-year event. Two four-foot culverts extend through a graveled, graded, and drained road. To pass the design flow, an additional 54-inch CMP culvert with an end section matching the slope of the embankment is needed. This would cost approximately $5300 and have a capacity of 370 c.f.s.

5. Structure two would be overtopped by 1.1 feet during the 25-year event. There is one four-foot culvert through a graveled, graded, and drained road. Two alternatives could be used to pass the 25-year flood event. The first would consist of installing three four-foot CMP culverts having a capacity of 393 c.f.s. at a cost of $13,400. A second alternative would be to install two five-foot CMP culverts. Their capacity would be 363 c.f.s. and they would cost $10,500.

Bridges

Structure five is a 14 x 21 foot bridge through a graded and drained roadway. The roadway would be overtopped by 1.8 feet on the 25-year event with no effect on the water surface elevation. Though the capacity of the bridge is sufficient to handle the 25-year event, the roadway elevation on both sides is too low and the road is overtopped during high flows. Backwater from conditions downstream cause this. To have the structure pass a 25-year flood event and the roadway stay above water, the bridge would need to be replaced and the roadway raised three feet. This would cost approximately $75,000. The new roadway elevation would be 1503.0 MSL. If the roadway is left in its existing condition and becomes flooded, Highway #2 may be used as a detour. Therefore, replacement of this bridge is not recommended.

The other bridges will handle the 25-year event and meet the standard design criteria. Structure eight is Highway #2 and consists of box culverts.

Structures 11, 13, 19 are standard county bridges. Structure six is a railroad bridge and structure nine is an abandoned railroad trestle.

Iverson Dam

Iverson Dam is a small storage reservoir on Little Coulee. Three 48-inch CMP culverts serve as the dam's spillway. The combined capacity of these culverts is approximately 400 cfs.

Preliminary study of Iverson Dam reveals the structure is inadequate to handle the 100-year flood event. If improvements are made below Hurricane Lake, the vulnerability of Iverson Dam failure may be increased. However, the hydrologic analysis of the area showed that the peak discharge from Hurricane Lake would occur later than the Iverson Dam main peak. The final result of the analysis indicated that the proposed improvements below Hurricane Lake would increase the 100-year peak inflow to Iverson Dam by 40 c.f.s. This was reduced from the original estimate of 100 c.f.s. after a more detailed study. Since Iverson Dam retards the flow in Little Coulee, channel improvements below Hurricane Lake would not significantly increase the discharge below Iverson Dam unless the dam was overtopped.

V. SUMMARY AND RECOMMENDATIONS

Channel and structure capacity was analyzed for the existing conditions along Little Coulee. The HEC 2 computer program was used to determine the water elevations along the channel and at the structures. These elevations were plotted on a profile of existing conditions to create a water surface profile. The two primary events analyzed were the 25-year flood and 100-year flood. A profile of 100 cfs above the 100-year flood was analyzed to determine the impact of possible additional inflows from Hurricane Lake.

The cover in the channel is a hindrance to the lower flows in the channel. Cover in the channel is mostly medium height grasses. Removal of these would not have a significant effect on lowering the water surface elevations. To

keep the channel clear of tall grasses would require a regular maintenance program. Although the benefits from such a program may not exceed the costs, in the long term additional flooding damages may be avoided.

There are several secondary road structures that can not pass a 25-year flood; structures 2, 3, 4, 5, 7, 15, 17 and 18. Structure 17 is a Texas crossing which is not useable during the 25-year event. Structure 18 is a washed out culvert. In areas where the structures were inadequate, flooding occurred to varying degrees but did not pose any serious problems with the roads. Structure five was affected due to its low roadway elevation in relation to the surrounding area. Crossings that were inadequate to pass the 25-year flood were evaluated with different alternatives so that the roads would be above water during the flood.

Recommended improvements to pass the 25-year flood event for the structures are as follows:

1. Structure two would require three four-foot culverts or two five-foot culverts to be installed to keep the road open during a 25-year flood. The cost of installing the two five-foot culverts is $10,500.
2. Structure three would require a 54-inch CMP culvert be installed at a cost of $5300 to pass the 25-year flood event.
3. Structure four is classified a primitive road and does not cause a significant change in the water surface elevation so the alternative is to do nothing.
4. Structure seven would require two five-foot culverts to be installed to pass the 25-year event at a cost of $14,300. The west culvert is 3/4 plugged at the present time and should be cleared.

5. Structure fifteen would require a four-foot culvert to be installed to pass the 25-year flood, at a cost of $4500. This would lower the backwater elevation but would not have a significant effect on the tailwater of other existing structures due to the channel slope.

Table four is a summary of preliminary cost estimate.

TABLE 4

PRELIMINARY COST SUMMARY FOR CULVERT INSTALLATION

ITEM	COST
Structure two:	
Install two 54-inch CMP culverts	$10,500
(Alternative: Three 48-inch CMP culverts	13,400)
Structure three:	
Install one 54-inch CMP culvert	5,300
Structure seven:	
Install two 60-inch CMP culverts with 0.5 feet of gravel fill on roadway	14,400
Structure fifteen:	
Install one 48-inch CMP culvert	4,500

Total amount includes costs for engineering and contingencies.

STRUCTURE NO. 8

STRUCTURE NO. 9

STRUCTURE NO. 10

STRUCTURE NO. 11

STRUCTURE NO. 12

STRUCTURE NO. 13

STRUCTURE NO. 14

STRUCTURE NO. 15

STRUCTURE NO. 16

STRUCTURE

BEAVER

LAKE IBSEN

LAKE ORSEN

LAKE LBSEN

NORMANIA

The Buttes

Golf Course

Leeds Airport

Lake Thaen

Lebanon Ch

School No 4

School No 2

Brutsmarie

Coulee

O'Connell Lake

NATIONAL WILDLIFE

SILVER LAKE

BURLINGTON NORTHERN

PACIFIC

STRUCTURE NO. 11

STRUCTURE NO. 12

STRUCTURE NO. 13

STRUCTURE NO. 14

STRUCTURE NO. 15

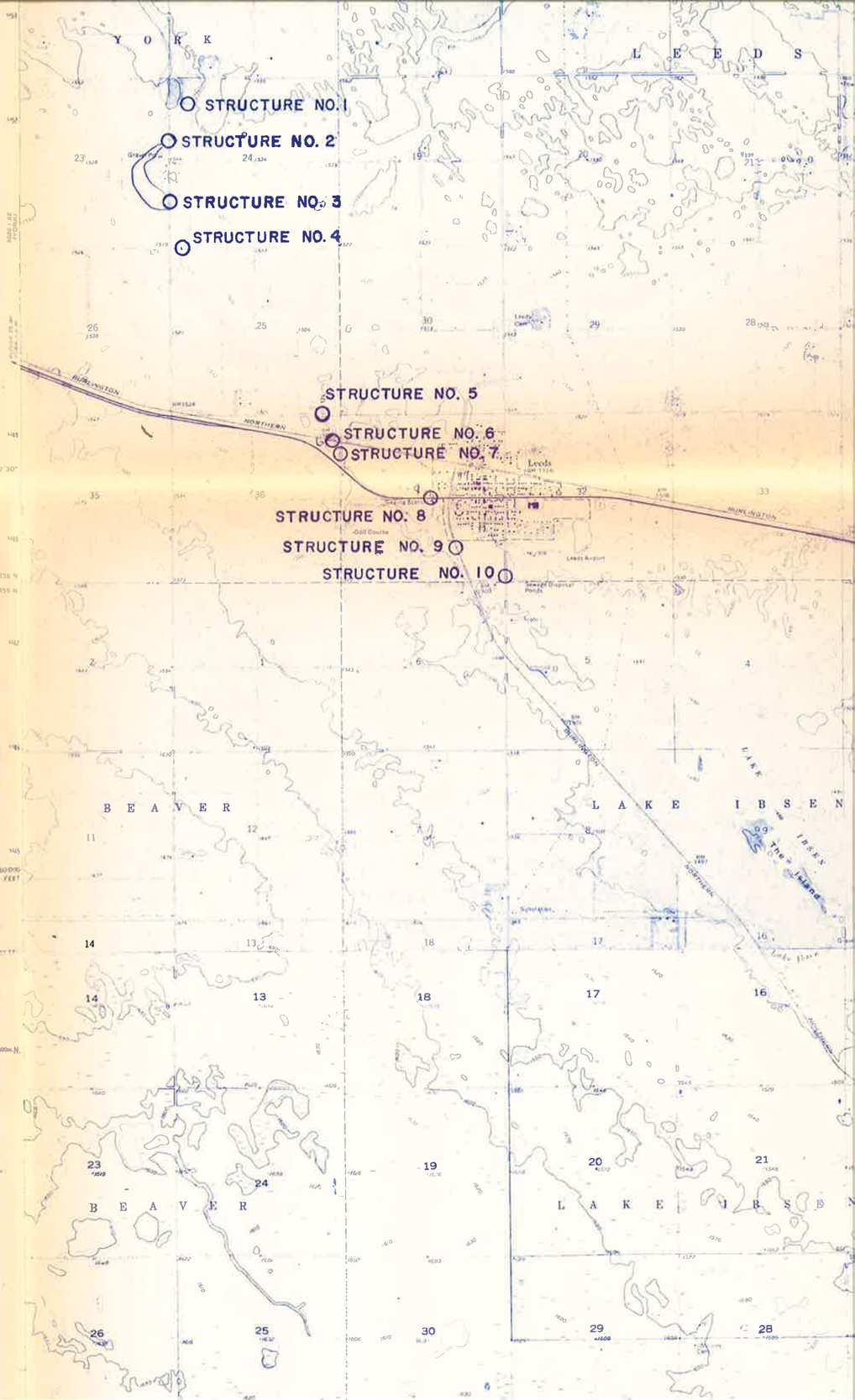
STRUCTURE NO. 16

STRUCTURE NO. 17

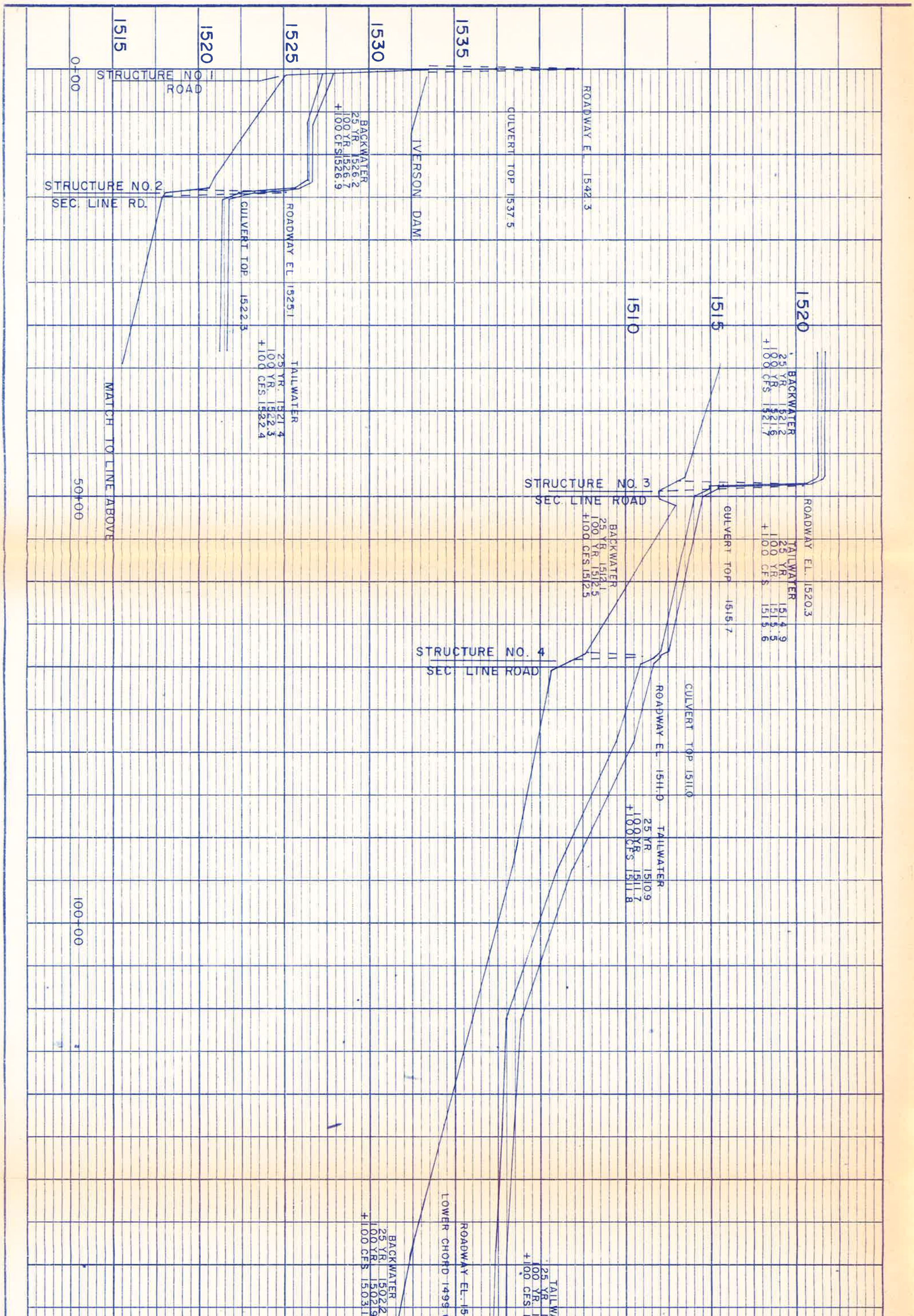
STRUCTURE NO. 18

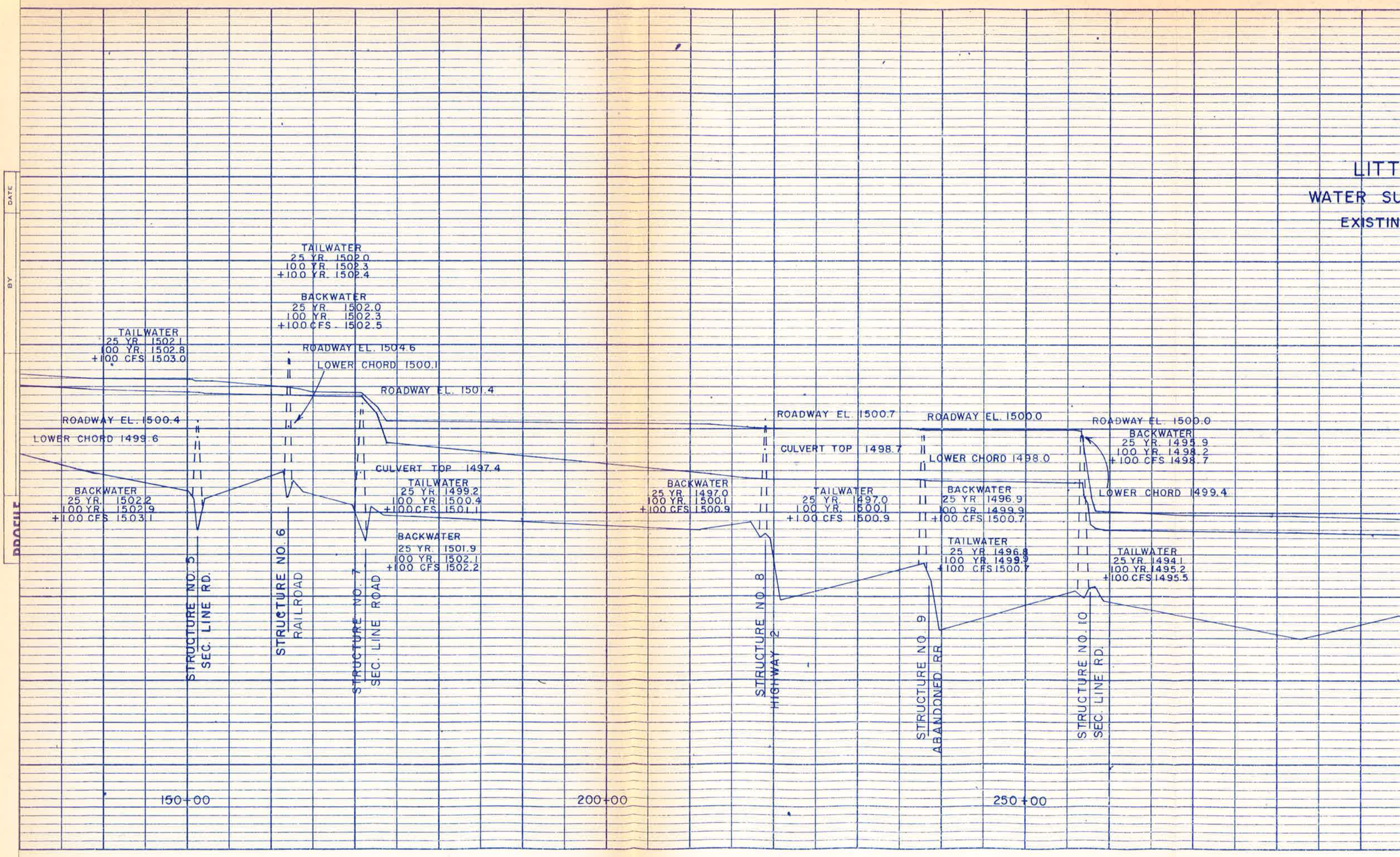
STRUCTURE NO. 19

STRUCTURE LOCATIONS


STRUCTURE NO. 1
STRUCTURE NO. 2
STRUCTURE NO. 3
STRUCTURE NO. 4
STRUCTURE NO. 5
STRUCTURE NO. 6
STRUCTURE NO. 7
STRUCTURE NO. 8
STRUCTURE NO. 9
STRUCTURE NO. 10
Y O R K
L E E D S
B E A V E R
L A K E I B S E N
BURLINGTON NORTHERN

PROFILE		BY	DATE
NOTE BOOK No.	SURVEYED		
	PLOTTED		
	GRADES CHECKED		
	B. M.'s NOTED		
	STRUCTURE NOTATIONS CHECKED		




TAILWATER
25 YR. 1502.1
100 YR. 1502.8
+100 CFS 1503.0
ROADWAY EL. 1500.4
LOWER CHORD 1499.6
BACKWATER
25 YR. 1502.2
100 YR. 1502.9
+100 CFS 1503.1
STRUCTURE NO. 5
SEC. LINE RD.
TAILWATER
25 YR. 1502.0
100 YR. 1502.3
+100 YR. 1502.4
BACKWATER
25 YR. 1502.0
100 YR. 1502.3
+100 CFS. 1502.5
ROADWAY EL. 1504.6
LOWER CHORD 1500.1
ROADWAY EL. 1501.4
STRUCTURE NO. 6
RAILROAD
CULVERT TOP 1497.4
TAILWATER
25 YR. 1499.2
100 YR. 1500.4
+100 CFS 1501.1
BACKWATER
25 YR. 1501.9
100 YR. 1502.1
+100 CFS 1502.2
STRUCTURE NO. 7
SEC. LINE ROAD
150+00
ROADWAY EL. 1500.7
BACKWATER
25 YR. 1497.0
100 YR. 1500.1
+100 CFS 1500.9
CULVERT TOP 1498.7
TAILWATER
25 YR. 1497.0
100 YR. 1500.1
+100 CFS 1500.9
STRUCTURE NO. 8
HIGHWAY 2
200+00
ROADWAY EL. 1500.0
LOWER CHORD 1498.0
BACKWATER
25 YR. 1496.9
100 YR. 1499.9
+100 CFS 1500.7
TAILWATER
25 YR. 1496.8
100 YR. 1499.9
+100 CFS 1500.7
STRUCTURE NO. 9
ABANDONED RR
250+00
ROADWAY EL. 1500.0
BACKWATER
25 YR. 1495.9
100 YR. 1498.2
+100 CFS 1498.7
LOWER CHORD 1499.4
TAILWATER
25 YR. 1494.1
100 YR. 1495.2
+100 CFS 1495.5
STRUCTURE NO. 10
SEC. LINE RD.
LITT
WATER SU
EXISTIN
DATE
BY
PROFILE

LITTLE COULEE
WATER SURFACE PROFILES
EXISTING CONDITIONS

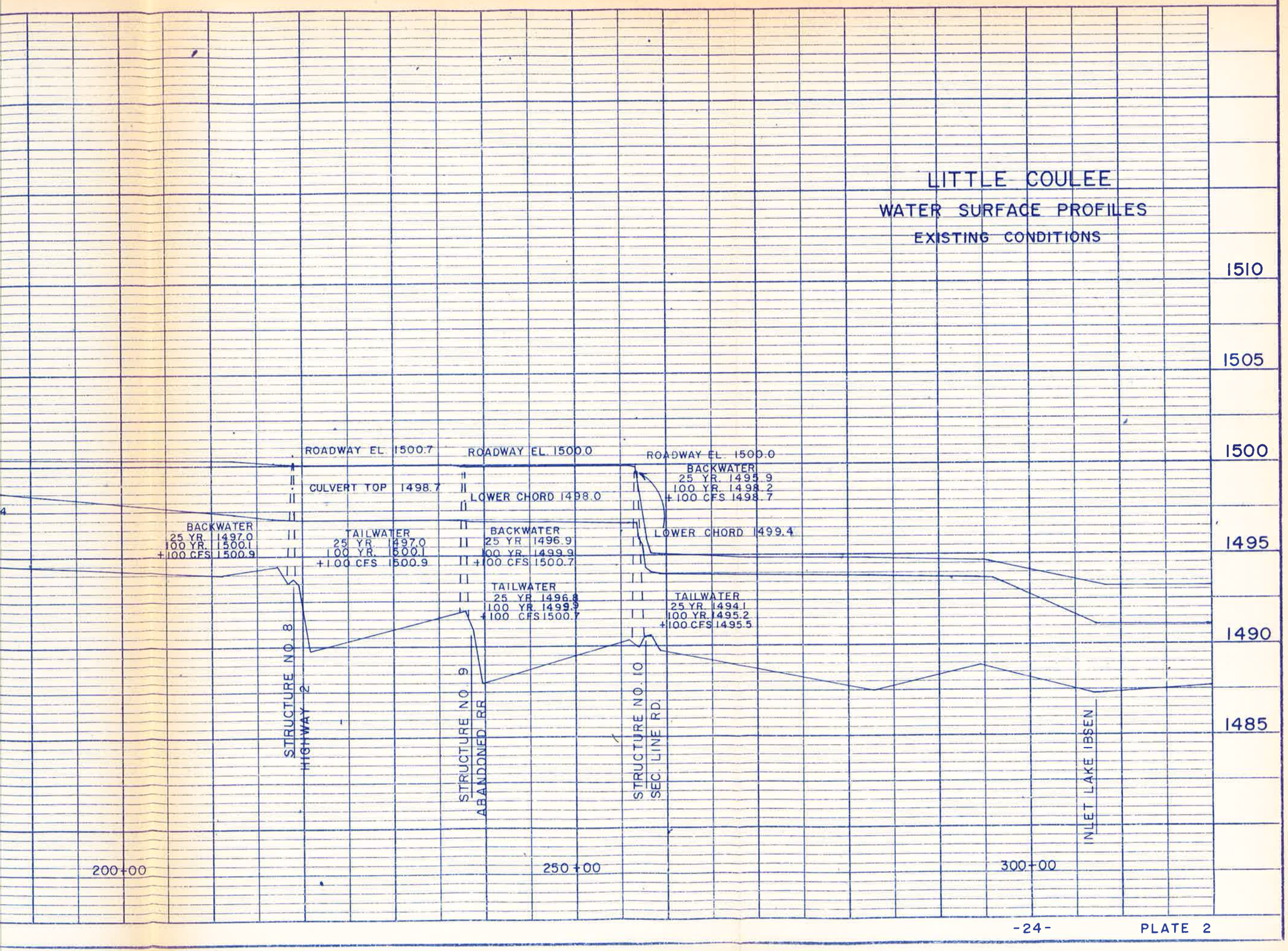
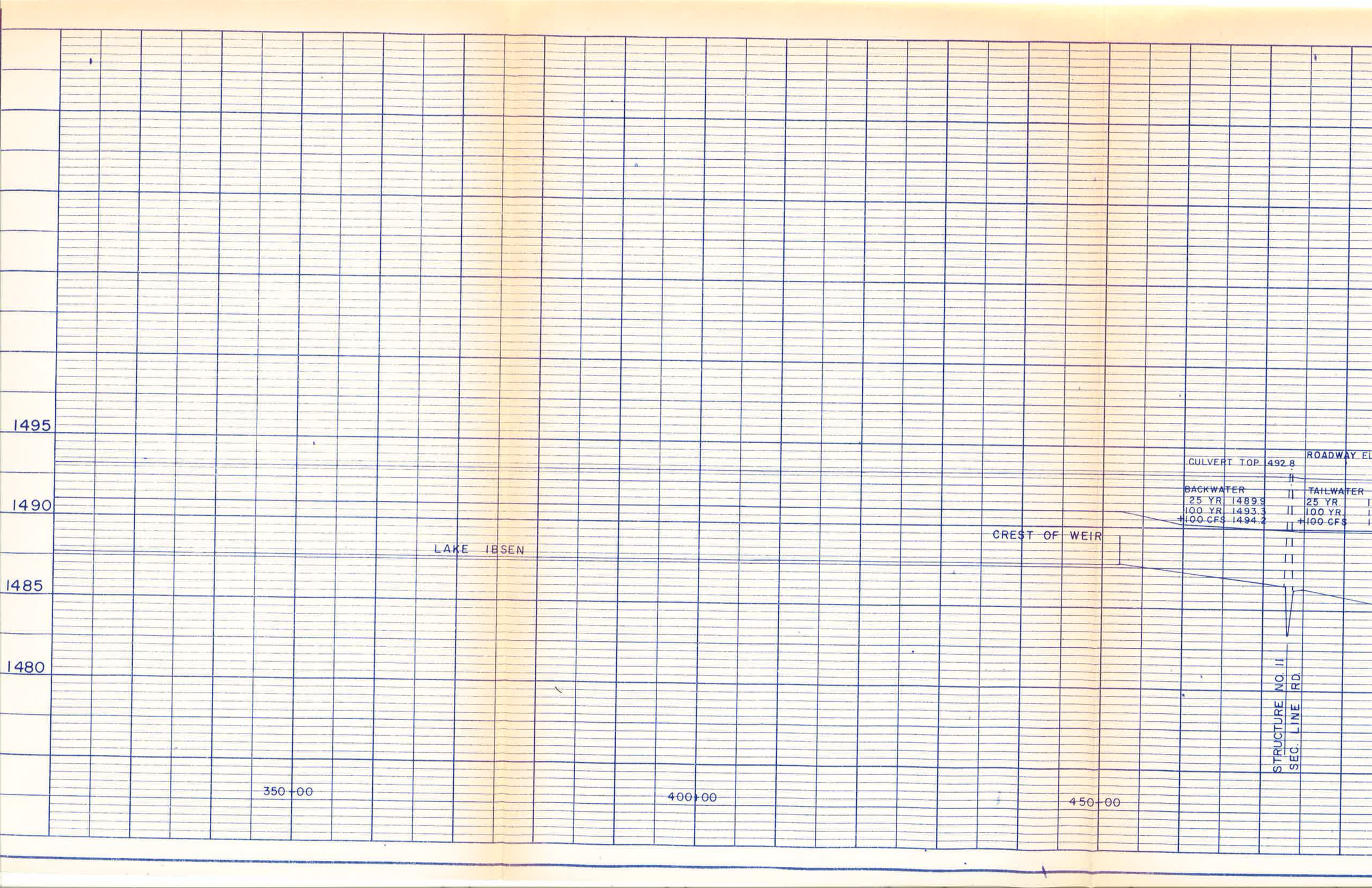


PLATE 2


1495
1490
1485
1480
LAKE IBSEN
CREST OF WEIR
CULVERT TOP 492.8
ROADWAY EL
BACKWATER
25 YR 1489.9
100 YR 1493.3
+100 CFS 1494.2
TAILWATER
25 YR
100 YR
+100 CFS
STRUCTURE NO. 11
SEC. LINE RD.
350+00
400+00
450+00

DATE

BY

ROADWAY EL. 1493.8

CULVERT TOP 492.8

BACKWATER
25 YR 1489.9
100 YR. 1493.3
+100 CFS 1494.2

TAILWATER
25 YR. 1489.9
100 YR. 1493.2
+100 CFS 1494.0

STRUCTURE NO. 11
SEC. LINE RD.

ROADWAY EL. 1493.0

BACKWATER
25 YR 1489.8
100 YR. 1493.2
+100 CFS 1493.7

CULVERT TOP 1487.6

TAILWATER
25 YR. 1488.7
100 YR. 1489.4
+100 CFS 1489.8

STRUCTURE NO. 12
SEC. LINE RD.

ROADWAY EL. 1491.5

CULVERT TOP 1490.5

BACKWATER
25 YR. 1487.3
100 YR. 1488.8
+100 CFS 1489.5

TAILWATER
25 YR. 1487.1
100 YR. 1488.2
+100 CFS 1488.7

STRUCTURE NO. 13
℄ RD. & BRIDGE

+00

500+00

550+00

LITTLE COULEE
WATER SURFACE PROFILES
EXISTING CONDITIONS

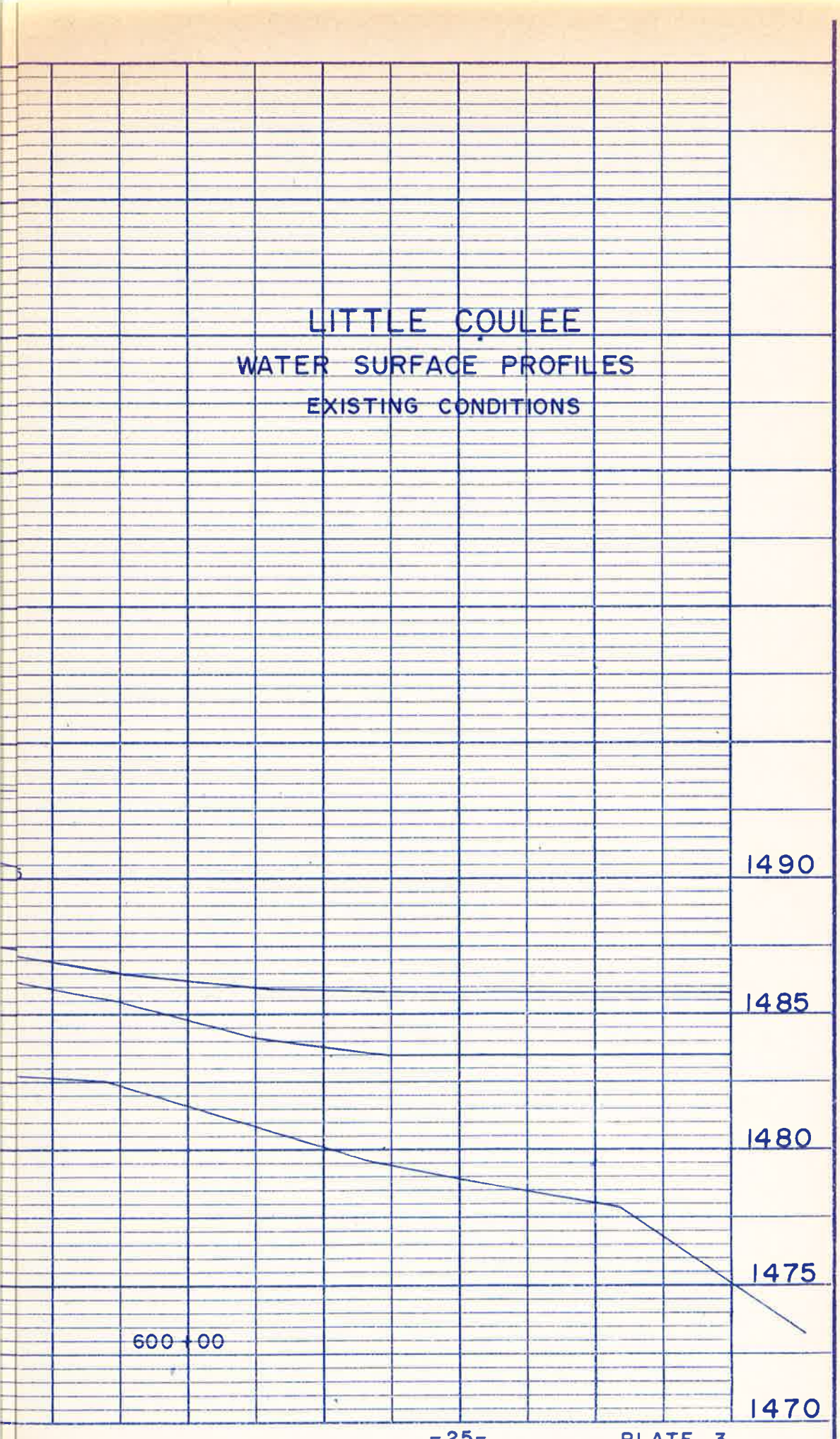


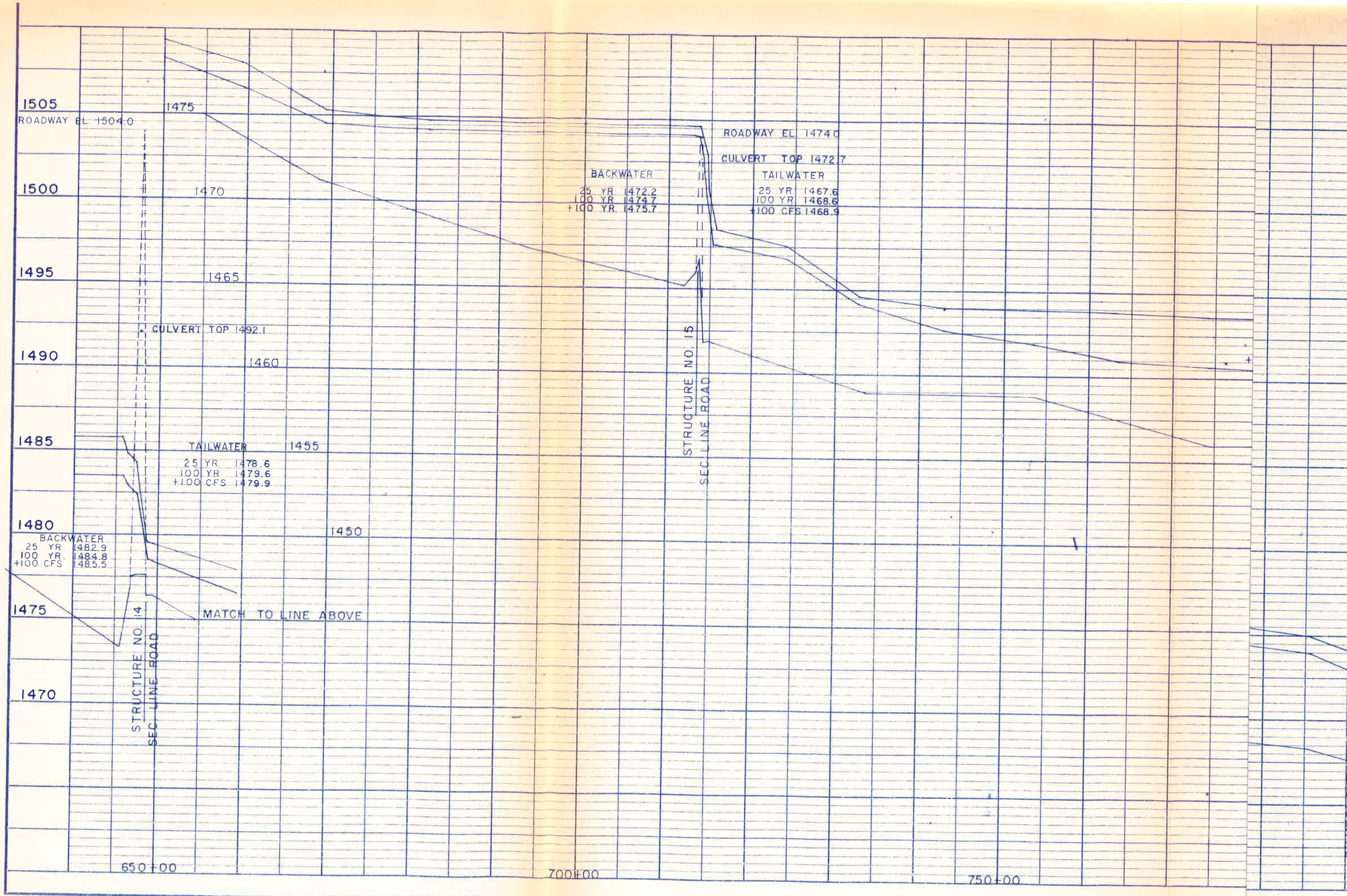
PLATE 3

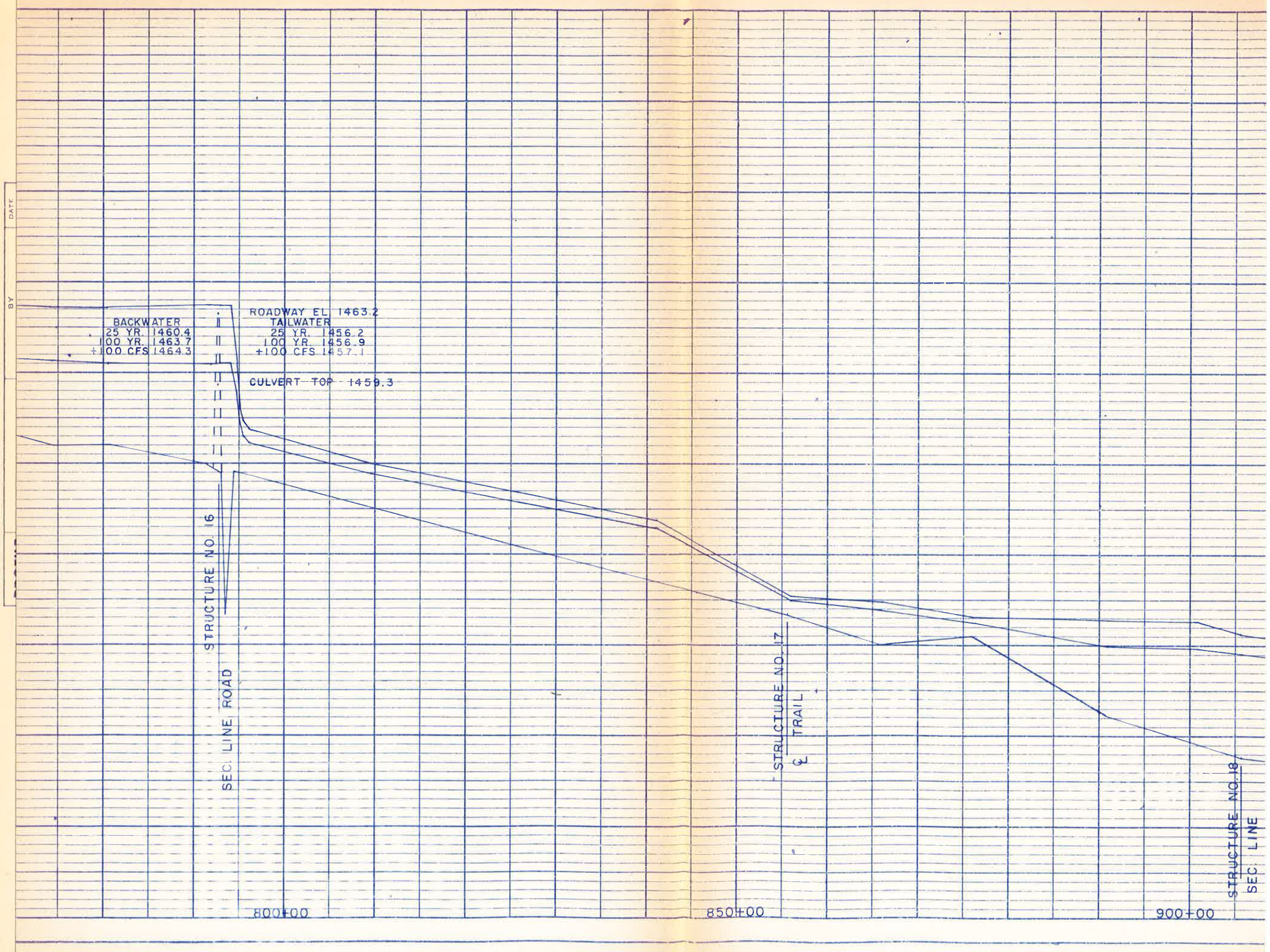
PROFILE

NOTE BOOK No.

SURVEYED
PLOTTED
GRADES CHECKED
B. M.'s NOTED
STRUCTURE NOTATIONS CHECKED

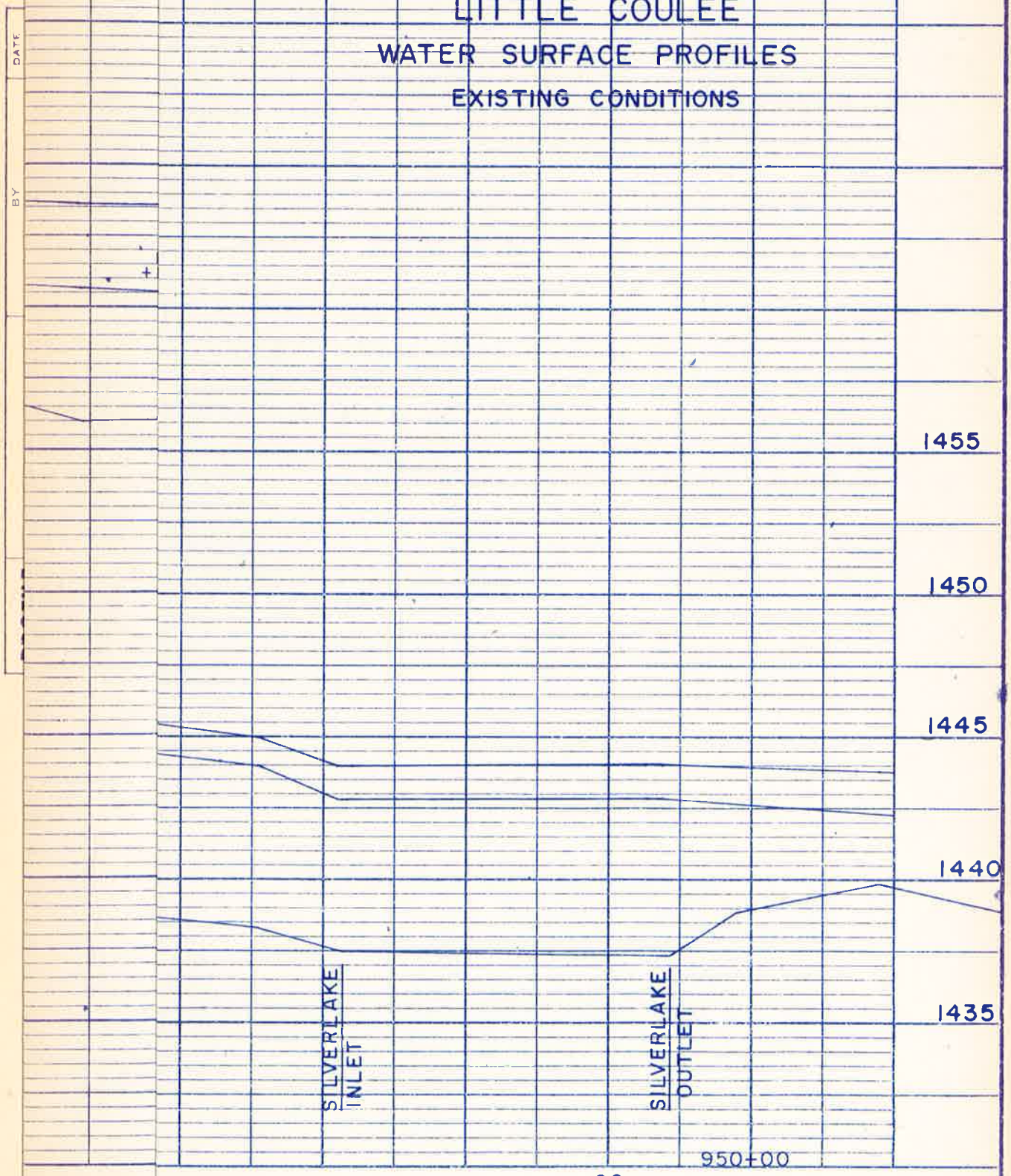
DATE BY





BY
DATE
BACKWATER
25 YR. 1460.4
100 YR. 1463.7
+100 CFS 1464.3
ROADWAY EL 1463.2
TAILWATER
25 YR. 1456.2
100 YR. 1456.9
+100 CFS 1457.1
CULVERT TOP 1459.3
STRUCTURE NO. 16
SEC. LINE ROAD
STRUCTURE NO. 17
℄ TRAIL
STRUCTURE NO. 18
SEC. LINE
800+00
850+00
900+00

LITTLE COULEE
WATER SURFACE PROFILES
EXISTING CONDITIONS



PROFILE		BY	DATE
NOTE BOOK No._____	SURVEYED		
	PLOTTED		
	GRADES CHECKED		
	B. M.'s NOTED		
	STRUCTURE NOTATIONS CHECKED		

1440 1445 1450

1435

1430

1425

960+00

BACKWATER
25 YR 1442.1
100 YR 1442.7
+100 CFS 1444.8

ROADWAY EL. 1444.4

CULVERT TOP 1443.4

TAILWATER
25 YR 1441.3
100 YR 1441.5
+100 CFS 1441.7

STRUCTURE NO. 19
SEC. LINE ROAD

1000+00

CONFLUENCE WITH BIG COULEE

1030+00

BY

DATE

LITTLE COULEE

WATER SURFACE PROFILES

EXISTING CONDITIONS

PLATE 5

APPENDIX A

PRELIMINARY INVESTIGATION AGREEMENT

SWC Project #1724
April 23, 1980

AGREEMENT

Preliminary Investigation by the
North Dakota State Water Commission
for Little Coulee

I. PARTIES

THIS AGREEMENT is between the North Dakota State Water Commission, hereinafter referred to as the Commission, acting through the State Engineer, Vernon Fahy; and the Devils Lake Basin Joint Water Management Board, acting through its Chairman, Charon Johnson, hereinafter referred to as the Board.

II. INTENT OF AGREEMENT

The Commission and the Board have concurrent jurisdiction to alleviate, to the extend possible, flooding in the State. These authorities are granted in Sections 61-02-01, 61-02-14, 61-02-24.1, 61-16-11 and 61-21-02 of the North Dakota Century Code.

It is the intent of the Commission that the funds discussed herein will be utilized to develop water surface profiles along Little Coulee to determine the effect of existing channel conditions and structures on selected flows. These water surface profiles will show actual depth of flow in the channel at these flows, taking into account all back water due to obstruction in the channel, as well as inadequate bridge or culvert openings.

III. PROJECT LOCATION

The investigation will include Little Coulee and portions of its tributaries as they occur in Benson County from Iverson Dam to the confluence of Little Coulee with the Mauvais Coulee. This covers a distance of approximately 18 miles.

IV. DEPOSIT REFUND

The Board shall deposit $2,000 with the Commission to partially cover the cost of the investigation. Upon receipt of a request from the Board to terminate the investigation; or upon a breach of this agreement by any of the parties, the Commission shall provide the Board with a statement of all expenses incurred in the investigation and shall refund to the Board any unexpended funds.

V. RIGHTS OF ENTRY

The Board agrees to obtain written permission from any affected landowner for surveys by the Commission which are required for the preliminary investigations.

VI. INDEMNIFICATION

The Board hereby accepts responsibility for, and holds the Commission free from all claims and damages to public or private properties, rights, or persons arising out of this investigation. In the event a suit is initiated or judgement entered against the Commission, the Board shall indemnify it for any judgement arrived at or judgement satisfied.

VII. CHANGES TO AGREEMENT

Changes to any contractual provisions herein will not be effective or binding unless such changes are made in writing, signed by the parties and attached hereto.

VIII. AGREEMENT BECOMES INVALID

This agreement becomes invalid if not executed by the Board within sixty (60) days of execution by the State Engineer.

DEVILS LAKE BASIN JOINT WATER MANAGEMENT BOARD

Charon Johnson
Chairman

DATE: April 28, 1980

NORTH DAKOTA STATE WATER COMMISSION

Vernon Fahy
State Engineer

DATE: April 23, 1980

WITNESS:

WITNESS:

Dist:
Board
SWC Accountant
SWC Project #1724
Investigations Engineer