LESSER SLAVE LAKE REGULATION

STATUS REPORT

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PLANNING DIVISION

JULY 1993

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LESSER SLAVE LAKE REGULATION

SUMMARY

The purpose of the Lesser Slave Lake Regulation report is to provide information to the area residents on the background leading to the regulation of water levels and on the effects this regulation has on the Lesser Slave Lake water levels. Impacts of the regulated water levels on agriculture, recreation, fisheries and municipal water supply are presented. The analyses are based on simulated water levels from 1916 to 1992 with the regulation project being in place and are compared to the water levels which existed under the natural lake outlet conditions.

The Lesser Slave Lake area has experienced flooding problems caused by high lake levels since the area was first settled in the early 1900's. In response to the concerns of Lesser Slave Lake area residents, over the high water levels in 1965 and the flooding in the mid 1970's, the provincial government, in 1978, accepted the recommendation of the local residents and the Lesser Slave Lake Basin Local Advisory Committee that improving the lake outlet channel was the preferred method of reducing flooding concerns.

A number of methods were investigated to regulate Lesser Slave Lake. The outlet control works subsequently constructed consisted of:

- eight meander "cut-offs" in the upper 24 km of the Lesser Slave River; and
- a fixed crest weir and a fishway to allow fish to migrate into the lake.

The purpose of the cut-offs is to increase the capacity of Lesser Slave River to carry higher flows. The weir and the cut-offs in combination have the following effect on the lake water levels:

- lower the high lake levels
- raise the low lake levels
- reduce the mean lake level
- reduce the lake level fluctuation

Construction of the cut-offs began in the fall of 1980; the weir was constructed in the fall of 1983 and the installation of the fishway ladder and the safety features were completed by fall of 1984.
Lesser Slave Lake water level data were used to simulate continuous water levels from 1916 to 1992, for the natural and

regulated lake outlet conditions. The assessments in the report, are based on these two sets of water levels. Actual lake levels, since construction of the outlet control works, are also included in the report.

The water level requirements of different lake users were developed to enable analyses of the effects of Lesser Slave Lake Regulation on agriculture, recreation, fisheries and municipal water supply.

The regulation of Lesser Slave Lake will for all practical purposes eliminate flooding of agricultural land between elevations of 578.9 m and 578.3 m. These elevations represent the highest natural and regulated lake levels during the 77 years of record. A total of 4,500 ha (11,000 acres) will benefit. A further 21,000 ha (52,000 acres) of lakeshore land located between elevations 578.3 m and 576.3 m; being the regulated highest and the regulated mean water levels will benefit from regulation. All lands between these elevations will receive some degree of flood reduction.

The impact of regulated water levels on the recreational beaches is two fold. A general benefit results from reducing the width of beaches that are too wide at natural low water levels and increasing the width of beaches that are too narrow at natural high water levels. However, a few beaches will experience increased excessive beach widths because of the lower regulated mean water level. The impact of regulated levels is less favourable compared with the natural levels for the operation of the eleven docks and boat launches investigated. However, it should be noted that the federal docks at Joussard, Faust and Canyon Creek are constructed at higher than optimum elevations even for natural water level conditions.

The regulated water levels will generally meet the requirements for the spawning and rearing of northern pike and lake whitefish. However, some northern pike spawning habitat could be affected because of reduced flooding of the shoreline, which might impact northern pike populations. No adverse impacts are anticipated on lake whitefish populations. It is more difficult to predict the long term impact on walleye. However, there are concerns that since the regulated mean water level is lower than the natural mean it could potentially reduce walleye rearing habitat. This is being investigated further by Alberta Environmental Protection, Fish and Wildlife Services.

The regulated water levels meet the minimum water level requirements for all water supply intake structures, except for the Hamlet of Joussard intake structure. The Joussard intake structure does not meet the minimum water level requirements for

boating safety and ice formation under either the natural or regulated conditions.

The overall impact of the Lesser Slave Lake Regulation Project is to reduce the range of long term water level fluctuations from 3.5 metres to 2.7 metres, and to reduce the frequency and the duration of both high and low water levels.

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1.0 INTRODUCTION

1.1 Purpose

The Report has been prepared by Alberta Environmental Protection to meet the following objectives:

- to provide local residents with the background to the Lesser Slave Lake Regulation project and to describe the outlet control works that have been constructed;
- to describe the effects the outlet control works have on Lesser Slave Lake water levels; and
- to describe the effects that changes in water levels due to Lesser Slave Lake regulation have on agriculture, recreation, fisheries and water supplies.

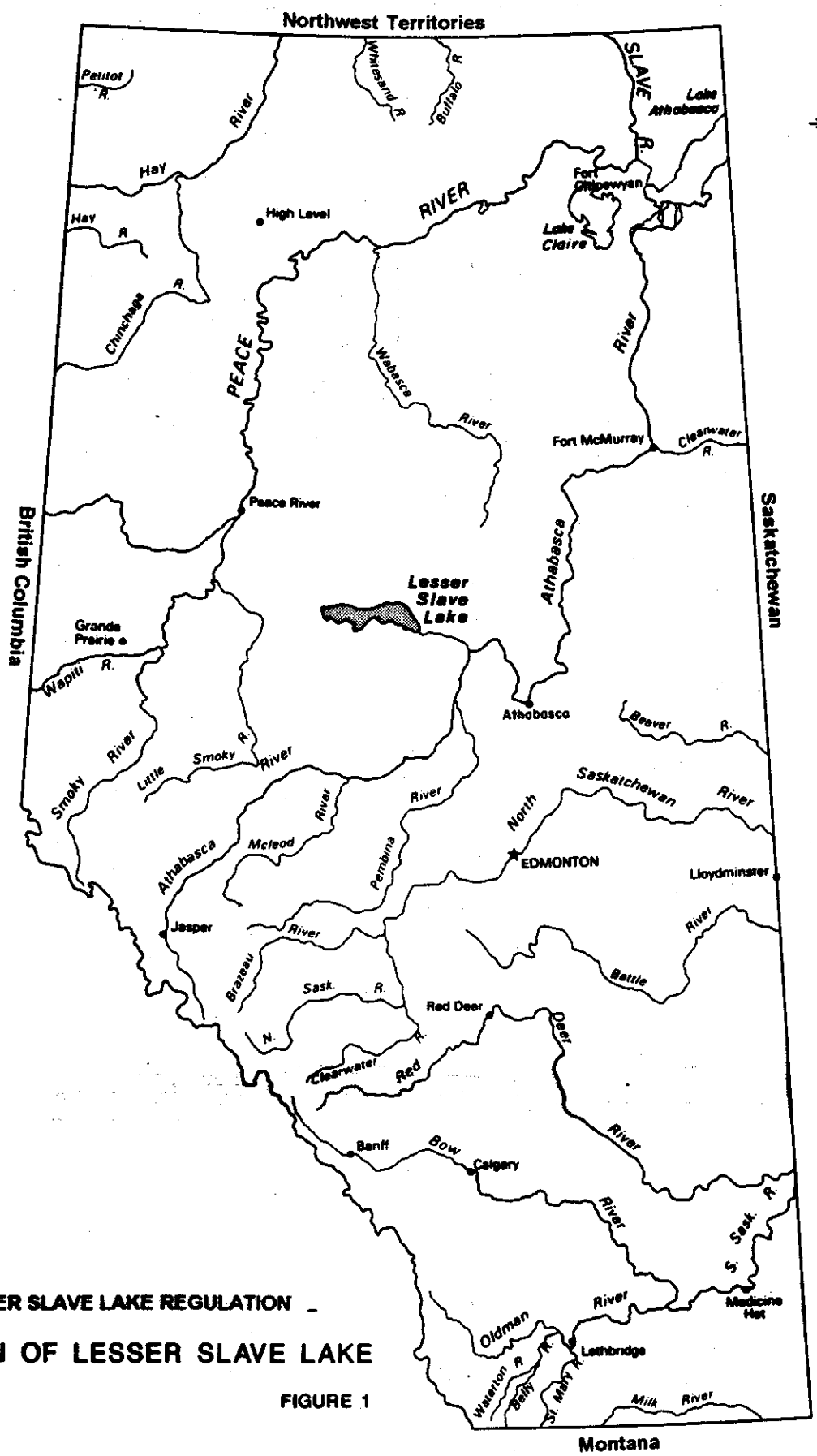
1.2 Basin Overview

Lesser Slave Lake (Figure 1) is located in north central Alberta, 250 km northwest of Edmonton. The lake surface area is approximately 1,150 km^2 at the historical mean level of 576.6 metres above mean sea level. It has a drainage area of approximately 12,700 km^2. The lake's outlet, the Lesser Slave River, is at its east end. Figure 2 shows the Lesser Slave Lake drainage basin.

Lesser Slave Lake receives runoff from several volatile rivers originating in the Swan Hills and from the more passive and partially controlled South Heart River system originating in the northwest. The East and West Prairie River watershed and the Buffalo Bay/Horse Lakes delta complex, which includes the lower reaches of the South Heart River, comprises approximately 3,000 square kilometres and forms the south-western sub-basin of Lesser Slave Lake. Inflows to the lake from all these river systems have, at times, greatly exceeded the capacity of the lake outlet, the Lesser Slave River, causing a rise in lake water levels.

The Lesser Slave River, as it flows eastward to its confluence with the Athabasca River, encounters a natural deposit of gravel and cobbles (glacial till) 48 km downstream of the lake known as the Saulteaux Weir.

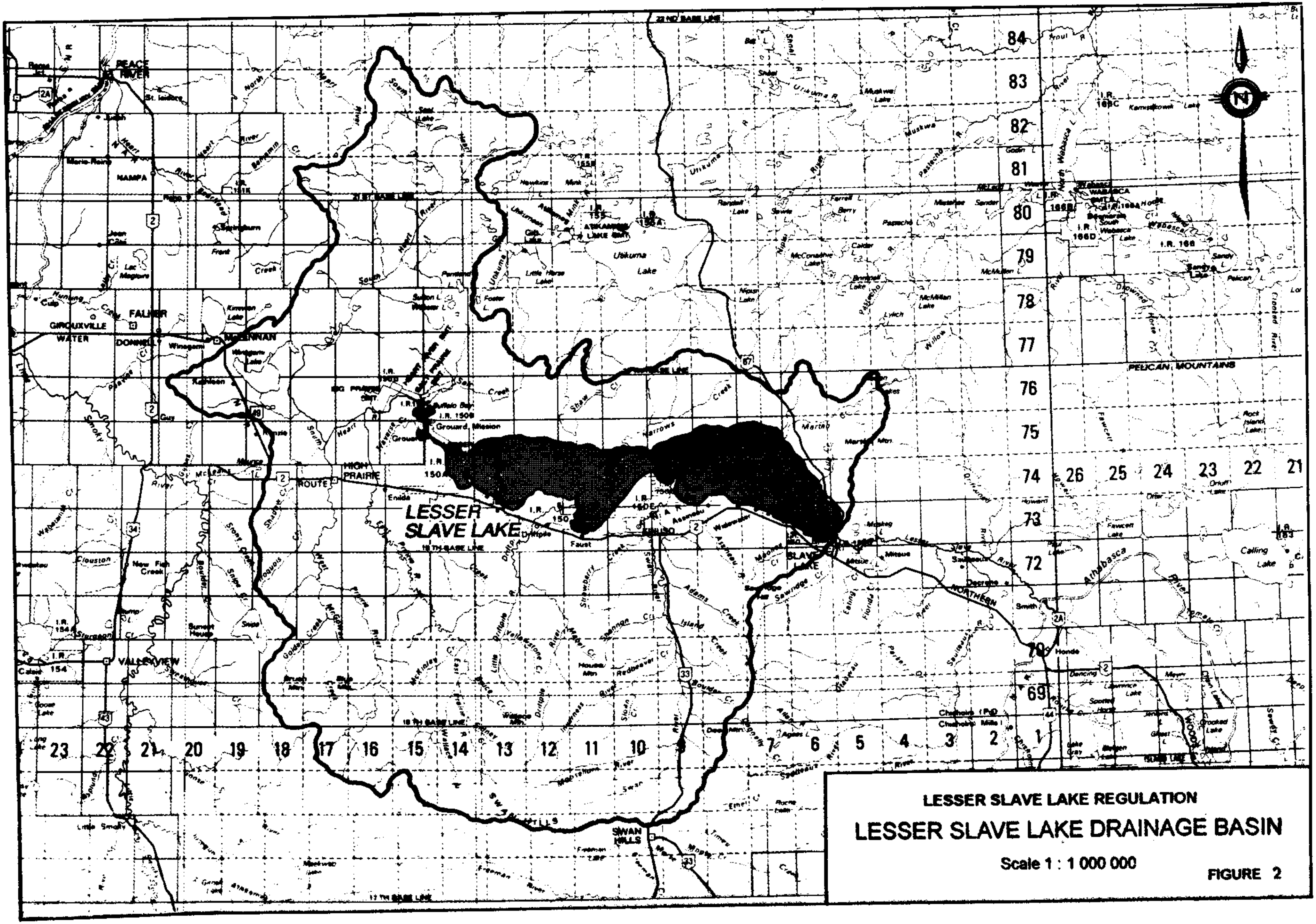
The Saulteaux Weir produces two distinct slopes along the Lesser Slave River. The reach of the river between the lake and the Saulteaux Weir has a shallow slope of 0.1 metre/kilometre (m/km). The reach of Lesser Slave River downstream from the Saulteaux Weir to its confluence with Athabasca River has a steeper slope of 0.7 m/km. It is the shallow slope created by the existence of the Saulteaux Weir which controlled the outflow from Lesser Slave Lake and has, therefore, controlled the lake water levels.



LESSER SLAVE LAKE REGULATION

LOCATION OF LESSER SLAVE LAKE

FIGURE 1



LESSER SLAVE LAKE REGULATION

LESSER SLAVE LAKE DRAINAGE BASIN

Scale 1 : 1 000 000

FIGURE 2

2.0 BACKGROUND

Since the area was first settled in the early 1900's, the residents of Lesser Slave Lake have experienced flooding problems related to high lake water levels. They have petitioned the provincial government for action to alleviate these problems.

As a consequence of the high water levels in 1965, the provincial government commissioned a number of studies to determine how the levels could be controlled. The studies indicated that the cost of regulation schemes would be greater than the benefits and recommended purchase of flooded lands.

In 1968, the government adopted a policy of buying land affected by high water levels from farmers wishing to sell. By 1978, approximately 6,300 ha of agricultural land (13% of the flood prone land) was purchased by the provincial government. Under this policy much of the purchased land was leased back to the farmers for haying. Some area residents, however, preferred a solution which would improve the productive capability of the land. Moreover, about one quarter of the affected land belongs to Indian Bands, and was ineligible for purchase.

In the late 1970's, the provincial government came under renewed pressure from the local residents to adopt measures to reduce the flooding which the residents felt was becoming more frequent and lasting longer. In response, Alberta Environment initiated studies to investigate lake regulation alternatives. Local residents were involved in the studies both through the Lesser Slave Lake Basin Local Advisory Committee and public meetings.

The Committee and the public reviewed a number of proposed alternatives to regulate the water levels and ultimately recommended to the Minister of the Environment that improving the lake outlet channel was the preferred method of reducing the flooding concerns.

This recommendation was accepted by the government in 1978.

Detailed engineering and hydraulic studies were then begun to determine how best to minimize the long term lake level fluctuation range, thereby reducing the extent and frequency of flooding of land adjacent to the lake. The lake water level range between 1916 and 1978 was 3.5 m from a high of 578.9 m recorded in 1935 to a low of 575.4 m recorded in 1947. Two alternatives to reduce this fluctuation and to regulate water levels were investigated:

- a canal bypassing the upper 22 km of the Lesser Slave River and a weir at the upper end of the canal; or

- eight river channel cut-offs in the upper 24 km of Lesser Slave River and a weir across the first cut-off immediately downstream of the Lesser Slave Lake outlet.

The alternative comprising of cut-offs and the weir was selected.

The purpose of the cut-offs is to increase the capacity of Lesser Slave River to carry higher flows. The weir and the cut-offs, in combination, affect the water levels by:

- lowering the high lake levels;
- raising the low lake levels;
- reducing the mean lake level; and
- reducing the overall lake level fluctuation.

In 1981, during the construction of the first five cut-offs, Lesser Slave Lake levels were low. It was recognized that the low water levels had occurred as a result of natural conditions and were not caused by the construction of the cut-offs. Due to the concerns over low lake levels expressed by the Lesser Slave Lake Basin Local Advisory Committee the decision was made not to delay construction of the weir, as had been originally scheduled, but to proceed immediately with the construction of the weir.

This decision was approved by the Lesser Slave Lake Basin Local Advisory Committee. The weir was constructed in November 1983, and the Lesser Slave Lake Regulation project which included the weir, fishway and cut-offs, was fully completed by fall of 1984. The constructed weir is 30 metres wide and the crest elevation is 575.5 metres above mean sea level.

3.0 LESSER SLAVE LAKE WATER LEVELS

Hydrological studies were undertaken to produce data on two different sets of lake water levels. One represents what the lake water levels would have been for the period 1916 to 1992 if the regulation project had been in place and the other represents the natural levels that would occur without any regulation. These water levels were used in the hydrological and statistical analyses necessary in the design and assessment of the Lesser Slave Lake Regulation Project.

Regulation of Lesser Slave Lake affects the lake water levels for the period 1916 to 1992 as follows:

- reduces the maximum water level by 0.6 m from 578.9m to 578.3 m.
- increase the minimum water level by 0.2 m from 575.4m to 575.6 m.
- reduces the mean water level by 0.3 m from 576.6 m to 576.3 m.
- reduces the range of water level fluctuation from 3.5 metres to 2.7 metres.

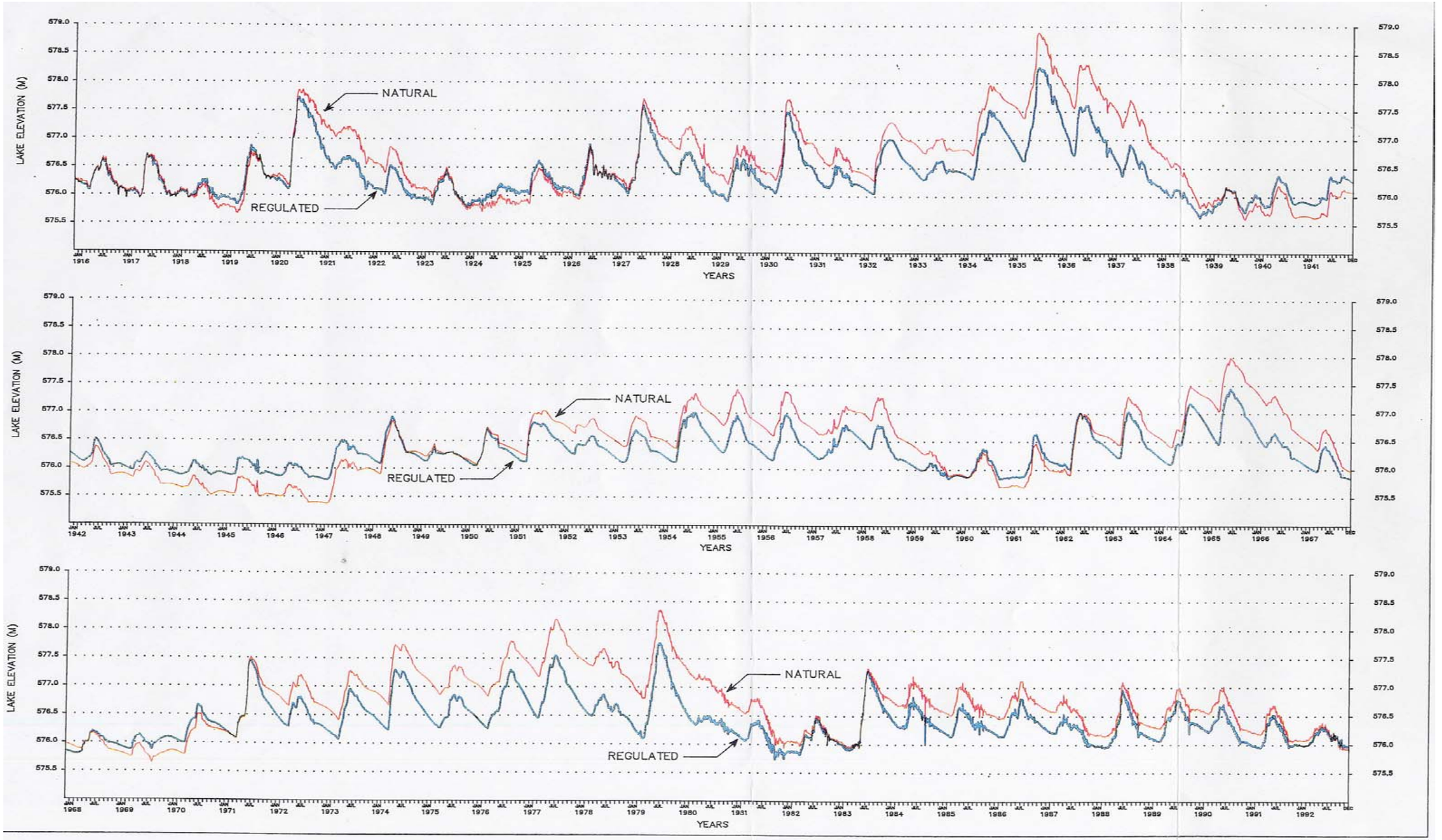
3.1 Natural Lake Water Levels 1916-1992

The natural lake water levels refer to the water levels which have and would have occurred in Lesser Slave Lake under the natural outlet conditions. The natural outlet is the Lesser Slave River prior to construction of the outlet control works in 1983.

The recorded maximum and minimum water levels for Lesser Slave Lake are 578.9 m in 1935 and 575.6 m in 1945 respectively. However, extended periods of missing records occurred in the 1940's and 1950's. Water levels for this period were estimated by using hydrological analyses based on recorded regional stream flow and precipitation data. The analyses indicated that the historic minimum lake water level was 575.4 m in 1947, and gave an historic water level fluctuation range of 3.5 m from a maximum of 578.9 m to a minimum of 575.4m.

The natural lake water levels shown in Figure 3 are for the historic period 1916 to 1992. These consist of:

- recorded and infilled water levels from 1916 to 1982 and are the water levels which occurred under the natural outlet condition; and
- simulated natural water levels from 1983 to 1992 and these are the predicted water levels which would have occurred if the weir and the cut-offs had not been constructed.



LESSER SLAVE LAKE REGULATION

LAKE LEVELS, 1916–1992

FIGURE 3

3.2 Regulated Lake Water Levels 1916-1992

The regulated lake water levels for the period 1916-1992 refer to the simulated Lesser Slave Lake water levels which would have occurred if the weir and the eight cut-offs in Lesser Slave River had been in place since 1916. These simulated regulated lake water levels are presented in Figure 3.

3.3 Actual Lake Water Levels 1984-1992

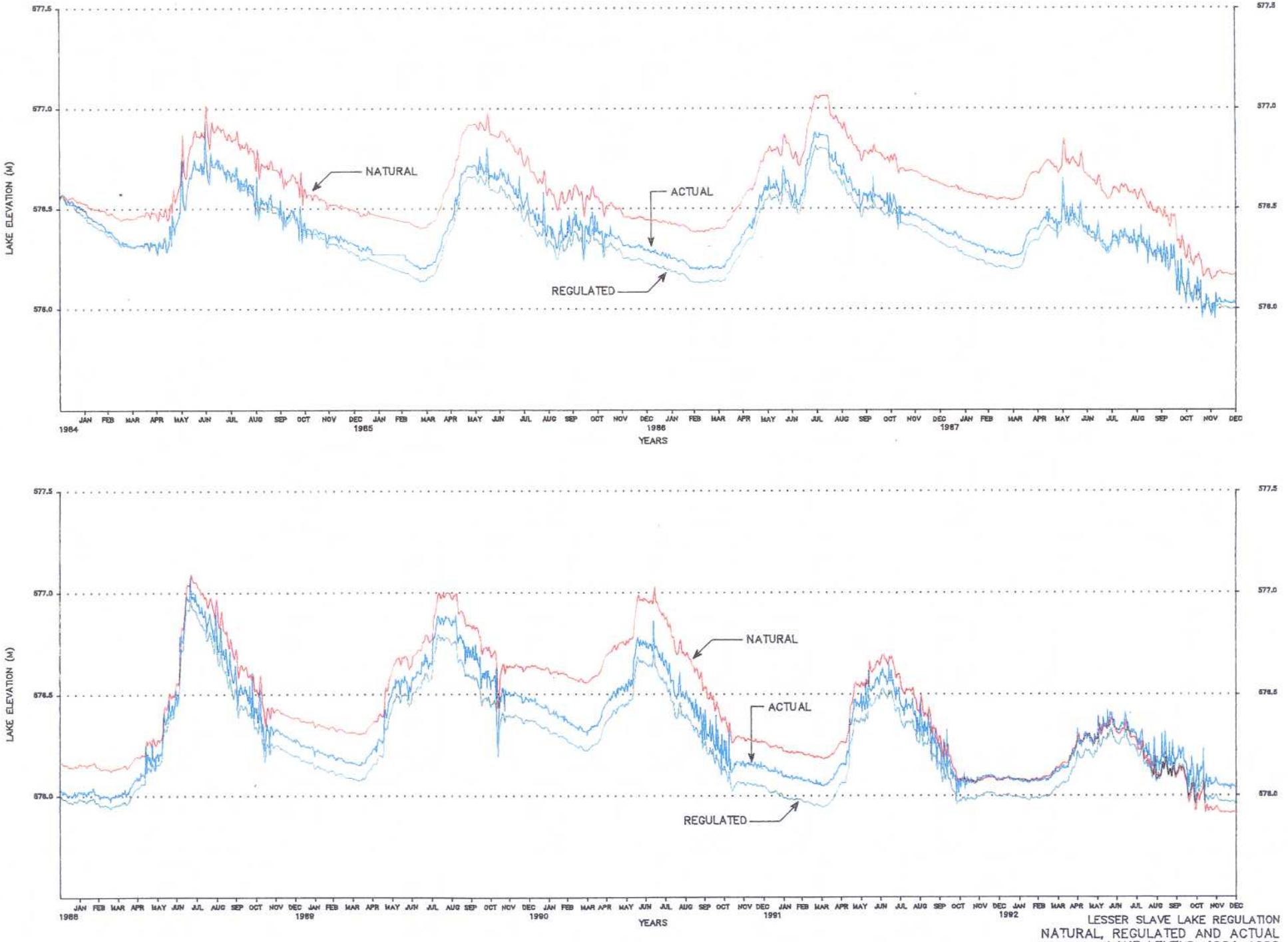
The actual lake water levels are the recorded Lesser Slave Lake water levels since the outlet control works were completed. Figure 4 shows the natural, regulated and actual water levels for the period 1984 to 1992. In December 1992, the measured actual water levels were 0.08 m higher than the simulated regulated water levels. This is because the Lesser Slave River channel had probably not stabilized to the extent anticipated due to the lack of flood events. The actual water levels were also approximately 0.11 m below the simulated natural water levels.

3.4 Hydrological Frequency Analysis

A frequency analysis of Lesser Slave Lake water level data was carried out to determine the probability of various water levels occurring. Table 1 shows the lake water levels expected to occur under both the natural and regulated outlet conditions for commonly used return periods. A return period is a method of expressing the probability that a particular event will occur in any one year. For example, a return period of 100 years means that every year there is a 1% chance that Lesser Slave Lake would reach the specified lake water levels. The return periods for various lake levels are indicated in Table 1.

Table 1
Frequency Analysis of
Lesser Slave Lake Water Levels

Return Period (years)	High Water Level (m)		Low Water Level (m)	
	Natural	Regulated	Natural	Regulated
100	578.65	578.10	575.26	575.67
50	578.44	577.90	575.35	575.70
20	578.12	577.63	575.50	575.75
10	577.85	577.40	575.64	575.81
5	577.54	577.15	575.82	575.88
2	576.97	576.74	576.19	576.03



LESSER SLAVE LAKE REGULATION
NATURAL, REGULATED AND ACTUAL
LAKE LEVELS, 1984–1992

FIGURE 4

4.0 IMPACTS OF OUTLET CONTROL WORKS ON LAKE USERS

The Lesser Slave Lake Regulation Project was designed to regulate the lake water levels between elevation 577.9 m and 575.7 m. These levels represent a return period of 50 years. The expected outcome of lake regulation is a lowering of the frequency and magnitude of higher levels and a general raising of water levels when they would have been low under natural conditions.

To assess the impacts of lake regulation on the users of Lesser Slave Lake, the natural and regulated water levels were compared to the range of preferred lake water levels for agriculture, recreation, fisheries and municipal water supplies.

4.1 Agriculture

The Lesser Slave Lake Regulation Project has the effect of lowering high water levels and, therefore, reducing the incidence and extent of flooding. In the assessment of flooded areas and flood damage to agricultural land, a soil saturation factor was included. Land extending a vertical distance of 0.6 m above the water level was considered to be saturated and, therefore, not suitable for cultivation.

The regulation of Lesser Slave Lake will, for all practical purposes, eliminate flooding of agricultural land between elevations of 578.9 m and 578.3 m. These elevations represent the highest natural and regulated water levels during the 77 years of record. A total of 4,500 ha (11,100 acres) will benefit. A further 21,000 ha (51,900 acres) of lakeshore land located between elevations 578.3 m and 576.3 m; being the regulated highest and the regulated mean water levels will benefit from regulation. All lands between these elevations will receive some amount of flood reduction.

4.2 Recreation

Lesser Slave Lake supports a large water based recreation industry. Provincial campgrounds, municipal picnic areas, private beaches, private and federal docks and boat launches are located on the lake. Boating, sailing, canoeing, windsurfing, swimming, fishing and beach activities attract thousands of people each year to Lesser Slave Lake. A popular event on Lesser Slave Lake is the Annual Golden Walleye Classic; considered one of the major walleye sport fishing competitions in North America. Recreation impacts were assessed based on the effects of lake water levels on beaches, docks and boat launches.

4.2.1 Beaches

Lake water levels dictate the available beach width. This width is measured from the water's edge to the shoreline. Low water levels expose more beach width. This could cause increased maintenance costs and could lead to reduced recreational use due to the greater distance of the shore from the water's edge. High water levels reduce the width of the beach and this may cause crowding. Fluctuation of water level is desirable since inundation helps remove floating debris.

A beach width of between 30 metres and 50 metres is preferred by beach operators. Table 2 lists the beaches, their use and their preferred water levels. Table 3 shows the beach widths for various water levels for both the natural and regulated outlet conditions.

The following qualitative deductions may be made:

i) At higher water levels (water levels that are exceeded only 10% of the time), the regulated outlet condition exposes more beach width compared to the natural outlet condition. This is particularly significant for the following beaches.

- Devonshire Beach, Section A1, the beach width increases from 5 m to 32 m.
- Martin Campground, Section C1; the beach width increases from 11 m to 40 m.
- Spruce Point Beach; Section H1; the increase in beach width is from 5 m to 33 m.

ii) At lower water levels (water levels that are exceeded 90% of the time), the beach widths are narrower under regulated outlet condition. The difference in the width, however, is not significant.

iii) At the mean water levels, the beach widths are greater with the regulated outlet compared to the natural outlet condition. This has mixed significance for the beaches surveyed. In the case of Shaw's Point, Spruce Point and to some extent Hilliard's Bay Park beaches (section F1) the effect is deemed to be positive, because of the wider beach area exposed. In the case of Devonshire, Martin River Campground and Diamond Willow Resort beaches the impact is somewhat negative because beach widths exceed the acceptable range and in some cases may become excessive.

iv) A general benefit of Lesser Slave Lake regulation appears to be the reduction in the annual variability in beach widths.

Table 2
Recreational Beaches on Lesser Slave Lake

Beach Name/ Location	Ownership	Average Weekend Use	Comments by Beach Operators on Water Levels
Hilliard's Bay Provincial Park Day Use Area 17-75-13W5	Provincial Government	50-75 persons	- 1986 summer levels (approximately 576.6 m) about right - present water levels (1986 summer) are exposing rocks - if water levels drop 0.3 m most swimming area is lost
Spruce Bay Campground, Hilliard's Bay Provincial Park 17-75-13W5	Provincial Government	minimal use	- undeveloped beach; now only used to moor boats - demand for development of the beach - lower water levels would restrict swimming use
Devonshire Beach 19-73-5W5	Provincial Government	150 persons	- 1986 summer water levels (approx. 576.6 m) okay - prefer 50 m beach width for weed control - would like to see a fluctuation in summer levels
Martin River Campground 8-75-6W5	Provincial Government	350-400 persons	- 1986 summer water levels (approx. 576.6 m) okay - prefer 50 m beach width for weed control - would like to see a fluctuation in summer levels
Martin River Cottage Subdivision SW19-75-6W5	Private; 60 cottages	180 persons	- present water levels (approx. 576.6 m) okay for swimmers - 0.3 m rise would reduce beach by approximately 10 m - 0.3 m drop would increase beach width 6 m on average
Diamond Willow Resort 19-73-5W5	Herb Johnson	75-100 persons	- present levels (approx. 576.6 m) not too low - lowering water levels by 0.3 m would expose gravels - raising water levels by 0.3 m would significantly narrow the beach - more fluctuation in levels preferred
Spruce Point Park 5-74-10W5	Village of Kinuso	400-500 persons	- present levels (approx. 576.6 m) okay but prefer lower levels - 0.6 m lower levels would widen beach 13 m on average
Shaw's Point 12-75-14W5	Carson Porisky	200 persons	- 1986 summer water levels okay - prefer to see the lake 0.6 m higher than at present (August 1987)

Table 3
Lesser Slave Lake Beach Widths (metres)

Beach Name and Description	Location	Natural Outlet Condition			Regulated Outlet Condition		
		10% Exc. 577.42 (m)	Mean 576.6 (m)	90% Exc. 575.83 (M)	10% Exc. 576.92 (m)	Mean 576.3 (m)	90% Exc. 575.94 (m)
1. Devonshire							
Section A1	7-73-5 W5	5	37	116	32	61	112
Section A2	7-73-5 W5	28	46	114	41	79	112
Section A3	18-73-5 W5	35	57	113	51	72	111
Section A4	18-73-5 W5	20	38	113	35	53	78
Section A5	18-73-5 W5	19	37	78	32	63	75
Section A6	19-73-5 W5	6	11	16	9	13	15
2. North Shore							
Section A7	NE-30-73-5 W5	6	13	18	10	15	16
3. Martin River Campground							
Section C1	SW-18-75-6 W5						
Section C2	SW 18-75-6 W5	11	59	130	40	83	122
		16	65	134	44	76	120
4. Diamond Willow Resort							
Section D1	NW 18-75-6 W5						
Section D2	SW 19-75-6 W5	14	54	73	50	59	62
		20	75	129	73	85	120
5. Martin River Cottage Subdivision							
Section E1	SW 19-75-6 W5						
Section E2	NE 24-75-7 W5	19	31	74	25	39	71
		34	56	91	44	67	79
6. Hilliard Bay Park							
Section F1	NW 17-75-13 W5						
Section F2	NE 17-75-13 W5	19	24	37	23	29	35
		25	58	86	45	69	79
7. Shaw's Point							
Section G1	SW 12-75-14 W5	20	26	66	23	29	44
Section G2	SW 12-75-14 W5	11	17	29	15	19	24
Section G3	SW 12-75-14 W5	25	37	74	34	52	71
Section G4	SW 12-75-14 W5	19	40	76	38	62	73
8. Spruce Point Park							
Section H1	SW 9-74-10 W5	5	41	69	33	48	64

NOTES:

- 10% Exc. is the lake level that is equalled or exceeded only 10% of the time over the period of 1916 to 1992.
- 90% Exc. is the lake level that is equalled or exceeded 90% of the time over the period of 1916 to 1992.
- Section A1, A2, etc., refer to the beach cross-sections surveyed in November 1986 at the specified locations.

4.2.2 Docks and Boat Launches

Eleven permanent docks and boat launches on Lesser Slave Lake were investigated to determine the effects of varying lake water levels. In addition, a number of other docks were also examined including the removable docks at Hilliard's Bay Park and commercial craft docks operated by the federal government at Joussard, Faust and Canyon Creek.

The following criteria were used to determine the water levels required for docks and boat launches to operate properly.

- a dock is functional when a boat can be moored to the dock without scraping the lake bottom while still maintaining reasonable access to the boat. Commercial fishing boats require a minimum 1.0 m depth of water, and at least 0.5 m between the water surface and the top of the dock. However, 1.0 m is preferable. Small crafts require 0.5 m depth of water, and a maximum of 1.0 m between the water surface and the top of the dock.
- a boat launch is functional when a boat can be unloaded from a trailer while the trailer is still on the boat launch. It is considered usable when the water surface is 1.0 m or more above the toe of the ramp for commercial boats and 0.5 m or more for small boats.

- preferred operating ranges for the optimal use of these facilities were developed and are shown in Table 4.

The effects of variation in lake levels on the existing docks and boat launches on Lesser Slave Lake were investigated.

At lower lake levels (water levels that are exceeded 90% of the time) both the natural and regulated water levels are generally below the preferred operating range. The facilities most affected by these low water levels are the federal docks at Joussard, Faust and Canyon Creek and the federal boat launches at **Joussard and Canyon Creek and the marina at Shaw's Point.**

It should be noted that even the natural mean lake water level is significantly lower than the preferred operating range for the federal docks at Joussard, Faust and Canyon Creek and the boat launch at Shaw's Point Marina. Since the regulated mean water level is lower than the natural mean water level, it is, therefore, less favourable for the operation of the existing docks and boat launches.

Table 4

Effects of Lake Water Levels on the Preferred Operating Range for the Docks and Boat Launches

Facility Name and Location**	Preferred Operating Range (m)	Depth Below Preferred Operating Range (m)					
		Natural Conditions			Regulated Condition		
		90% Exc. 575.8	Mean 576.6	10% Exc. 577.4	90% Exc. 575.9	Mean 576.3	10% Exc. 576.9
Slave Lake (Provincial) Boat Launch SE7-73-5W5	576.1-577.8	0.3	0	0	0.2	0	0
Joussard (Federal) Dock 7-74-13W5	577.5-578.0	1.7	0.9	0.1	1.6	1.2	0.6
Joussard (Federal) Boat Launch 7-74-13W5	576.5-578.5	0.7	0	0	0.6	0.2	0
Faust (Federal) Dock N1/2-17-73-10W5	577.1-577.6	1.3	0.5	0	1.2	0.8	0.2
Faust (Federal) Boat Launch N1/2 17-72-10N5	576.1-578.1	0.3	0	0	0.2	0	0
Canyon Creek (Federal) Dock 31-73-7W5	577.1-577.6	1.3	0.5	0	1.2	0.8	0.2
Canyon Creek (Federal) Boat Launch 31-75-7W5	576.5-578.1	0.7	0	0	0.6	0.2	0
Hilliard's Bay (Provincial) Dock 17-75-13W5	576.2-577.1	0.4	0	* 0.3	0.3	0	0
Float Plane Harbour/ Marina (N. Sequin) SE 12-73-6W5	575.4-578.0	0	0	0	0	0	0
Shaw's Point Marina Boat Launch SW 12-75-14W5	576.7-577.7	0.9	0.1	0	0.8	0.4	0

NOTES:

- 10% Exc. is the lake water level that is equalled or exceeded only 10% of the time during the period 1916 to 1992.
- 90% Exc. is the lake water level that is equalled or exceeded 90% of the time during the period 1916 to 1992.

* Denotes depth above preferred operating range.

** Data were not available for Hilliard's Bay (Provincial) Boat Launch (17-75-13-W5)

4.3 Fisheries

The three main species of sportfish found in Lesser Slave Lake are walleye, northern pike and lake whitefish. These species have particular habitat needs, especially for spawning, which are affected by lake water levels. Low levels would reduce the extent of the littoral zone (shallow shoreline areas) and consequently reduce the most productive area of the lake for feeding, spawning and rearing habitat.

4.3.1 Walleye

Walleye are a predator species that relies heavily on the littoral zone for food and shelter. The majority of mature walleye in Lesser Slave Lake migrate to the west end of the lake in spring to spawn in the Grouard Channel, Buffalo Bay and South Heart Rivers. Adequate water levels are required in these locales to permit migration, spawning and rearing.

Spawning beds are located along the Grouard Channel, in Buffalo Bay and in the South Heart River. All beds are confined to the few gravel areas in the system. Walleye fry rear in the River and the Bay. Spawning begins in late April to early May, shortly after ice-break up as temperatures warm to 6-8°C.

A minimum depth of 1.0 metre is required in Buffalo Bay to ensure migration, spawning and rearing. There are concerns that water depths of less than 1.0 metre will inhibit adult walleye migration and increase the risk of Buffalo Bay becoming too warm for young walleye to survive.

It is more difficult to predict the long term impact on walleye as a result of spawning habitat change. However, there are concerns that since the regulated mean water level is lower than the natural mean, it could potentially reduce walleye rearing habitat. This is being investigated further by Alberta Environmental Protection, Fish and Wildlife Services.

4.3.2 Northern Pike

The littoral zone of Lesser Slave Lake stretches from the shore to about the 4 metre depth of water in the lake. This zone is dominated by rooted plants that provide food and shelter to fish. Pike also spawn on emergent and submergent vegetation in littoral and flooded shoreline habitat.

Studies relating spring lake water levels to the populations of adult northern pike six years later suggest that high spring water levels, due to flood events, are related to maximum pike abundance.

The littoral zone is an important rearing, spawning and feeding habitat for northern pike. Low lake levels in the short term decrease the width of littoral zone and, therefore, reduce the area available to this species.

The outlet control works have increased the outflow capacity of Lesser Slave Lake and have reduced the frequency of flood events, which are responsible for maximizing pike spawning success and production. The frequency of the population booms associated with these flooding events will likely decrease.

The regulated mean water level of 576.3 m is 0.3 m below the natural mean water level of 576.6 m. This will cause an increase in the littoral zone in some areas and a decrease in others. The lack of shoreline profile data makes estimates of the percent change in littoral zone impossible. It is felt that only temporary reductions in pike populations will result as the plant communities adjust (colonize) to the new levels.

4.3.3 Lake Whitefish

Lake whitefish lay their eggs in lake September and October in gravel-cobble shoreline areas with water depths of 1.5 to 2.0 m. Site selection is dependant on the availability of suitable substrates (gravel-cobble).

The eggs require open water, below the frozen lake surface, to survive the winter. The average thickness of ice in Lesser Slave Lake during winter is approximately 1.1 m. This provides an open water depth of between 0.4 m and 0.9 m under the ice for the eggs during the winter period. The eggs hatch shortly after ice break-up in the spring. Newly hatched whitefish prefer rearing along rocky shorelines where sharp drop-offs occur. This shoreline feature is common in the east basin. There are no data on the west basin.

Winter water level drops of up to 0.4 m will not adversely affect egg survival, a drop of between 0.4 m and 0.9 m will cause some whitefish egg mortality and a water level drop in excess of 0.9 m could cause a large number of eggs not to hatch. Considering the preferred depths for spawning, drops in mean fall water levels may impact spawning success if preferred substrates do not extend out from shore far enough. Reductions in water levels will decrease the amount of preferred rearing habitats in those areas of the lake exhibiting sharp drop-offs near the shore.

Table 5 compares the winter water level drops for the natural and regulated outlet conditions for the period 1916 - 1990.

Table 5 Winter Water Level Drops Under Natural and Regulated Conditions from 1916-1990		
Description	**Natural Outlet**	**Regulated Outlet**
Average annual drop (m)	0.33	0.38
Number of years drop less than 0.4 m	49	47
Number of years drop between 0.4 m - 0.9 m	25	25
Number of years drop more than 0.9 m	1	3

The regulated and natural outlet conditions are similar except for the additional water level drops of more than 0.9 m in the regulated condition. A water level drop of more than 0.9 m may cause many of the eggs not to hatch.

The frequency of this occurrence, 1 in 25 years, will likely not have a significant effect on the whitefish population. Although the data on shoreline profiles, depths and width of gravel spawning substrates is limited, it is anticipated that a decrease in mean water level of 0.3 m, will not affect spawning success.

4.4 Water Supply Intakes

Lesser Slave Lake is the source of water for municipalities, industries and farming operations around the lake. Eleven users currently have water diversion licences. Water is pumped from the lake usually through a water intake structure located in the lake. Low water levels tend to create unstable conditions which could damage the pump impellers resulting in higher maintenance costs. They promote build up of surface debris and ice formation in winter around the intake structure reducing pumping performance. Low water levels are also a potential safety hazard to boaters and water skiers in the vicinity of the water intake structures.

For optimum performance, the intake assembly of the pump should have a minimum submergence of 0.5 m. To ensure that the intake structure does not pose a safety hazard to boaters and skiers a

minimum depth of submergence of 2.0 m is preferred. To keep the intake free of ice during winter, a minimum depth of submergence of 1.5 m is required.

An examination of the lake water levels and their comparison, with the preferred water level requirement indicates that the water depth requirements for all intake structures were met with the exception of the Hamlet of Joussard water intake. Both the natural and regulated lake water levels meet the requirement to protect the system from accumulation of surface debris, however, they do not meet the requirements for boating safety and ice formation.

Since the regulated mean lake level is lower than the natural mean lake level, the intake structure will continue to pose a risk to boating, water skiing and ice formation at lower water levels.

5.0 CONCLUSIONS

The conclusions are based on the Lesser Slave Lake water levels for the period 1916-1992 under both the natural and regulated outlet conditions. The effects of regulated water levels on lake users for agriculture, recreation, fisheries and municipal water supply, are discussed.

5.1 The Lesser Slave Lake Regulation Project affects the lake water levels for the period 1916 to 1992 as follows:

- reduces the maximum water level by 0.6 m from 578.9m to 578.3 m.
- increase the minimum water level by 0.2 m from 575.4m to 575.6 m.
- reduces the mean water level by 0.3 m from 576.6 m to 576.3 m.
- reduces the range of water level fluctuation from 3.5 metres to 2.7 metres.

5.2 The Lesser Slave Lake Regulation Project benefits agriculture by reducing the amount of land flooded by the lake. It will essentially eliminate flooding of 4,500 ha (11,000 acres) of land between elevations of 578.3 m to 578.9 m. It will also provide flood protection benefits to a further 21,000 ha (52,000 acres) of agricultural land between elevations 578.3 m and 576.3 m being the regulated maximum and the regulated mean water levels respectively.

5.3 The regulated lake levels have the following effects on the recreational beaches:

- a general benefit is seen in the annual reduction of extreme beach widths, since the regulated levels will reduce the lake level fluctuations.
- beaches such as Devonshire, Martin River Campground and Diamond Willow Resort will experience increased excessive beach widths, since the regulated mean water level is lower than the natural mean water level.

5.4 Lesser Slave Lake regulation will affect the operation of the federal docks at Joussard, Faust and Canyon Creek, and the federal boat launches at Joussard, Canyon Creek and Shaw's Point, Marina. It should, however, be noted that these federal docks and boat launches are constructed higher than the optimum elevations even for the natural lake water level conditions.

5.5 The regulated water levels will generally meet the requirements for the spawning and rearing of northern pike and lake whitefish in the littoral zone. However, the spawning habitat could be affected because of reduced flooding of the shoreline and this may impact northern pike populations. No adverse impacts are anticipated on the lake whitefish populations. It is more difficult to predict the long term impact on walleye. However, there are concerns because the regulated mean level is lower than the natural mean and it could potentially reduce walleye rearing habitat.

5.6 The regulated water levels meet the minimum water level requirements for all intake structures, except for the Hamlet of Joussard intake structure. The Joussard intake structure also does not meet the minimum water level requirements for boating safety and ice formation even under natural conditions. Since the regulated mean lake level is lower than the natural mean lake level, the intake structure will continue to pose a risk to boating, water skiing and ice formation at lower lake levels.

5.7 In December 1992, the actual Lesser Slave Lake water levels were approximately 0.08 m higher than the predicted regulated water levels, because the Lesser Slave River had not fully stabilized to the extent anticipated due to the lack of high flow events.

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