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ENVIRONMENT
saskatchewan

JACKFISH AND
MURRAY LAKES

**INVESTIGATIONS
TO DETERMINE
A PERMANENT
FULL SUPPLY LEVEL**

HYDROLOGY BRANCH

HYD-7-10

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JACKFISH AND MURRAY LAKES

INVESTIGATIONS TO DETERMINE A PERMANENT FULL SUPPLY LEVEL

REPORT NO. HYD-7-10

Prepared by:

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April, 1976

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SYNOPSIS

This report provides a summary and interpretation of studies undertaken to consider the implications of a possible higher permanent FSL for Jackfish and Murray Lakes than the currently licensed FSL of 1737.0.

The conclusion reached is that the lake should probably be licensed permanently at a FSL of 1737.5. Although the level of 1737.0 is probably the most suitable in terms of maintaining a minimum erosion and maximum recreation potential for the shoreline, the general shallowness of the lake, the average net drawdown over the summer season due to evaporation and other losses and the reduction in drought potential are factors which indicate that the level of 1737.5 is probably the most advantageous considering all the various interests. It is noted that the lake has been at or near this elevation over the past five years and no severe problems have been raised.

Assuming that a recommendation for a permanent level of 1737.5 will be accepted, the report also suggests that land control to this elevation should probably be obtained by way of easement at an anticipated cost in the order of \$35,000.00.

Chapter I
INTRODUCTION

The level of Jackfish Lake has been controlled by an outlet structure since 1932. However, a license under The Water Rights Act was not granted until January 8, 1970. At that time the Jackfish Lake Watershed Association Board was entrusted with the responsibility of operating the control structure so as to reach a maximum lake level of 1737.0 as soon as possible following the spring runoff. However, every year since that time the Board has, upon request to the Minister of the Environment, received temporary authorization to maintain the lake at 1737.5. Land control by way of easement only allows for permanent flooding to 1737.5 until June 15 of each year. The government has assumed responsibility for any damage claims that may result from maintaining a temporary level not higher than 1737.5, but the Board is liable for any damages which may result from holding the level above 1737.5. Because recreation interests favour a higher lake level than the licensed level of 1737.0 the need to investigate the implications of a higher level has been recognized and in issuing a special Minister's Order for 1975 to allow a level of 1737.5 the Minister indicated it was issued on the condition that steps be taken by the Board to allow licensing of the lake to a higher level than 1737.0 on a permanent basis. The Board agreed to this and the Departments of Agriculture, Environment and Tourism and Renewable Resources took appropriate follow up studies aimed at determining the most desirable permanent level for the lake considering the needs of all concerned.

This report is primarily a summary and interpretation of studies which have been undertaken to consider the implications of a possible permanent higher FSL for Jackfish and Murray Lakes. These include the following studies submitted by the Departments of Environment and Agriculture and referenced specifically in this report:

1. "Jackfish Lake Land Control," Department of Agriculture, Conservation and Land Improvement Branch, July 7, 1975.
2. "A Study of the Effects of Fluctuating Water Levels on the Shorelines of Jackfish and Murray Lakes," Department of the Environment, Land Protection Branch, December, 1975.
3. "Jackfish Lake Hydrology Study," Department of the Environment, Hydrology Branch, July 24, 1975.

Reference has also been made to information contained in two previously completed reports dated February, 1973. These are:

1. "Proposed Study of Water Level of Jackfish and Murray Lakes," Department of Natural Resources; Research, Planning and Policy Branch, February, 1973.
2. "Summary of Department of Agriculture Information Regarding Jackfish Lake," Department of the Environment, Land Protection Branch, February 15, 1973.

Chapter II

LAND CONTROL

The following discussion on land control on Jackfish and Murray Lakes is based on the Department of Agriculture report of July, 1975.

Present land control around Jackfish and Murray Lakes exists by way of easements on agricultural lands as follows:

1. Permanent flooding to 1738.0 (70 per cent of parcels);
2. Permanent flooding to 1737.5 (8 per cent of parcels); and
3. Temporary flooding to 1737.5 until June 15 of each year and drawdown beginning on that date to achieve a permanent level of 1737.0 by July 1 (22 per cent of parcels).

In addition, all of the easements have provision for release of flood damages to elevation 1740.0.

Under the conditions provided for in these agreements approximately 64 acres of unauthorized flooding would occur if the FSL was raised to 1737.5 and an additional 74 acres of unauthorized flooding would occur if the FSL was raised to 1738.0.

Although the three types of easements provide for different rights, compensation to the landowners was made on the basis of the amount of land affected below elevation 1740.0. Therefore, in acquiring rights to eliminate unauthorized permanent flooding at levels above 1737.0, the Jackfish Lake Watershed Association Board contends that all landowners should be paid on the basis of the amount of land flooded at the new FSL regardless of previous payments. In this manner all landowners would be paid on an equal basis.

The Department of Agriculture has suggested three methods by which land control may be obtained. The method, control elevation and cost based on 1976 estimates is shown in Table 1.

From this table it is apparent that acquisition by easement would be the most economical method since the minimum amount of land would be acquired. Whereas the land existing below 1737.0 need not be considered when acquiring additional easements the legal descriptions of many of the parcels affected includes land below this elevation which must be considered when acquiring legal title. On Jackfish and Murray Lakes the amount of land below 1737.0 amounts to approximately 734 acres.

Table 1

COMPARATIVE COSTS FOR VARIOUS METHODS OF ACQUIRING LAND CONTROL*

Method	FSL = 1737.5		FSL = 1738.0		Comments
	Acreage	Cost	Acreage	Cost	
By Way of Easement	307.1	\$ 35,500	527.4	\$ 61,000	Land cost = \$115 per acre
Purchasing and Acquiring Title to Designated FSL	1041.1	\$152,800	1262.1	\$178,000	Includes additional survey cost of \$33,000
Purchasing and Acquiring Title by Legal Sub-divisions	2665.7	\$356,000	2665.7	\$356,000	Includes no survey cost but does include agricultural land at \$150 per acre

* Does Not Include Land On Saulteaux Indian Reserve

Chapter III

SHORELINE EFFECTS AT VARIOUS WATER LEVELS

The following discussion regarding possible shoreline effects at various water levels is based primarily on material presented in the December, 1975 report from the Land Protection Branch, Department of the Environment.

The erosion and recreation potential of the shoreline around the lakes was determined on the basis of information obtained from profiles run perpendicular to the beach at intervals of 500 to 1000 feet in the developed areas and one-half to one mile in the undeveloped areas. As well, the number of structures existing at various elevations was investigated.

Figure 1 shows the general locations of the cottage subdivisions that were investigated on Jackfish and Murray Lakes.

A. Structure Flooding

The assessment of the number of structures existing at various elevations has been done on the basis of one foot contours. Therefore, the number of structures affected by permanent flooding considering one-half foot variations in the FSL cannot be precisely determined. However, Table 2 shows the upper limit of the number of structures that could be flooded at each FSL or at higher water elevations in the event of an abnormally high amount of runoff.

The flood potential of waterfront subdivisions is generally assessed on the basis that the coincident occurrence of a 1:25 flood

and 40 m.p.h. winds is reasonable criteria to evaluate waterfront subdivisions in Saskatchewan. From information contained in the hydrology report completed for this study it can be said generally that the 1:25 water levels would be 0.4 feet higher for the same flood if the FSL was 1738.0 rather than 1737.5. Although wind induced wave effects may cause wave levels to be two to three feet higher than the still water level one cannot attempt to define how many additional structures would be affected at each FSL because of the dependence of wave effects on beach slopes which will vary at each particular site.

Table 2

NUMBER OF STRUCTURES AFFECTED AT THE INDICATED WATER ELEVATIONS

Type of Structure	Elevation			
	1737.5	1738.5	1739.5*	1740.5*
Cottages	0	4	55	84
Outdoor Toilets	0	0	35	97
Accessory Buildings (boat houses)	72	94	109	122

* 1:25 Flood Peak Still Water Level When FSL is 1737.5 = 1739.4

* 1:25 Flood Peak Still Water Level When FSL is 1738.0 = 1739.8

(Adapted from Tables 1, 2 and 3 of 1975 report on shoreline effects by Land Protection Branch, Department of the Environment)

At the permanent FSL of 1737.5 approximately 72 accessory buildings would be flooded. At 1738.0, at most 94 accessory buildings and four cottages would be affected.

B. Erosion Potential

Generally the potential for erosion will increase as water levels are increased. Depending on the beach material and slope the amount of erosion was judged to vary from light, with little or no bank erosion; to moderate with 2 to 10 feet of erosion expected; to severe with greater than 10 feet of bank erosion expected.

At the present FSL of 1737.0 there should be little or no erosion. If the water level is increased to 1737.5 or 1738.0, 25 per cent and 32 per cent of the locations respectively will experience an increase in erosion in the developed cottage areas. Table 3 shows the distribution of erosion potential at each prospective FSL. The table shows that at the higher levels of 1737.5 and 1738.0, 76 and 68 per cent, respectively, of the sites investigated would experience little or no erosion. Where erosion will increase in the developed areas the sites would be approximately equally divided between moderate and severe erosion at lake levels of 1737.5 and 1738.0.

C. Recreation Potential

The recreation potential of the sites analyzed was determined by using such factors as wet beach width, dry beach material, back-shore slopes and dry beach width for private use. Weights were applied to each of these factors and a relative recreation potential for each location was determined as being low, moderate or high.*

* Jaakson, R., "A Method to Analyze the Effects of Fluctuating Reservoir Water Levels on Shoreline Recreation Use," Water Resources Research, Washington, D.C., American Geophysical Union, Vol. 6, No. 2, April 1970, p.p. 421-429.

Table 3

PER CENT DISTRIBUTION OF THE EROSION POTENTIAL AT VARIOUS
LEVELS FOR THE SITES INVESTIGATED ON JACKFISH
AND MURRAY LAKES

Erosion Potential	Light (Less than 2 ft. of erosion)		Moderate (2-10 ft. of erosion)		Severe (Greater than 10 ft. of erosion)	
FSL	1737.5	1738.0	1737.5	1738.0	1737.5	1738.0
Per Cent Distribution In Cottage Areas *	76%	68%	12%	18%	12%	14%
Per Cent Distribution In Cottage and Undev- eloped Areas *	68%	61%	15%	21%	17%	18%

* Total Number of Cottage Area Sites = 51

* Total Number of Undeveloped Sites = 44

(Adapted from Table 4 of 1975 report on shoreline effects by Land
Protection Branch, Department of the Environment)

Tables 4 and 5 show a summary of the distribution of recreation potential around the lakes at three lake levels and the relative effect an increase in the FSL would have on the recreation potential.

Few of the undeveloped areas would be suitable for further development at any FSL as 80 per cent have a low to moderate recreation potential at the present lake level of 1737.0.

In general the best use of recreation potential at the various sites considered in the cottage areas will be obtained if the lake remains at 1737.0 since 79 per cent of the sites have a moderate to high recreation potential. At 1737.5 and 1738.0 only 69 and 61 per cent of

the sites, respectively, have a similar potential. In addition, at the present elevation the best use is made of the high recreation potential sites in the developed areas.

D. Most Beneficial Water Level

Using essentially the same method used to determine the recreation potential of each site, the erosion and recreation potentials were compromised to determine the most suitable water level for each site. However, generally in the cottage areas where the recreation potential was high to moderate the erosion potential was low.

Table 6 shows a summary of the results of the analysis of the most beneficial water levels for selected sites in the cottage subdivisions. The table shows that approximately 90 per cent of the sites would find the present level most beneficial or at least tolerable. The sites investigated have a substantially lower tolerance at water elevations of 1737.5 and 1738.0. Although many of the sites might tolerate a higher water level, 1737.0 is clearly the most suitable in terms of high recreation and low erosion potential.

Table 4

PERCENTAGE DISTRIBUTION OF RECREATION POTENTIAL AT
VARIOUS WATER LEVELS FOR THE SITES INVESTIGATED
ON JACKFISH AND MURRAY LAKES

Recreation Potential \ FSL	Cottage Area			Cottage and Undeveloped Area Together		
	1737.0	1737.5	1738.0	1737.0	1737.5	1738.0
Low	21%	31%	39%	34%	45%	57%
Moderate	23%	33%	37%	29%	30%	28%
High	56%	36%	24%	37%	25%	15%

(Adapted from Table 5 of 1975 report on shoreline effects by Land Protection Branch, Department of the Environment)

Table 5

PERCENTAGE DISTRIBUTION OF RELATIVE CHANGE
IN RECREATION POTENTIAL IF THE FSL WAS
INCREASED FROM 1737.0 TO THE INDICATED LEVEL

Relative Change in Recreation Potential at Cottage Areas	New FSL	
	1737.5	1738.0
Improved	10%	8%
Worse	29%	43%
Same	61%	49%

(Adapted from Table 5 of 1975 report on shoreline effects
by Land Protection Branch, Department of the Environment)

If it is assumed that the distribution of cottages at each subdivision will remain the same in the future, then an estimate can be made on which level is most beneficial to the greatest number of cottage users. Table 7 shows a summary of the distribution of the number of cottages that would tolerate the various water levels. This table indicates that the present level will benefit the greatest number of cottage users. The number of cottages located in each subdivision is based on a table given in the February, 1973, summary report prepared by Land Protection Branch, Department of the Environment. In Table 7 the percentage distribution of sites classified according to the particular water level at each subdivision were weighted according to the number of cottages in each subdivision.

Table 6

PER CENT DISTRIBUTION OF THE MOST BENEFICIAL
WATER LEVELS CONSIDERING THE COTTAGE SITES
INVESTIGATED ON JACKFISH AND MURRAY LAKES

Affect On Sites In Cottage Area	FSL	1737.0	1737.5	1738.0
Tolerable or Most Suitable		90%	55%	35%
Most Suitable		41%	4%	0%

Table 7

PER CENT DISTRIBUTION OF THE MOST BENEFICIAL
WATER LEVELS IN TERMS OF NUMBER OF COTTAGES AFFECTED

Affect on Cottages	FSL	1737.0	1737.5	1738.0
Tolerable or Most Suitable		97%	73%	58%
Most Suitable		67%	3%	0%

* Total Number of Cottages = 990

(Adapted from Table 6 from 1975 report on shoreline effects
by Department of the Environment, Land Protection Branch)

Chapter IV

GENERAL CONSIDERATIONS

Although increasing the FSL of the lake would increase the potential for flood damages it would decrease the drought potential and lessen the effects of any drought related consequences. However, the consequences of drought on the recreation potential of the lake (swimming, boating, fishing) has not been quantitatively assessed.

There is a 50 per cent probability that peak levels over the summer season will be less than the FSL of the lake. Therefore, if 1737.0 is considered a minimum required level for proper recreation utilization of the lake, setting the FSL 0.5 feet higher at 1737.5 would ensure that the probability would be greater than 50 per cent for having at least the minimum use level of 1737.0 or more. In addition, the lake tends to experience an average drawdown of 0.5 feet over the summer season considering the net effect of summer rainfall runoff and net evaporation. Therefore, to have an average year end elevation of 1737.0, a FSL of 1737.5 would be required.

Because Jackfish Lake is a relatively shallow lake (average depth equals 11 feet, maximum depth equals 17 feet at an FSL of 37.5) an extra 0.5 feet of water could be important for proper maintenance of aquatic life. Considering drought levels which have a probability of recurrence of one in five, the lake would be approximately two feet below a FSL of 1737.5 and 0.5 feet of water would represent five per cent of the average depth of the lake and therefore represent a volume of water equal to five per

cent of the total volume. This serves merely to point out that 0.5 feet of water on Jackfish Lake cannot be considered a negligible amount of water in a moderate drought period. In a February, 1973, report prepared by the Department of Natural Resources it was stressed that a permanent level of 1738.0 would be most beneficial to biological conditions on Jackfish and Murray Lakes. It was noted that a high yield of production of pike has been correlated with high constant water levels on marshes which serve as spawning grounds for the pike.

In a recent memo* the view was expressed that the higher the water level the better will be the habitat for fish. The best conditions for pike spawning are a rise of water levels in the spring to flood grasses and marshes, maintained for three to four weeks, followed by a gradual drop to allow return of pike fry to the lake. It was noted that the drastic decline in fish populations during the late 1950's and early 1960's appeared to be related to very low water levels and a build-up of dissolved minerals in the water.

The flooding of low lying marshes may benefit fish production, but reduces the potential for hay production around the lake. Water levels greater than 1737.0 increase agricultural flooding along some creeks that drain into Jackfish and Murray Lakes. Sloughs along Jackfish Creek affecting at least three to five farmers and one slough near Crystal Creek affecting one farmer incur backwater from the lakes and do not readily drain when lake levels are high. In the Department of Agriculture report on land control it was reported that the consensus

*R. P. Johnson, Superintendent of Fisheries, Fisheries and Wildlife Branch, Prince Albert. March 3, 1976, memo to L. G. Lensen, Director, Regional Services Branch, Regina, Saskatchewan.

among the farmers affected was that a level of 1737.5 could be tolerated, but any higher levels would have an adverse effect on hay production. The FSL of the lake has been set at 1737.5 since 19⁷⁹~~20~~ and no serious flooding problems have been reported.

The lake levels which have been recorded since 1964 are shown on Figures 2, 3 and 4.

Chapter V

CONCLUSIONS

1. Any Conclusions Reached With Regard To Setting A Permanent Water Level Based On the Evaluation Of The Recreation Potential Of The Shoreline Should Be Based Primarily On The Results As They Apply To The Developed Cottage Areas

Few of the undeveloped areas would be suitable for future development at any FSL as 80 per cent have a low to moderate recreation potential at the presently licensed level of 1737.0.

2. Elevation 1738.0 Is Unsuitable For A Full Supply Level For Jackfish And Murray Lakes

A permanent increase in the water level of Jackfish and Murray Lakes would generally increase the potential for erosion along the shoreline and reduce the suitability of the shoreline for recreational use. At a water elevation of 1738.0 only 35 per cent of the sites investigated in the cottage areas would be suited to proper utilization of the resultant shoreline. In addition, the recreation and agricultural conflicts at this level are difficult to resolve in view of the qualitative nature of much of the information.

3. Any Increase In The Level Of The Lake Beyond 1737.0 Would Probably Be Beneficial In Terms Of The Suitability Of The Lake For Recreation Activities

Because of the shallowness of the lake an increase in the water level would aid in maintaining the suitability of the lake for recreational activities such as boating, fishing and swimming during periods of below average runoff.

4. Elevation 1737.5 Is The Best Compromise Level Considering All Uses

Fifty-five per cent of the sites investigated in the cottage areas and 73 per cent of the cottage users could tolerate a level of 1737.5. Considering the shallowness of the lake, the 0.5 foot average net drawdown over the summer season and the reduction in drought potential, the level of the lake should probably be licensed permanently at 1737.5. The lake has been at or near this elevation over the past five years and no severe problems have been raised.

5. Land Control To Elevation 1737.5 Should Probably Be Obtained By Way Of Easement At An Anticipated Cost In The Order of \$35,000

Acquisition of land control by purchasing title by legal subdivisions would reduce future compensation costs in the event of a very rare flood, but at ten times the cost of obtaining easements it is probably not warranted.

Chapter VI

RECOMMENDATIONS

1. It Is Recommended That Jackfish And Murray Lakes Be Licensed Permanently To A FSL of 1737.5
2. If A FSL Higher Than 1737.5 Is Considered In The Future It Is Recommended That The Following Additional Studies Be Undertaken:

(a) A Management Study

Because of the shallowness of the lakes and the apparent correlation between fluctuating water levels and fish populations it is recommended that a management study be undertaken to determine what benefits to fisheries management may result when the lake levels are greater than 1737.5.

(b) A Study Of The Benefits Of Higher Water Levels In Alleviating Algae And Weed Growth

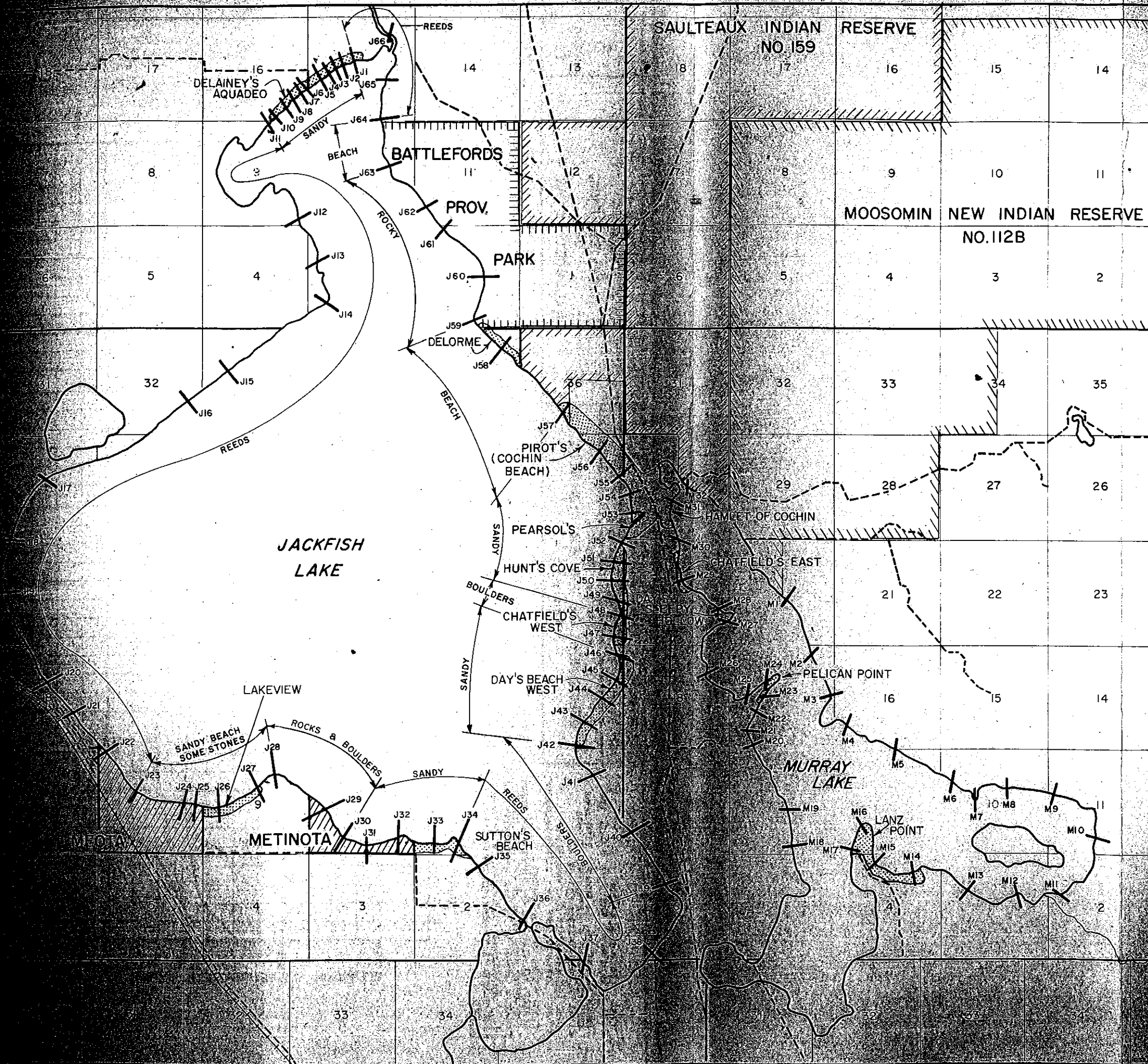
Because algae and weed growth in the offshore areas of the lakes tend to inhibit recreational use of the lake and are generally associated with low water levels, the possible benefits of water levels higher than 1737.5 in alleviating such problems should be investigated.

(c) A Quantitative Assessment of Day Users

Such a study should only be undertaken if higher lake levels are found to be highly conducive to recreation (fishing, swimming, boating).

(d) Investigation Of The Feasibility Of, And The Costs
Involved In, Alleviating Agricultural Flooding Problems

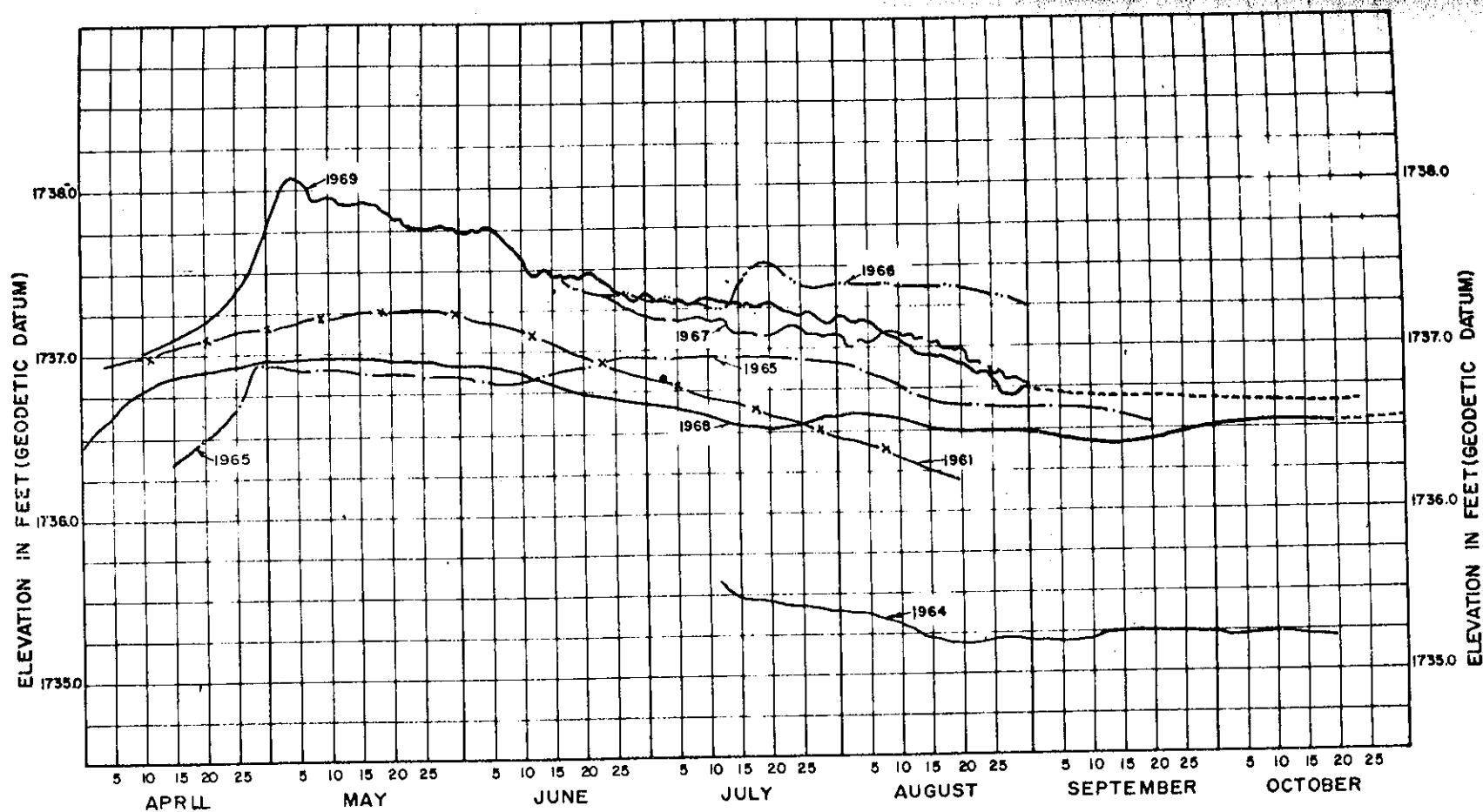
Any benefits that might accrue to recreation by virtue of higher water levels must be considered in the perspective of the costs involved in alleviating agricultural flooding problems which tend to be aggravated at water levels greater than 1737.5. Consideration could be given to the purchase of the problem areas, construction of dykes or payment of compensation in the event of lost production.



SASKATCHEWAN
DEPARTMENT OF THE ENVIRONMENT
LAND PROTECTION BRANCH

COTTAGE AREAS
AND CROSS SECTION LOCATIONS
ON
MURRAY AND JACKFISH LAKES

DATE: DECEMBER, 1972	FIGURE 1
PLAN NO. M4-4-2 (1)	



NOTES

1. THE OUTLET IS ARTIFICIALLY CONTROLLED BY A STRUCTURE LOCATED IN N.E. 10-47-17-W3.
2. LEVELS TAKEN AT COCHIN BREAKWATER FOR THE YEARS 1964, 1965, 1966, AND 1968. THESE LEVELS ARE AFFECTED BY INFLOW FROM MURRAY LAKE DURING RUNOFF PERIODS.
3. LEVELS TAKEN AT THE BATTLEFORDS PROVINCIAL PARK FOR THE YEARS 1967 AND 1969.
4. PART OF 1968 AND 1969 LEVELS WERE ESTIMATED FROM PERMITTENT RECORDS TAKEN AT THE OUTLET CONTROL STRUCTURE.
5. REFER TO PLAN NO. J1-6-4-(1) 2 OF 3 FOR LAKE LEVELS AFTER 1959.

SASKATCHEWAN DEPARTMENT OF THE ENVIRONMENT HYDROLOGY BRANCH

DRN. D.R.C.

DATE AUG. 1975

STA. NO. 29-127

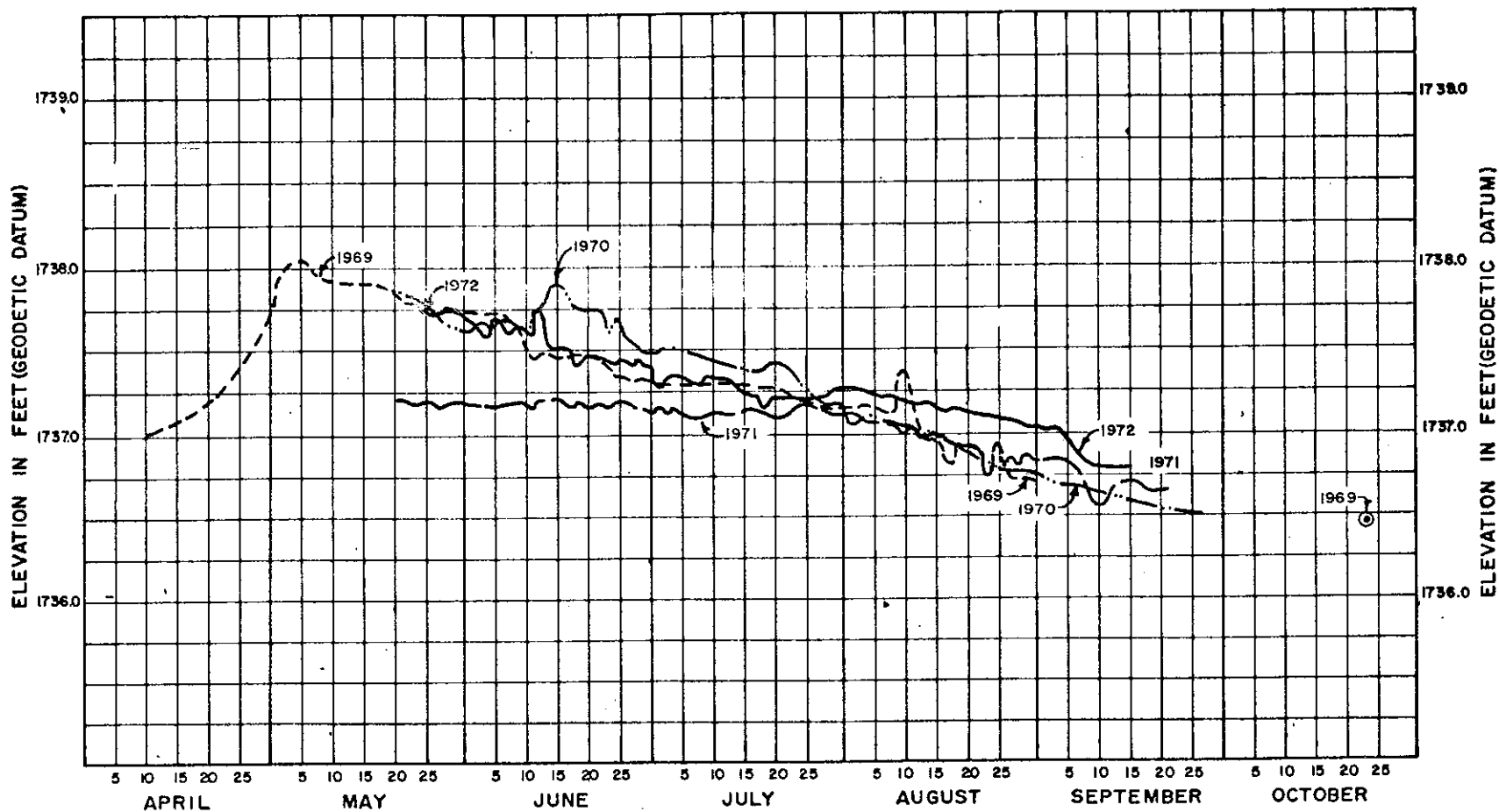
PLAN NO. J1-6-4(1)

RECORDED LEVELS OF JACKFISH LAKE NEAR COCHIN

1 OF 3

FIGURE

2

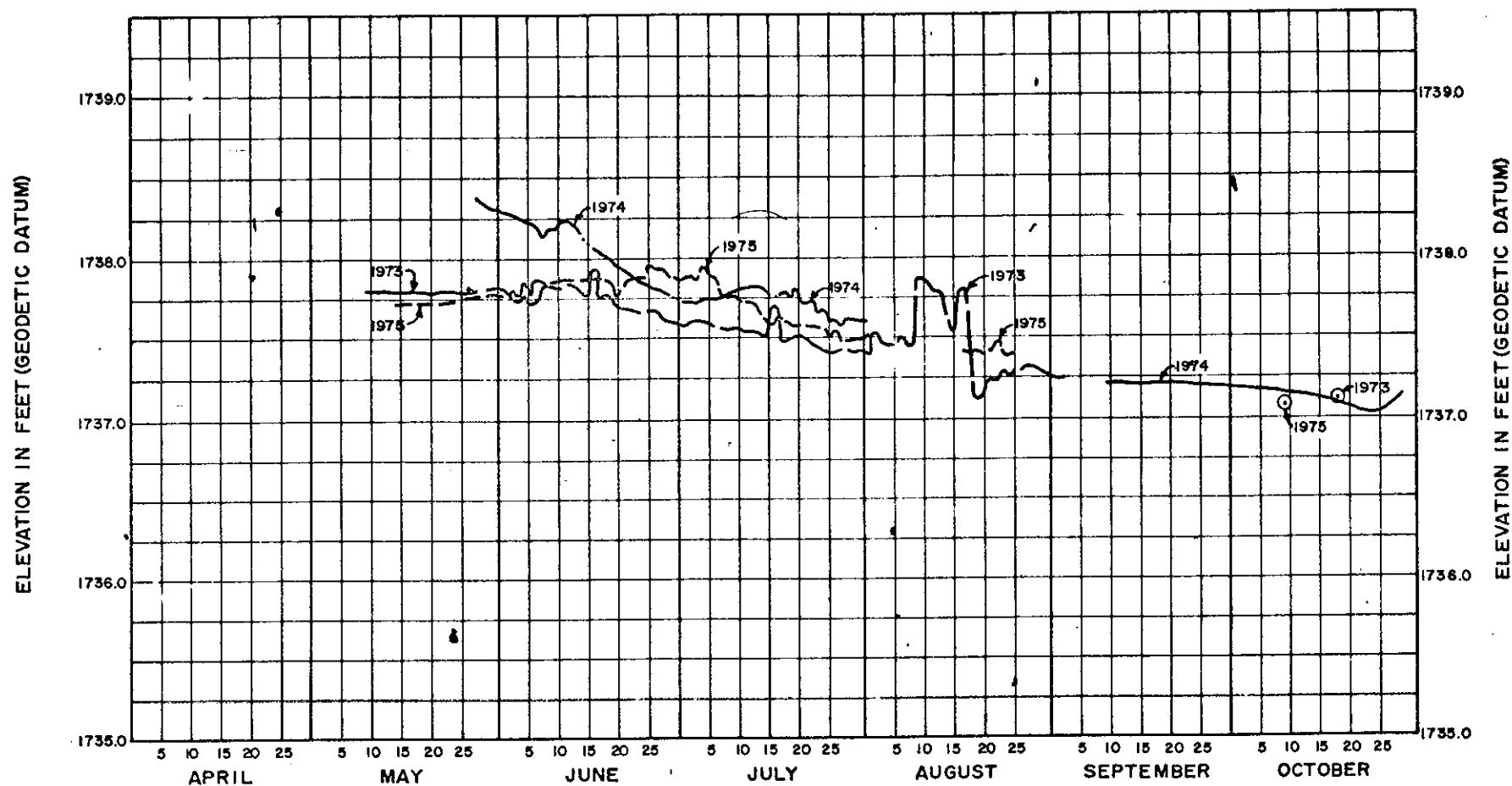


NOTES

1. THE OUTLET IS ARTIFICIALLY CONTROLLED BY A STRUCTURE LOCATED IN N.E. 10-47-17-W3.
2. REFER TO PLAN NO. J1-6-4 (I) 1 of 1 FOR LAKE LEVELS BEFORE 1969.
3. REFER TO PLAN NO. J1-6-4 (I) 3 of 3 FOR LAKE LEVELS AFTER 1972.

2 OF 3

SASKATCHEWAN DEPARTMENT OF THE ENVIRONMENT HYDROLOGY BRANCH		RECORDED LEVELS OF JACKFISH LAKE NEAR COCHIN	FIGURE 3
DRN. D.R.C.	DATE AUG. 1975		
STA. NO. 29-127	PLAN NO. J1-6-4 (I)		



NOTES

1. THE OUTLET IS ARTIFICIALLY CONTROLLED BY A STRUCTURE LOCATED IN N.E. 10-47-17-W3.
2. REFER TO PLAN NO. J1-6-4 (I) 2 of 3 FOR LAKE LEVELS BEFORE 1973.

3 OF 3

SASKATCHEWAN DEPARTMENT OF THE ENVIRONMENT HYDROLOGY BRANCH		RECORDED LEVELS OF JACKFISH LAKE NEAR COCHIN	FIGURE 4
DRN. R.J.C.	DATE MARCH , 1976		
STA NO. 29-127	PLAN NO. J1-6-4 (I)		