EVALUATION OF THE ECONOMIC, SOCIAL, AND RECREATIONAL IMPACTS OF PROPOSED CHANGES TO THE RULE CURVES DEFINING THE OPERATION OF RAINY AND NAMAKAN LAKES

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EXECUTIVE SUMMARY

The evaluation of economic, social and recreation data contained in this report was undertaken and completed as a part of the work requirements of the "*Plan of Study for Review of the IJC Order for Rainy and Namakan Lakes*," dated February 1, 1996. The initial work for this effort was undertaken by the St. Paul District of the U.S. Army Corps of Engineers and was published in a draft report entitled, *"Rainy and Namakan Lakes Proposed Rule Curve Changes - Phase A - Economics: Evaluation of Existing Data"*, October 1996. The work published in this report embodies the "*Phase A*" evaluation and completes the requirements of the Plan of Study to critique, summarize and to establish current economic, social and recreational values in a number of impact categories and estimate the incremental changes that would result, if alternate rule curves were adopted. This analysis was limited in scope to Rainy and Namakan lakes. To the extent possible, quantitative analysis was performed, but qualitative where necessary, to determine the effects of the proposed changes to the rule curves. The effects are analyzed for a total of nine different resource categories for the Base Case (Alternative F1-IJC) and three alternative rule curves (Alternatives F1-SC, C1 and M1).

Hydropower - Hydropower is generated by Boise Cascade on the U.S. side and by Abitibi-Consolidated on the Canadian side, at the outlet of Rainy Lake. The demand for electricity at the pulp and paper mills owned by the Companies exceeds their power generating capability at all times. The value of the power produced is approximately US$5.1 million per annum. When compared to the Base Case rule curves, all of the alternatives result in a decrease in hydropower energy production, particularly in the winter months when it is most costly to replace. The additional yearly average cost of replacing this power is US$114,000 under Alternative C1, US$261,000 under Alternative M1 and US$376,000 under Alternative F1-SC.

Flood Damages - All of the alternatives evaluated resulted in increased flood damages when compared to the Base Case (Alternative F1-IJC). The average annual flood damages for the 1958-96 simulation period are US$15,100 for the Base Case (Alternative F1-IJC), US$21,300 for Alternatives C1 and M1 and US$23,500 for the rule curves proposed by the International Steering Committee (F1-SC). For the 1950 flood of record, flood damages increased by about US$2.4 million under Alternatives C1 and M1 and by about US$2.8 million under Alternative F1-SC, when compared to the Base Case rule curves. Overall, there are small differences in flood damage potential among the alternatives, except for extreme events where the differences are large.

Recreation/Tourism - In 1990 the fishery and associated tourism generated approximately US$8.7 million in gross revenues in the Rainy-Namakan basin, with 98% of this contributed by the sports fishery (For comparison, the equivalent value on Lake of the Woods is US$46.2 million.). The recreation-tourism benefits of the alternatives evaluated could not be quantified, but were assessed qualitatively. Alternatives F1-SC on Rainy Lake and particularly F1-SC, C1 and M1 on Namakan Lake should provide positive benefits to recreation and tourism due to the early spring refill and associated improvements in the fishery and navigation access. In this regard alternatives F1-SC, C1 and M1 should provide significant positive benefit to Namakan Lake due to the decreased winter drawdown. Alternatives F1-SC and M1 on Rainy Lake and F1-SC, C1 and M1 on Namakan Lake, which feature slowly declining summer levels, may negatively impact recreation and tourism due to potential problems with navigation access in the late summer.

Recreation/Navigation - On Rainy Lake, the elevation on which all navigation charts are based is 337.4 meters. On Namakan Lake, local information suggests that the rule curve should not go below 340.5 meters during the navigation season from about May through September. Recreation-navigation benefits of the alternatives evaluated could only be defined qualitatively. Higher spring water levels are beneficial for navigation early in the season. Alternative F1-SC is the only alternative that provides average May water levels greater than 337.4 meters on Rainy Lake, although Alternatives F1-IJC, C1, and M1 provide average May water levels only slightly below 337.4 meters. None of the alternatives provide average May water levels up to the desired level of 340.5 meters on Namakan Lake; however, all of the alternatives except F1-IJC are relatively close to the desired level. Lower late summer levels have a negative effect on navigation by limiting access to the shallower areas of both lakes, particularly by sailboat. All of the alternatives provided late summer water levels greater than 337.4 meters on Rainy Lake and 340.5 meters on Namakan Lake, except for Alternative F1-SC on Rainy Lake, which provided average September water levels just slightly below 337.4 meters.

Water Supply - The effects of the proposed changes in rule curves on water supply were determined based on a qualitative assessment. Water intakes on Rainy and Namakan lakes would primarily be affected only in conditions of extreme drawdown. Since none of the alternatives evaluated result in this type of drawdown, there would be no impact.

Commercial Fishing - The commercial fishing industry on Rainy and Namakan lakes is relatively small with total revenues of about US$140,000, which is less than 2% of the total fishery revenues of US$8.7 million. Commercial fishing appears to be stable or possibly declining in terms of the harvest allowed. Any potential improvement in the fishery on the lakes could have a positive effect on the commercial fishing industry. However, because of the harvest quotas and "willing seller" license buy-outs by regulatory agencies it is uncertain whether an improvement in the fishery would translate directly to improved commercial fishing. Overall, impacts to commercial fishing that would result from implementation of any of the rule curve alternatives are small.

Shoreline Erosion - Erosion and damage to shoreline development is known to occur throughout the Rainy-Namakan basin, especially under conditions of high water in conjunction with strong winds. Discussions with representatives of local Soil and Water Conservation Districts did not indicate that there were a lot of requests from lake homeowners for assistance on erosion control projects for residences. Many lake residents have built breakwaters or have riprapped the shoreline to reduce damages. Although there are some archaeological and residential sites located around the shoreline that might be affected by erosion, no major additional problems with erosion were identified with any of the alternatives evaluated.

Native American Transportation - People of the Lac La Croix First Nation, tourism businesses, and recreationists use the Loon River, a tributary to Namakan Reservoir, for navigation (personal, business, and recreation reasons) between Crane and Sand Point lakes and isolated parts of the upper watershed on Loon Lake and Lac La Croix. Water-based transportation by Native Americans and others should be improved under Alternatives F1-SC, C1 and M1. This improvement is based on expected increases in spring water levels, allowing easier access to and from tributary lakes and rivers in the upper reaches of the basin.

Wild Rice - The bays and inlets of Rainy Lake serve as one of the major wild rice growing areas within the region. Wild rice is a high value crop, and the product is a specialty item for which premium prices are paid and all of the harvest has typically been purchased. In addition to its commercial value, the harvest of wild rice has been an important part of the cultural and social activity of Aboriginal Peoples in Ontario as well as Native Americans in Minnesota. Overall for Rainy Lake, compared to the Base Case (Alternative F1-IJC), it appears that Alternative F1-SC provides positive benefits to wild rice, while Alternatives C1 and M1 maintain the status quo.

1. INTRODUCTION

Following its April 1995 semi-annual meeting, the International Joint Commission (IJC) requested that its International Rainy Lake Board of Control (IRLBC) prepare a plan of study to review its 1970 Supplementary Order for the regulation of Rainy Lake and the Namakan chain of lakes. This request followed concerns expressed by interests and organizations within the basin that the current rule curves did not fully reflect certain benefits to areas such as the fishery, environmental resources and navigation that could be better achieved by a change to the rule curves. This concern culminated in a specific proposal for new rule curves, submitted to the Commission by the Rainy Lake and Namakan Reservoir Water Level International Steering Committee (SC) in its "Final Report and Recommendations" dated November 1993. At the IJC semi-annual meetings in the spring and fall of 1994, the Board made presentations to the Commission summarizing the issues and recommended that the Order be reviewed. Subsequently, the IJC asked its International Rainy Lake Board of Control (IRLBC) to review the 1970 IJC Order for the regulation of these lakes and investigate the effect of these proposed changes.

The Board then prepared and released a Draft Plan of Study on August 9, 1995 for public and IJC comment. Based on comments received from the public and the IJC, a final Plan of Study, dated February 1, 1996, was prepared and distributed to the public and stakeholders. The Plan of Study called for a Status Report, Draft Final Report and Final Report to be submitted to the IJC, describing the results of technical studies and evaluating the impacts of the proposed rule curve changes. The Plan of Study focused the work in three primary areas and required technical reports to be prepared in each of the following areas:

- Hydrologic Factors
- Environmental Resource Factors
- Economic, Social and Recreation Factors

The purpose of this report is to assist in accomplishing some of the work identified in the Board's Plan of Study by focusing on describing the economic, social, and recreational effects of the proposed changes to the 1970 IJC rule curves for Rainy and Namakan lakes. The effects are evaluated for a total of nine different economic, social, and recreational impact categories. These categories, and the effects of the rule curve changes in each of them, are described in **Section 3** of this report. It is recognized that the potential socio-economic impacts of the proposals extend well beyond the Rainy and Namakan Lake basins. However for the purposes of this study, only the Rainy and Namakan Lake basins were considered. For other affected downstream interests on the Rainy River and Lake of the Woods, input from responsible parties has been requested by the Board and will be provided in the IRLBC review.

The evaluation of economic, social and recreation data contained in this report was undertaken and completed as a part of the work requirements of the "*Plan of Study for Review of the IJC Order for Rainy and Namakan Lakes*," dated February 1, 1996. The initial work for this effort was undertaken by the St. Paul District of the U.S. Army Corps of Engineers and was published in a draft report entitled, *"Rainy and Namakan Lakes Proposed Rule Curve Changes - Phase A - Economics: Evaluation of Existing Data"*, October 1996.

The work published in this report embodies the "*Phase A*" evaluation and completes the requirements of the Plan of Study to critique, summarize and to establish current economic, social and recreational values in a number of impact categories and estimate the incremental changes that would result, if alternate rule curves were adopted. This analysis was limited in scope to Rainy and Namakan lakes. To the extent possible, quantitative analysis was performed, but qualitative where necessary, to determine the effects of the proposed changes to the rule curves. The effects are analyzed for a total of nine different resource categories for the Base Case (Alternative F1-IJC) and three alternative rule curves (Alternatives F1-SC, C1 and M1).

2. BACKGROUND

2.1 Basin Description

Location and Physiographic Characteristics

The Rainy River basin straddles the Minnesota-Ontario boundary and encompasses an area bounded on the east by the Lake Superior drainage system, on the south by the upper Mississippi River drainage area, and on the west by the Red River basin. The Rainy River runs west and north into Lake of the Woods and eventually discharges to Hudson Bay through the Winnipeg River and Nelson River systems. The portion of the basin above the outlet of Rainy Lake has a total drainage area of 38,600 square kilometers (14,900 square miles), of which 42 % is in the United States with the remainder being in Canada. Rainy Lake has a surface area of approximately 894 square kilometers (344 square miles) while the Namakan chain of lakes, which discharges into Rainy Lake, is comprised of five lakes (Namakan, Kabetogama, Crane, Sand Point and Little Vermillion) with a combined surface area of 270 square kilometers (104 square miles).

The topography of the Rainy River basin is the result of glacial action. Generally the tributaries to the Rainy River include streams inter-connecting numerous lakes, and flow is in well defined channels without conspicuous floodplains. The eastern headwaters of the basin are about 19 kilometers (12 miles) from Lake Superior at an elevation of 550 meters (1800 feet). The total fall through the chain of boundary lakes from North Lake at the headwaters of the Rainy Lake basin to Rainy Lake is 136 meters (442 feet) in a distance of approximately 260 kilometers (160 miles). The soil cover over the underlying rock formation is so meager and interspersed with so many boulders and rock outcrops that the basin is generally unsuited for agricultural purposes other than forestry.

The Rainy Lake watershed is in the Superior Upland geological province. The area was subject to violent volcanic activity during an ancient era, and contains heavily wooded igneous rock terrain partially covered by numerous lakes and streams.

Climate

The climate of the Rainy River basin is typified by long, severe winters and short, hot summers. Snow cover usually begins to accumulate in November and is present into April. Lakes typically freeze up in early December and break up near the end of April. Mean annual precipitation is 680 millimeters (27 inches) of which 30 % falls as snow. Evapotranspiration is 490 millimeters (19 inches), or 72 % of the mean annual precipitation. December through March are typically the driest months in terms of precipitation; while June, July and August are the wettest. Due to a combination of snowmelt and rainfall, the inflow of the streams to the lakes is typically the highest in May and June. However heavy rains at any time during the rainy season can cause significant runoff and consequent flooding.

Hydraulic Works

The outlet of Rainy Lake has been controlled since 1909 by an international dam extending between Fort Frances, Ontario, and International Falls, Minnesota. The dam is located at the site of the former Koochiching Falls. The dam is of stone-masonry construction and is U-shaped, with the apex facing upstream. Ten gate-controlled arched sluiceways are on the Canadian side while the American side is designed as an uncontrolled spillway section. An additional 5 gate-controlled sluiceways discharge into a never-used navigational canal on the Canadian side. Two powerhouses exist at the site, one on each side of the dam, in Canada and the United States, respectively. They are used to produce power for two paper mills, and have a combined capacity of about 24 megawatts (MW).

The outflow from Namakan Lake has been controlled by two small dams at Kettle Falls since 1914. One, entirely located in Canada (at the former Squirrel Falls), is known as the Canadian Dam. The other dam straddles the international boundary and is known as the International Dam. No power is generated at the sites and access is limited to boat or aircraft only. Both structures consist of 5 stop-log controlled sluices. One of the sluices in each structure was constructed as a fishway, but neither has been used as such.

In addition to the structures described above, there are two natural overflows from Namakan Lake. These overflows, at Gold Portage and Bear Portage, are significant because they bypass the regulatory dams at Kettle Falls. Gold Portage has become the more significant of the two overflows due to enlargement by local residents in the mid-1950's and by natural erosion.

2.2 REGULATION

The Rainy Lake basin lies within the Canada-United States boundary waters and is therefore subject to the Boundary Waters Treaty of 1909 ratified by the two countries. The basin has long been of interest to the two governments, which issued a Rainy Lake Reference in 1925 requesting the IJC to make recommendations as to the regulation of Rainy Lake and other boundary waters within the Rainy Lake watershed. The final report on this reference was submitted by the IJC to governments in May 1934 and was ratified by Canada and the United States in October 1940. The 1940 Convention did not define any specifics for the regulation, but assigned the IJC the power to determine when emergency conditions exist in the Rainy Lake basin and to adopt control measures as necessary. The Commission then created the International Rainy Lake Board of Control in 1941 and directed it to examine and report on the issue of emergency conditions.

The International Rainy Lake Board of Control then initiated studies to fulfill the Commission's obligations, which the Commission integrated into its Order of June 8, 1949. This defined single rule curves for both Rainy and Namakan lakes, an approach that seemed a good compromise between the desires of the riparian interests for uniform levels year-round and the desires of the power interests for fluctuating levels to obtain outflows when needed for power generation. In issuing its Order, the Commission interpreted its powers as being able to act not only in the event of emergency conditions, defined in terms of absolute levels on the lakes, but also to preclude the occurrence of such conditions.

Excessive spring runoff during the years 1950 and 1954 caused both Rainy and Namakan lakes to exceed their respective summer rule curve elevations. Numerous complaints were registered with the Commission from recreational interests regarding the adverse impacts of high water levels. The Commission subsequently issued a directive in April 1956 requesting the Board to prepare a report covering the possibilities of formulating and putting into effect a revised method of regulation. No change was suggested to the Rainy Lake rule curve. However a maximum rule curve was suggested for Namakan Lake to provide greater flexibility of operation. The Commission adopted the changes and issued a Supplementary Order dated October 1, 1957 which amended the 1949 Order. The Supplementary Order was to be in force until 1962, but was twice extended for five-year periods.

Because of high and low water conditions on Rainy and Namakan lakes from 1957 through 1968 the rule curve elevations were violated on many occasions, culminating in the extreme high levels during July 1968. In August 1968, the Commission directed the Board to consider and report on the advisability of further regulatory measures. Experience had demonstrated the difficulties of trying to regulate Rainy and Namakan lakes to precise elevations on certain dates under all conditions of supply. The Board evaluated the matter and presented its proposals to the Commission in June of 1969. On July 29, 1970 the Commission, after receiving input from the International Rainy River Pollution Advisory Board, issued a Supplementary Order amending the previous Orders. Some of the key provisions of the 1970 Order were: a focus on, insofar as possible, anticipating high and low flows in regulating the lakes so as to prevent the occurrence of emergency conditions, the addition of a rule curve band for Rainy Lake, and the reduction of outflows when low water emergency conditions occur. The rule curves for Namakan Lake were also amended, and elevations defined under which full discharge capacity was to be utilized under high water conditions on both lakes. Since 1970 a number of Supplementary Orders have been issued, primarily to authorize minimum flow deviations during low flow periods.

2.3 SOCIOECONOMIC PROFILE

The area surrounding Rainy and Namakan lakes is well established as a destination for a wide range of outdoor recreation pursuits. In order to better understand the broader economic and social characteristics of the region, and their possible sensitivity to issues involved with potential changes to levels and flows on Rainy and Namakan lakes and adjoining waters, these characteristics are described in the sections that follow. The socioeconomic profile information is provided for the surrounding area in the United States, followed by the surrounding area in Canada.

2.3.1 Rainy Lake and Surrounding Area in the United States

2.3.1.1 Background and Socioeconomic Data

The socioeconomic information for the surrounding area in the U.S. is presented for the city of International Falls, Minnesota and the surrounding Koochiching County. These areas were selected because they represent the major population and economic center adjacent to the lakes in the U.S.

International Falls is the major center for government services in the region and plays a pivotal role in the trading area that contributes significantly to the local economy. It is an active community located on Rainy Lake and Rainy River. It is also a major point of entry into the U.S., on the border of the Province of Ontario and the State of Minnesota.

St. Louis and Koochiching counties form the primary boundaries of the study area in the United States. St. Louis County bisects Rainy Lake and extends from Voyageurs National Park on the west to beyond Namakan and Lac La Croix lakes on the east. Koochiching County extends almost to the Town of Rainy River on the west, and to Voyageurs National Park on the east. Because Koochiching County encompasses the major population and economic centers in the study area, it was selected as the primary regional area to use for the socioeconomic data. International Falls is the major city located within Koochiching County.

2.3.1.2 Population

The population of International Falls was 8,325 in 1990, and increased 48% from the 1980 population of 5,611. The population of Koochiching County was 16,292 in 1990, and decreased 7.8% from the 1980 population of 17,571. County population projections for 1990-2020 reflect a further decline of 16.7%, to a population of 13,570. Persons living on farms comprised only 3.6% of the county population. A total of 45.4% of the population in Koochiching County lived in rural, non-farm areas, and the remaining 51% lived in more urbanized parts. About 2.5% of the population of Koochiching County consisted of racial minorities, primarily American Indian. *(Note: all historic population data provided in this section came from the 1990 U.S. Census, and all estimates of future population came from the Minnesota State Office of Planning)*

2.3.1.3 Unemployment Rate

The unemployment rate was 10.9% for Koochiching County and 5.3% for International Falls in 1993. Overall, the unemployment rate of Koochiching County was twice that of Minnesota, which was 5.1%. Unemployment statistics for the county were influenced by the number of jobs available, the number of people moving in or out of the county, and the number of people actively seeking employment. The county has gone through a time when residents who lost jobs had to make decisions about staying in the area or moving out, going back to school, or seeking employment elsewhere, according to Koochiching County situation analysis. Many families were exploring self-employment for the first time. According to the Minnesota Department of Employment Security in International Falls, periodic layoffs by industry have affected the employment status, but at the same time, it was offset by recalls or seasonal changes in other sectors. *(Note: all unemployment data described above is from the Minnesota Department of Employment Security).*

2.3.1.4 Income

The per capita income was US$14,858, and median household income was US$23,411 (1990) for Koochiching County residents, compared to US$20,427 and US$30,909 respectively, for Minnesota residents. *(Note: all income data described above is from the 1990 U.S. Census).*

2.3.1.5 Labor Force

There were 6,506 workers (1993) in the Koochiching County labor force compared with 2,466,000 for the State. The projection of the percentage change in the labor force over the period 1990-2020 for Koochiching County is a reduction of 15.5% compared to a reduction of 20.7% for the State. Most women in the county labor force have been working in the service category. Men are represented in larger numbers in managerial, professional, technical, sales, and labor-operator roles. **Table 1** shows the number of workers by work category.

Table 1: Category of Workers (Koochiching County)

Category of Workers	Number of Workers
Private for-profit wage and salary workers	5,212
Private not-for-profit wage and salary workers	331
Local government workers	709
State government workers	247
Federal government workers	198
Self employed workers	451
Unpaid family workers	11
Total number of workers	7,159

(Note: all labor force data shown above is from the Minnesota Department of Employment Security).

2.3.1.6 Employment

Shown in **Table 2** is the list of employment by the major employers in the county.

Table 2: Employment Data (Koochiching County)

Major Employers	Product/Service	Employees
Boise Cascade Corp.	Paper Products	1,200
Intl. Falls School District #361	School District	305
United Health Care	Insurance Processor	300
Koochiching County	County Government	120
International Bildrite, Inc.	Insulation Board	64
Rainy River Community	College	56
City of International Falls	City Government	55
Shannon's Plumbing & Heating	Plumbing Contractor	50

In International Falls, the major employer is Boise Cascade Corporation, which is by far the largest single employer in the area. The next two largest are the International Falls School District, and United Health Care. The major economic bases for the county are related to: forest products, tourism, retail sales, and agriculture, and they are the major areas for employment. *(Note: all employment data described above is from the Minnesota Department of Trade and Economic Development)*

2.3.1.7 Social Resources

Koochiching County's vitality, both socially and economically, has been greatly influenced by the Rainy River basin and its forests, as reflected in the substantial employment provided by Boise Cascade Corporation and International Bildrite, Inc. The median family income for Koochiching County was US$23,411 (1990), which is relatively higher than other counties in the region. The median wage for Pulp and Paper Mill workers was US$13.79/hour, which is among the better paying job categories. With its comparative advantage in natural resources, Koochiching County has the potential to see even more economic development.

2.3.2 Rainy River District and Surrounding Area in Canada

1.

2.3.2.1 Background and Socioeconomic Data

The information is presented for the city of Fort Frances, Ontario, and the surrounding area, which is known as the Rainy River District. These areas were selected because they represent the major population and economic center adjacent to the lakes in Canada. They were also selected because they were the primary areas for which socioeconomic data was available in the region.

Fort Frances is the major center for government services in the region and plays a pivotal role in the trading area that contributes significantly to the local economy. It is an active community located on Rainy Lake and Rainy River. It is also a major point of entry into Canada, on the border of the Province of Ontario and the State of Minnesota in the U.S.

The Rainy River District is a large region that extends from the Town of Rainy River on the west, to the eastern edge of Quetico Provincial Park on the east, and from Nestor Falls on the north, to the border between Canada and the U.S. on the south.

2.3.2.2 Population

The 1990 population of the Rainy River District was 22,997, and for Fort Frances it was 8,891. The population of Fort Frances has been relatively stable, fluctuating around 9,000 people from 1976 to 1990. *(Note: all population data described above is from the 1991 Canadian Census).*

2.3.2.3 Unemployment Rate

The unemployment rate of 10.1% in Fort Frances is slightly higher than the unemployment rate of 9.9% in the Rainy River District. The unemployment rate for the Rainy River District is relatively close to the rate of 10.9% in the neighboring Koochiching County in the U.S. However, the unemployment rate for Fort Frances is almost twice that of her neighboring city of International Falls in the U.S. (5.3% in 1993). *(Note: all unemployment data described above for Canada is from the 1991 Canadian Census).*

2.3.2.4 Income

In Fort Frances, the average per capita income was CAN$ 24,637, and the median household income was CAN$ 40,582. The average per capita income for the Rainy River District was CAN$ 22,065, and the median household income was CAN$ 42,604. *(Note: all income data described above is from the 1991 Canadian Census).*

2.3.2.5 Labor Force

The total labor force in Fort Frances, age 15 years and over was 4,570 or approximately 51% of the total population based on the 1991 Canadian Census. The largest occupational fields in Fort Frances are clerical and services. In contrast, the smallest occupational field (with only 140 employees) is found in the primary industries (agriculture, forestry, fisheries, energy, and mining). The distribution of the total labor force is shown in **Table 3**.

Table 3: Distribution of Total Labor Force (Rainy River District)

Legend	Percentage
Primary Industries	6.4
Manufacturing	15.9
Construction	5.5
Transport/Storage	3.5
Communication/Utility	2.1
Trade	15.4
Financial	4.3
Government Services	9.8
Educational Services	6.9
Health/Social Services	14.2
Other	16.0

Source: Statistics Canada- 1991 Census.

2.3.2.6 Employment

There are four primary economic components in Fort Frances. The first is the forest-related industry. The Abitibi-Consolidated, Inc. pulp and paper mill is the major industry and largest single employer here, with about 900 employees. The second is the local tourism industry, which contributes a total of approximately 1,650 jobs for local people. The third component is the local agricultural industry. Finally, Fort Frances is the center for government services in the region. Shown in **Table 4** is the list of employment by the major employers in the Rainy River District.

Table 4: Employment Data (Rainy River District)

Major Employers	Product/Service	Employees
Abitibi-Consolidated	Paper Products	900
Rainy River Board of Education	Government-Education	450
Riverside Health Care	Health Care	240
Voyageur Panel	Wood Products	140
Canada Safeway	Retail	140
NorFab Building Components	Building Suppliers	40

(Note: all employment data described above is from the Rainy River Future Development Corporation)

2.3.2.7 Social Resources

Fort Frances, having a unique location on the Canada-U.S. border, is an ideal location for businesses that take advantage of the expanding markets of the two countries. With the advantage in geographic location, rural setting, inexpensive land, and relatively inexpensive hydroelectricity, Fort Frances is a potential market for some businesses in both countries. Together, the cities of Fort Frances and International Falls provide a broad spectrum of facilities, services, and activities that enhance the potential for economic development in the region.

2.4 METHODOLOGY

2.4.1 Overview

The methodology used to analyze the effects of the proposed rule curve changes in the various resource categories varied from a quantitative approach in some categories to a more qualitative approach in others. The methodology used was largely dependent upon what data was available for each resource category. The primary data used to determine the effect of the proposed rule curve changes throughout all of the alternatives was output from the "REGUSE" computer model. This is described in more detail below in **Section 2.4.2**.

2.4.2 REGUSE Model

In order to evaluate the effects of the proposed rule curve changes in the various impact categories, output such as projected lake levels, outflows, and power generation was obtained from the "REGUSE" computer model. This model was developed by Environment Canada, and has been used previously on other transboundary basin studies conducted by the IJC. The model was used by Environment Canada to simulate the regulation of Rainy and Namakan lakes on a daily time interval, according to the regulation criteria specified for the various alternatives being evaluated under this study. The model was run using daily net inflows that were developed for a 39-year period of historical record for the years 1958-96. This period of historical inflows used for modeling does not include the largest flood (in terms of water volume) recorded in the basin, which occurred in 1950. Because of the importance of this year in terms of analyzing potential flood impacts, a separate simulation was done for this year for the four rule curve alternatives (F1-IJC, F1-SC, C1, and M1) evaluated. In this report, the 1950 data was used only in the flood damage analysis.

2.5 ALTERNATIVES

Four different rule curve alternatives (F1-IJC, F1-SC, C1, and M1) were evaluated in this analysis. Within some of these, variations were considered to evaluate the sensitivity of the lake regulation within a given set of rule curves to variations in the operating policy. This sensitivity analysis was only performed for the existing IJC rule curves and the proposed SC rule curves. Variations within the C1 and M1 alternatives for the same operating policy variants are expected to be similar to those for the IJC and SC rule curves. A brief description of all of the alternatives and sensitivity runs evaluated in this analysis is provided in the following sections.

2.5.1 Alternative F1-IJC

This alternative represents the Base Case, which is operating according to the rule curves imposed by the International Joint Commission (IJC) 1970 Supplementary Order, while using a regulation algorithm that attempts to optimize the lake level regulation on mid-band (50% of band). This Order provides for year-around operating bands with upper and lower limits for both lakes, giving the operators more flexibility to respond to natural conditions as compared to the initial single-line rule curve of 1949. The 1970 IJC rule curves provide high stable summer and fall water levels for navigation and other interests, access to docks, and constant water supply to water intakes. They also provide for fall and winter drawdown for hydropower production and spring flood control.

2.5.2 Alternative F1-SC

This alternative is a modification to the existing IJC rule curves that has been proposed by the Rainy Lake and Namakan Reservoir Water Level International Steering Committee (SC). This alternative was also optimized on 50% of band. A summary of the major differences in these curves compared to the existing rule curves is as follows:

- an earlier rise in spring water levels
- stable, or declining water levels in June
- slight summer drawdown
- reduced overwinter drawdown

2.5.3 Alternative C1

This alternative represents a combination of the proposed SC rule curves for Namakan Lake, used in conjunction with the existing 1970 IJC curves for Rainy Lake. It was proposed by a group known as the Border Lakes Association.

2.5.4 Alternative M1

This alternative is a modification of Alternative C1. On Namakan Lake, the rule curves in this alternative are very similar to the SC rule curves, but they have a wider (in terms of time) rising hydrograph limb in the spring. On Rainy Lake, the rule curves used in this alternative are the same as the 1970 IJC curves for the April through June refill period, but then provide summer drawdown similar to the SC curves before blending back into the IJC curves over the winter.

2.5.5 Operating Policy Variants F4-IJC and F5-IJC

These operating policy variants are within a range of operating practices that might be followed by the dam operators within the existing 1970 rule curves (F1-IJC). Variant F4-IJC is a variation on this base alternative that attempts to maximize drawdown and refill of the lakes each year. Variant F5-IJC attempts to minimize drawdown and refill of the lakes each year.

2.5.6 Operating Policy Variants F4-SC and F5-SC

These operating policy variants are within a range of operating practices that might be followed by the dam operators within the proposed SC rule curves (F1-SC). F4-SC is a variation that attempts to maximize drawdown and refill of the lakes each year, while F5-SC attempts to minimize drawdown and refill of the lakes each year.

3. RESOURCE CATEGORIES AND EFFECTS OF PROPOSED RULE CURVE CHANGES

The effects of the proposed rule curve changes were evaluated for a total of nine different resource categories for the existing, and three alternative rule curves. Sensitivity to several operating policy variants were investigated and evaluated for the existing IJC and proposed SC rule curves. The sections that follow provide a brief description and background on each of the resource categories as well as a description of the effects of the proposed rule curve changes. The numerical results are presented in metric units, and the economic values are presented in U.S. dollars.

3.1 HYDROPOWER

3.1.1 Background

The hydropower projects that are evaluated in this report and would potentially be affected by these proposed changes in the rule curves are located on the Rainy River, on the international border between Fort Frances, Ontario, and International Falls, Minnesota. There are other projects downstream, at the outlets of Lake of the Woods and on the Winnipeg River below Lake of the Woods that would potentially be affected by these proposed changes. However, this analysis has been limited in scope to the hydropower projects on Rainy Lake.

The International Dam at the outlet of Rainy Lake, which was constructed in 1909 at the site of the former Koochiching Falls, is used to control the lake levels. Water withdrawn from Rainy Lake is used to power the generating units in these power plants. There are no hydropower facilities on Namakan reservoir.

There are two separate power plants located at the dam site. One is located in International Falls, Minnesota, and is owned and operated by the Boise Cascade Corporation to generate power for a pulp and paper mill owned by the company. This plant was constructed in the 1920's, and has seven generating units with a total capacity of 11.3 MW. Historically, the average annual energy generated by this plant is about 67,200 MWh. Four of the power generating units were rehabilitated in 1991. This project is licensed by the United States Federal Energy Regulatory Commission (FERC) under license #5223.

The other power plant at the site is located in Fort Frances, Ontario on the other side of the river, and is owned and operated by Abitibi-Consolidated, Inc. to generate power for a pulp and paper mill which they own and operate. This plant was constructed in 1910, and has eight generating units with a total capacity of about 12.8 MW. All of the turbines at the plant have been subsequently rebuilt, some in 1955, and the remainder in 1970. Historically, the average annual energy generated by this plant is 59,800 MWh, which represents about 10% of the mill's total power requirements.

It should be noted that although the Abitibi-Consolidated plant has a greater total capacity (12.8MW) than the Boise Cascade plant (11.3MW), the average annual energy produced has historically been less than the Boise Cascade plant. One reason for this is that four of the generating units in the Boise Cascade plant were rehabilitated in 1991, and are more efficient at producing energy than the generating units at the Abitibi-Consolidated plant. The other reason is that the hydraulic capacity of the Boise Cascade plant is higher than the Abitibi-Consolidated plant. The plants are operated in an effort to equally share the available water, up to the point where the hydraulic capacity of the Abitibi-Consolidated plant is reached. At that point, any additional water is passed through the Boise Cascade plant, up to its hydraulic capacity. The net result of this is that over a given operating year, more water tends to pass through the Boise Cascade plant than the Abitibi-Consolidated plant, thereby increasing the average annual energy produced at the plant.

Because the demand for power from both of these plants exceeds their power generating capability at all times, all of the energy that can be generated is of value in reducing their reliance on outside sources of power. On an annual average basis, these hydropower projects supply about 10% of the total power required to run the plants. When power must be purchased from outside sources, it is obtained from Ontario Hydro on the Canadian side, and Minnesota Power and Light on the U.S. side.

In terms of the operation of the two plants, available water is shared equally between them whenever the outflow from the lake is less than the maximum flow capability of the turbines. However, this sharing arrangement is adjusted during weekdays, when on-peak (from approximately 6 am to 10 pm) power generation is maximized, and is then equalized on the off-peak hours (from approximately 10 pm to 6 am on weekdays and all day on the weekend). It should also be noted that the hydraulic (flow) capacity of the power generating units is higher at the Boise Cascade power plant than it is at the Abitibi-Consolidated power plant. For this reason, water is shared at the two power plants up to the point where the hydraulic capacity of the Abitibi-Consolidated power plant is exceeded. At this point, the remaining flow is shifted to the other power plant up to its hydraulic capacity. The net result of this is that the average annual generation of the Boise Cascade power plant often exceeds that of the Abitibi-Consolidated power plant. The average annual value of the total power produced by both plants under the current rule curve operation (Alternative F1-IJC) is approximately US$5,100,000.

Another consideration in the operation of the two power plants for hydropower generation is the Wellstone Amendment, which was passed in 1993. This amendment requires Boise Cascade to maintain lake levels on Rainy Lake within the proposed SC rule curves where they are coincident with the IJC curves without contravening the IJC curves. It also requires that FERC ensure Boise Cascade compliance with the amendment, under penalty of fines that would be imposed by FERC. In the past, both power plants were regulated according to the IJC rule curves. However with the passage of the Wellstone Amendment, the Abitibi-Consolidated power plant is the only plant that is consistently operated only in accordance with the IJC rule curves. The implementation of these two regulation plans can sometimes cause conflicts in the regulation of the two plants. For example, there are times when the operators of the Abitibi-Consolidated power plant are opening sluice gates to pass more water, while the operators of the Boise Cascade power plant are ceasing operation of the turbines to conserve water and stay within the SC rule curves. The Wellstone Amendment was only intended as a stopgap measure until the IJC renders a decision in the current review of its Order for Rainy Lake. The amendment has a sunset clause that discontinues the amendment upon the IJC decision.

The hydropower economic analysis was done utilizing two primary types of information. The first was the change in the energy generated by the projects under the different alternatives being evaluated. This data was obtained from the REGUSE computer simulation model. The data used in this analysis represented the average annual and bimonthly energy generation. The second type of information used was the price of energy purchased from the local utilities that would be needed to compensate for reductions in the energy generated by the projects under the various alternatives. This information was obtained from the operators of the power plants. These two pieces of information were combined to determine the total power cost associated with the lost generation for the various alternatives.

3.1.2 Effects of Proposed Rule Curve Changes

3.1.2.1 Energy Generation

The average annual energy generation is shown in **Table 5** for each of the alternatives, along with the differences in generation compared to the Base Case, Alternative F1-IJC. In comparison with Alternative F1-IJC, all of the alternatives result in a decrease in the average annual energy generation. The changes range from –9,000 MWh (-7.4%) under Alternative F1-SC to -2,400 MWh (-2.0%) under Alternative C1.

Table 5: Average Annual Energy Generation, Alternatives

Base Alternative	(MWh)	Comparison Alternative	(MWh)	Difference (MWh)	Difference (%)
F1-IJC	121,700	F1-SC	112,700	-9,000	-7.4
		C1	119,300	-2,400	-2.0
		M1	115,800	-5,900	-4.8

Table 6 shows the average annual energy generation for the sensitivity analysis of the operating policy variants to F1-IJC and F1-SC. The results show the variability in the average annual energy generation for alternative F1-IJC could range from +0.3%, under operating policy variant F4-IJC, to -3.1% under operating policy variant F5-IJC. The variability in the average annual energy generation for alternative F1-SC could range from +1.2% under operating policy variant F4-SC, to -2.5% under operating policy variant F5-SC. These results are expected, since the F4 series of operating policy variants maximize drawdown and refill of the lakes, whereas the F5 series of operating policy variants minimize drawdown and refill. Minimizing drawdown and refill results in less water being released from the lakes for power generation, and reduced head on the power generating units during certain times of the year.

Table 6: Average Annual Energy Generation, Operating Policy Variants

Base Alternative	(MWh)	Comparison Variant	(MWh)	Difference (MWh)	Difference (%)
F1-IJC	121,700	F4-IJC	122,100	400	0.3
		F5-IJC	117,900	-3,800	-3.1
F1-SC	112,700	F4-SC	114,000	1,300	1.2
		F5-SC	109,900	-2,800	-2.5

The average bimonthly energy generation is shown in **Tables 7a and 7b** for each of the alternatives, along with the differences in generation compared to the Base Case condition, Alternative F1-IJC.

Tables 7a and 7b show that in general, the bimonthly energy generation decreases for almost all months for the different alternatives, compared to the Base Case, Alternative F1-IJC. The largest decrease occurs for Alternative F1-SC, and the smallest decrease for Alternative C1. During the period from May through June, there is a net increase in the average bimonthly energy generation for Alternative F1-SC, and the energy generation is the same as the Base Case for Alternatives C1 and M1. During the period from July through August, there is a net increase for all of the alternatives compared to F1-IJC.

Table 7a: Average Bimonthly Energy Generation (MWh), Jan–Jun, Alternatives

		January-February			March-April			May-June		
			Difference			Difference			Difference	
Base	Altern.	MWh	MWh	%	MWh	MWh	%	MWh	MWh	%
F1-IJC		10,700			9,000			8,800		
	F1-SC	9,200	-1,500	-14.0	7,300	-1,700	-18.9	9,000	200	2.3
	C1	10,100	-600	-5.6	8,500	-500	-5.6	8,800	0	0
	M1	9,400	-1,300	-12.1	8,200	-800	-8.9	8,800	0	0

Table 7b: Average Bimonthly Energy Generation (MWh), Jul–Dec, Alternatives

		July-August			September-October			November-December		
			Difference			Difference			Difference	
Base	Altern.	MWh	MWh	%	MWh	MWh	%	MWh	MWh	%
F1-IJC		11,200			9,900			11,200		
	F1-SC	11,300	100	0.9	9,400	-500	-5.1	10,200	-1,000	-8.9
	C1	11,400	200	1.8	9,800	-100	-1.0	10,900	-300	-2.7
	M1	11,500	300	2.7	9,700	-200	-2.0	10,300	-900	-8.0

Tables 8a and 8b provide the average bimonthly energy generation for each of the operating policy variants (F4 and F5), along with the differences in generation compared to the Base Case and proposed SC rule curves. This data gives some measure of the variability in the bimonthly generation under different operating policy variants which in turn gives some sense of the sensitivity of the results for F1-IJC and F1-SC to differing operating policy variants. The results in **Tables 8a and 8b** show that the variability in the average annual energy generation for alternative F1-IJC is greatest in the winter months, ranging from +2.8% to -7.5% in the January–February period, and least in the fall, ranging from +1.0% to –1.0% in the September-October period. The variability in the average annual energy generation for alternative F1-SC is also greatest in the January-February period, ranging from +5.4% to –4.3%, and least in the summer, ranging from 0.0% to –4.4% in the July-August period.

These results are expected, since operating according to the F4 series of operating policy variants maximizes drawdown and refill of the lakes, whereas the F5 series of operating policy variants minimize drawdown and refill. Minimizing drawdown and refill results in less water being released from the lakes for power generation, and reduced head on the power generating units during certain times of the year.

Table 8a: Average Bimonthly Energy Generation (MWh), Jan–Jun, Operating Policy Variants

		January-February			March-April			May-June		
			Difference			Difference			Difference	
Base	Variant	MWh	MWh	%	MWh	MWh	%	MWh	MWh	%
F1-IJC		10,700			9,000			8,800		
	F4-IJC	11,000	300	2.8	8,800	-200	-2.2	8,500	-300	-3.4
	F5-IJC	9,900	-800	-7.5	8,600	-400	-4.4	8,900	100	1.1
F1-SC		9,200			7,300			9,000		
	F4-SC	9,700	500	5.4	7,100	-200	-2.7	8,700	-300	-3.3
	F5-SC	8,800	-400	-4.3	7,500	200	2.7	9,200	200	2.2

Table 8b: Average Bimonthly Energy Generation (MWh), Jul–Dec, Operating Policy Variants

		July-August			September-October			November-December		
			Difference			Difference			Difference	
Base	Variant	MWh	MWh	%	MWh	MWh	%	MWh	MWh	%
F1-IJC		11,200			9,900			11,200		
	F4-IJC	11,200	0	0	10,000	100	1.0	11,500	300	2.7
	F5-IJC	10,900	-300	-2.7	9,800	-100	-1.0	10,900	-300	-2.7
F1-SC		11,300			9,400			10,200		
	F4-SC	11,300	0	0	9,600	200	2.1	10,500	300	2.9
	F5-SC	10,800	-500	-4.4	8,900	-500	-5.3	9,700	-500	-4.9

3.1.2.2 Power Purchase Prices and Power Costs

Under the arrangements between Boise Cascade and Minnesota Power and Light, the price of energy purchased in the U.S. for the mill is flat, and does not vary by season or by the time of the day or week. The constant price that is used is US$31.00/MWh, and there is currently no additional "demand" charge as there had been in the past. Under the arrangements between Ontario Hydro and Abitibi-Consolidated, Inc., the price of purchased energy used for their mill in Canada varies seasonally, as well as daily during the weekdays between "on-peak" and "off-peak" hours. As described previously, "on-peak" hours are from approximately 6 am to 10 pm, and "off-peak" hours are from approximately 10 pm to 6 am during weekdays and throughout all weekend hours. The power purchase prices for the Canadian power are shown in **Table 9** below.

Table 9 shows that the highest power purchase prices are in the winter months from December through February, while the lowest prices are in the spring months of March through May, and in the fall during November. The variations are largely correlated to the periods when the overall power demand in the system peaks. For the purposes of this analysis, an overall average value was determined for each bimonthly period to apply to the changes in the energy generated. This bimonthly value used a weighting procedure to combine both the U.S. and Canadian purchase price costs during both the "on-peak" and "off-peak" periods.

Table 9: Power Purchase Prices (US$/MWh)

Month	On-Peak Value (Range)	On-Peak Value (Average)	Off-Peak Value (Range)	Off-Peak Value (Average)
January	$76.70-$78.00	$77.35	$14.95-$15.60	$15.28
February	$76.70-$78.00	$77.35	$14.95-$15.60	$15.28
March	$37.70-$38.35	$38.03	$13.65-$14.30	$13.98
April	$36.40-$38.35	$37.38	$13.00-$13.65	$13.33
May	$38.35-$39.00	$38.68	$10.40-$11.05	$10.73
June	$58.50-$59.80	$59.15	$10.40-$11.05	$10.73
July	$58.50-$59.80	$59.15	$10.40-$11.05	$10.73
August	$59.80-$62.40	$61.10	$11.05-$11.70	$11.38
September	$40.95-$42.25	$41.60	$11.70-$12.35	$12.03
October	$41.60-$42.90	$42.25	$13.65-$14.30	$13.98
November	$38.35-$40.30	$39.33	$13.65-$14.30	$13.98
December	$76.70-$78.00	$77.35	$14.30-$14.95	$14.63

The assumptions and procedure used to determine these weighted values and the results of this process are described below.

- The criteria used in plant operation is that water is shared between the Canadian and American plants on an equal basis whenever the lake outflow is less than the full turbine flow capacity.
- Sharing of the water is done such that on-peak Canadian power generation is maximized during weekdays, and this water use is equalized by the generation done at the American plant during the off-peak weekday and weekend hours.
- Based on this relationship, it was determined that the hydropower plants are run an average of 16 hours/day, 5 days/week during on-peak periods where the power replacement value would be based on the on-peak cost of Canadian replacement power. This represents a total of 80 hours per week, or 48% of the 168 total hours per week. During the remaining 88 hours/week (52% of the total 168 hours per week), the power replacement value would be based on the off-peak value of U.S. replacement power.
- Using these percentages computed for the duration of weekly on peak and off-peak, the average weekly/monthly weighted power replacement value was calculated for each bimonthly period. As an example, the average monthly on-peak power replacement cost for Canadian power during the January-February period is US$77.35/MWh. The replacement cost for U.S. power is a constant value of US$31/MWh. Using the percentages described above, a weighted average value for this period was determined using the following equation: (0.48)(US$77.35) + (0.52)(US$31) = US$53.25/MWh.
- Bimonthly values were calculated for periods throughout the year, and these are shown in **Table 10** below.

Table 10: Average Bimonthly Power Purchase Price (US$/MWh)

Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Average
$53.25	$34.14	$39.52	$44.98	$36.25	$44.05	$42.03

Using these weighted power purchase prices and the bimonthly power generation, the overall power benefits provided by these plants, and the changes in those power benefits were determined and are shown below in **Tables 11a and 11b**.

Tables 11a and 11b illustrate that the largest power benefit impacts from these alternatives occur in the winter months when the cost of replacement power is the highest. The effect is magnified by the large decreases in power generation that occur during these months with these alternatives. During the period from May-June, there is an increase in the power benefits for Alternative F1-SC, and no change for Alternatives C1 and M1, compared to the base condition, F1-IJC. During the period from July-August, all alternatives result in an increase in power benefits compared to the base condition. However, the magnitude of the increase is smaller than the magnitude of the decreases that occur during the fall and winter months.

Table 11a: Bimonthly Power Benefit (US$1,000), Jan–Jun, Alternatives

		January-February			March-April			May-June		
			Difference			Difference			Difference	
Base	Altern.	Total		%	Total		%	Total		%
F1-IJC		1,139			614			695		
	F1-SC	980	-159	-14.0	498	-116	-18.9	711	16	2.3
	C1	1,076	-63	-5.5	580	-34	-5.5	695	0	0
	M1	1,001	-138	-12.1	560	-54	-8.8	695	0	0

Table 11b: Bimonthly Power Benefit (US$1,000), Jul–Dec, Alternatives

		July-August			September-October			November-December		
			Difference			Difference			Difference	
Base	Altern.	Total		%	Total		%	Total		%
F1-IJC		1,008			718			987		
	F1-SC	1,016	8	0.8	681	-37	-5.2	899	-88	-8.9
	C1	1,025	17	1.7	711	-7	-1.0	960	-27	-2.7
	M1	1,034	26	2.6	703	-15	-2.1	907	-80	-8.1

Tables 12a and 12b provide the bimonthly power benefit for each of the operating policy variants (F4 and F5), along with the differences in generation compared to the Base Case and proposed SC rule curves. This data gives some measure of the variability in the bimonthly power benefit under different operating policy variants which in turn gives some sense of the sensitivity of the results for F1-IJC and F1-SC to differing operating policy variants. These results are similar to the results for average bimonthly energy generation shown in **Tables 8a and 8b**. The variability in the bimonthly power benefit for alternative F1-IJC is greatest in the winter months, ranging from +2.8% to -7.5% in the January–February period, and least in the fall, ranging from +1.0% to –1.1% in the September-October period. The variability in the bimonthly power benefit for alternative F1-SC is also greatest in the January-February period, ranging from +5.4% to –4.4%, and least in the summer, ranging from 0.0% to –4.3% in the July-August period.

Again, these results are expected in like manner to the average bimonthly energy generation data presented in **Tables 8a and 8b**, since operating according to the F4 series of operating policy variants maximizes drawdown and refill of the lakes, whereas the F5 series of operating policy variants minimize drawdown and refill. Minimizing drawdown and refill results in less water being released from the lakes for power generation, and reduced head on the power generating units during certain times of the year.

Table 12a: Bimonthly Power Benefit (US$1,000), Jan–Jun, Operating Policy Variants

		January-February			March-April			May-June		
			Difference			Difference			Difference	
Base	Variant	Total		%	Total		%	Total		%
F1-IJC		1,139			614			695		
	F4-IJC	1,171	32	2.8	601	-13	-2.1	672	-23	-3.3
	F5-IJC	1,054	-85	-7.5	587	-27	-4.4	703	8	1.2
F1-SC		980			498			711		
	F4-SC	1,033	53	5.4	485	-13	-2.6	688	-23	-3.2
	F5-SC	937	-43	-4.4	512	14	2.8	727	16	2.3

Table 12b: Bimonthly Power Benefit (US$1,000), Jul–Dec, Operating Policy Variants

		July-August			September-October			November-December		
			Difference			Difference			Difference	
Base	Variant	Total		%	Total		%	Total		%
F1-IJC		1,008			718			987		
	F4-IJC	1,007	-1	-0.1	725	7	1.0	1,013	26	2.6
	F5-IJC	981	-27	-2.7	710	-8	-1.1	960	-27	-2.7
F1-SC		1,016			681			899		
	F4-SC	1,016	0	0	696	15	2.2	925	26	2.9
	F5-SC	972	-44	-4.3	645	-36	-5.3	855	-44	-4.9

Table 13 provides a summary of the average annual power benefit provided by these power plants under the Alternatives F1-IJC, F1-SC, C1, and M1. The table shows that there is a net loss in the power benefits for all of the alternatives when compared to Alternative F1-IJC. The loss differences range from US$376,000 for Alternative F1-SC, to US$114,000 for Alternative C1. Stated another way, this general loss in power benefits represents the additional cost associated with obtaining replacement power to operate the mills. These figures are based on average generation for the 30-year period of record analyzed for each of the four alternatives examined. It should be noted that the power costs could be higher or lower depending on the particular water conditions and operation used in a specific year.

Table 13: Average Annual Power Benefit (US$1,000), Alternatives

Base	Total	Comparison	Total	Difference	%
F1-IJC	5,161	F1-SC	4,785	-376	-7.3
		C1	5,047	-114	-2.2
		M1	4,900	-261	-5.1

Table 14 provides a summary of the average annual power benefits for the operating policy variants. This data gives some measure of the variability in the average annual power benefits under different operating policy variants which in turn gives some sense of the sensitivity of the results for F1-IJC and F1-SC to differing operating policy variants. From this table it can be seen that the variability in the average annual power benefits for Alternative F1-IJC ranges from +0.6% under operating policy variant F4-IJC, to -3.2% under operating policy variant F5-IJC.

The variability in the average annual power benefits for Alternative F1-SC ranges from +1.2% under operating policy variant F4-SC, to -2.9% under operating policy variant F5-SC. These results are expected, since operating according to variants F4-IJC and F4-SC maximizes drawdown and refill, which tends to improve power generation. Conversely, operating according to variants F5-IJC and F5-SC results in a decrease in power benefits due to the reduced drawdown and refill that occurs with this type of operation.

Table 14: Average Annual Power Benefit (US$1,000), Operating Policy Variants

Base Variant	Total	Comparison	Total	Difference	% Difference
F1-IJC	5,161	F4-IJC	5,190	29	0.6
		F5-IJC	4,996	-165	-3.2
F1-SC	4,785	F4-SC	4,843	58	1.2
		F5-SC	4,648	-137	-2.9

3.2 FLOOD DAMAGES

3.2.1 Background

The outlet of Rainy Lake has been controlled since 1909 by an international dam extending between Fort Frances, Ontario and International Falls, Minnesota at the site of the former Koochiching Falls. The flow out of Namakan Lake at Kettle Falls, above Rainy Lake, has been controlled since 1914 by two small dams. One, which is known as the Canadian Dam, is located entirely in Ontario (at the former Squirrel Falls). The other, which straddles the International border, is known as the International Dam. Both structures consist of controlled sluices to regulate outflows from Namakan Lake.

In 1926, the Governments of Canada and the United States asked the International Joint Commission (IJC) to investigate the regulation of the levels of Rainy Lake, Namakan Lake, and the boundary waters above Namakan Lake for various purposes. The Commission's recommendations led to the 1938 Rainy Lake Convention that empowered the Commission to define when emergency conditions exist in the Rainy Lake basin, whether by high or low water, and to adopt control measures as necessary with respect to existing and future dams in the basin. Under the convention, the Commission issued an Order in 1949 for the regulation of water levels of Rainy and Namakan lakes to preclude the occurrence of emergency conditions. The Order, which was amended in 1957 and 1970, specifies a band of upper and lower limits for water levels on each lake throughout the year.

The 1970 Order defines emergency conditions on Rainy Lake for high water when the lake level exceeds 337.75 meters, and the inflow into the lake exceeds the outflow capacity of the International Dam at the outlet of Rainy Lake. The 1970 Order defines emergency conditions on Namakan Lake for high water when the lake level exceeds 340.95 meters, and the inflow into the lake exceeds the outflow capacity of the Kettle Falls dams. A much more serious emergency condition exists when the "all gates open" level is reached. For Rainy Lake, this level is 337.9 meters, and under the present operating rules, all dam gates are to be fully opened to reduce lake levels as quickly as possible to minimize flood damage. The corresponding level for Namakan

Lake is 341.1 meters. It is generally acknowledged that property damage begins to occur when lake levels are within the range of these two elevations.

3.2.2 Methodology

The analysis used in this report employs a conventional approach to assessing damages based on developing elevation-damage relationships and determining flood damages based on historical flood levels. Two primary types of data were used in performing this analysis. The first was estimates of annual flooding, which were based on simulated water levels obtained from simulations conducted by Environment Canada using the “REGUSE” computer model for the years 1958-1996 and 1950. The second type of data was elevation-damage relationships that were used to determine the damages associated with different levels of flooding.

Annual damages were calculated for each of the years modeled, 1958-1996 and 1950, using the REGUSE model. Average annual damages were calculated for the 1958-1996 period for the four rule curve alternatives using a simple arithmetic average of the annual values. The 1950 event was not included in the average because it is not representative of the period modeled, but is representative of a much longer time period. The 1950 event produced almost 19 times as much damage as the total damages produced by all the floods in the 1958-1996 period.

Examination of the 1950 event is useful to provide insight into the potential for increased flood damages under the various alternatives for an extreme event. Elevation-damage data was obtained from a previous assessment of flood damage potential on the Rainy-Namakan System, which was completed in July 1993 by Acres International Limited under contract to Boise Cascade Corporation. As a part of this analysis, Acres developed damage estimates for four types of properties: cottages/residences; resorts; marinas; and float plane bases. Damage categories considered in the analysis include: docks; shops, sheds, and pumps; offices and showrooms; commercial lodges, cabins, and parking lots; and private cottages and residences. The inventory of properties establishing the elevation-damage relationships was estimated from recent mapping (1:50,000 scale), aerial and ground inspection, and discussions with government authorities. There were no elevations available from topographic maps (only 25-foot contours were available).

A sampling approach was developed since the number of properties was deemed too large to warrant individual elevation measurements and damage determinations. A total of 51 interviews were conducted, consisting of: commercial enterprises (28) and private cottages and residences (23).

The sample included nearly 50 % of the resorts in the Rainy basin, since these were found to be relatively unique and had greater variance in damage potential. Approximately 1 % of the residential cottages were sampled. These cottages were chosen strategically from fairly homogenous groups along the lakeshore, and were felt to be representative of similar structures in their respective areas, both in elevation and in damage potential.

Based on the results of the damage survey, standardized damage relationships were developed and applied to all properties on the lakes. Damages are distinguished between those that occur once per event (such as structural repair of homes) and those that increase with time (such as the cost of temporary lodging).

Elevation-damage relationships were then established by combining the information about the damage relationships by property type, the number of properties, and the respective elevations of the properties.

At the request of the Corps of Engineers, Acres International, Inc. provided additional information about the nature of the flood damage estimates to supplement what was used in their previous analysis. This information is a disaggregation of the elevation-damage curves. This new information provides insight into the types of damage that occur at any given elevation, and demonstrates the relative importance of each damage category in comparison to the whole for any level of flooding. Additionally, the zero-damage elevation for each damage category is identified. The ACRES flood damage assessment was not independently verified. Interviews conducted by the Corps of Engineers with local officials suggest that the zero damage points identified by the ACRES study are consistent with the personal experiences of lakeshore residents.

On Rainy Lake, it is evident that private cottages and residences have the greatest overall potential for damage, although the damages begin at elevations that are higher than for the other damage categories. The pattern is similar for the Namakan chain of lakes, although commercial lodges and cabins share a nearly equal potential for damage with the private cottages and residences.

The elevation-damage data developed for the lakes are shown in **Tables 15 and 16**. The damages are distributed into two main categories. The first set of information in each table is the fixed cost per flood event. It is based on the peak lake elevation reached during the flood event. The second set of information in **Tables 15 and 16** is the variable cost per flood event. It is based on the duration of the flood event.

There are several items that should be noted regarding these elevation-damage tables. First, the data is based on extrapolation from a sampling of what was thought to be representative residences/enterprises in each area of the lake. Second, the total number of properties on the lakes was estimated based on information such as maps, aerial and ground inspection, and government authorities. Finally, it can be seen from **Tables 15 and 16** that in several ranges of lake elevation, there is a significant jump in the damages that occur for a fairly small increase in the lake elevation. A good example of this is shown at the end of **Table 15** on the tabulation of Total Damages for Rainy Lake, where the total flood damage per event increases from US$222,227 at elevation 338.6 meters, to US$1,323,960 at elevation 338.8 meters. Another similar example is shown at the end of **Table 16**, on the tabulation of Total Damages for Namakan Lake, where the total flood damage per event increases from US$725,731 at elevation 341.8 meters, to US$1,438,114 at elevation 342.0 meters. These types of incremental changes in the elevation-damage tables can lead to significant differences in the flood damages for different alternatives based on relatively small changes in the lake elevations.

Table 15: Rainy Lake – Elevation versus Damage

Flood Damage per Event			Flood Damage per Week		
Elevation	**Increment**	**Cumulative**	**Elevation**	**Increment**	**Cumulative**
Category: Shops/Sheds/Pumps					
337.9	0	0	337.9	0	0
338.0	1,100	1,100	338.0	0	0
338.1	1,201	2,301	338.1	0	0
338.2	707	3,008	338.2	0	0
338.3	2,587	5,595	338.3	0	0
338.4	200	5,795	338.4	0	0
338.5	600	6,395	338.5	0	0
338.5	240	6,635	338.5	0	0
338.6	320	6,955	338.6	0	0
339.2	135,880	142,835	339.2	0	0
339.9	480	143,315	339.9	0	0
341.4	560	143,875	341.4	0	0
Category: Commercial Lodges/Cabins/Parking Lots					
337.9	0	0	337.9	0	0
338.1	0	0	338.1	350	350
338.2	0	0	338.2	800	1,150
338.3	0	0	338.3	17,975	19,125
338.4	16,567	16,567	338.4	0	19,125
338.5	0	16,567	338.5	16,713	35,838
338.8	28,400	44,967	338.8	14,000	49,838
338.9	32,507	77,474	338.9	18,047	67,885
339.2	135,520	212,994	339.2	3,400	71,285
339.9	158,107	371,101	339.9	7,187	78,472
341.4	367,687	738,788	341.4	10,127	88,599
344.4	81,247	820,035	344.4	2,940	91,539
Category: Private Cottages/Residences					
337.9	0	0	337.9	0	0
338.5	0	0	338.5	163,333	163,333
338.6	0	0	338.6	294,000	457,333
338.8	1,073,333	1,073,333	338.8	219,333	676,666
338.8	700,000	1,773,333	338.8	0	676,666
338.9	0	1,773,333	338.9	28,000	704,666
339.1	1,500,000	3,273,333	339.1	0	704,666
339.2	700,000	3,973,333	339.2	163,333	867,999
339.9	3,613,333	7,586,666	339.9	490,000	1,357,999
340.2	120,000	7,706,666	340.2	0	1,357,999
340.8	700,000	8,406,666	340.8	163,333	1,521,332
347.5	700,000	9,106,666	347.5	163,333	1,684,665
350.5	2,540,000	11,646,666	350.5	592,667	2,277,332

Table 15: Rainy Lake – Elevation versus Damage, (cont.)

Flood Damage per Event			Flood Damage per Week		
Elevation	**Increment**	**Cumulative**	**Elevation**	**Increment**	**Cumulative**
Category: Docks					
337.9	10,413	10,413	337.9	3,067	3,067
337.9	9,333	19,746	337.9	2,917	5,984
338.0	48,000	67,746	338.0	14,333	20,317
338.1	3,573	71,319	338.1	367	20,684
338.1	1,493	72,812	338.1	467	21,151
338.1	0	72,812	338.1	0	21,151
338.2	19,947	92,759	338.2	6,467	27,618
338.2	9,333	102,092	338.2	2,917	30,535
338.3	35,320	137,412	338.3	10,350	40,885
338.4	960	138,372	338.4	300	41,185
338.5	37,333	175,705	338.5	5,833	47,018
Category: Offices/Showrooms					
337.9	0	0	337.9	0	0
338.2	6,000	6,000	338.2	0	0
338.5	17,000	23,000	338.5	0	0
339.2	8,000	31,000	339.2	0	0
339.9	23,000	54,000	339.9	0	0
Total					
337.7	0	0	337.7	0	0
337.9	10,413	10,413	337.9	3,067	3,067
337.9	9,333	19,746	337.9	2,917	5,984
338.0	49,100	68,846	338.0	14,333	20,317
338.1	4,774	73,620	338.1	717	21,034
338.1	1,493	75,113	338.1	467	21,501
338.1	0	75,113	338.1	0	21,501
338.2	26,654	101,767	338.2	7,267	28,768
338.2	9,333	111,100	338.2	2,917	31,685
338.3	37,907	149,007	338.3	28,325	60,010
338.4	16,567	165,574	338.4	0	60,010
338.4	1,160	166,734	338.4	300	60,310
338.5	54,933	221,667	338.5	22,546	82,856
338.5	0	221,667	338.5	163,333	246,189
338.5	240	221,907	338.5	0	246,189
338.6	320	222,227	338.6	294,000	540,189
338.8	1,101,733	1,323,960	338.8	233,333	773,522
338.8	700,000	2,023,960	338.8	0	773,522
338.9	32,507	2,056,467	338.9	46,047	819,569
339.1	1,500,000	3,556,467	339.1	0	819,569
339.2	979,400	4,535,867	339.2	166,733	986,302
339.9	3,794,920	8,330,787	339.9	497,187	1,483,489
340.2	120,000	8,450,787	340.2	0	1,483,489
340.8	700,000	9,150,787	340.8	163,333	1,646,822
341.4	368,247	9,519,034	341.4	10,127	1,656,949
344.4	81,247	9,600,281	344.4	2,940	1,659,889
347.5	700,000	10,300,281	347.5	163,333	1,823,222
350.5	2,540,000	12,840,281	350.5	592,667	2,415,889

Table 16: Namakan Lake – Elevation versus Damage

Flood Damage per Event			Flood Damage per Week		
Elevation	**Increment**	**Cumulative**	**Elevation**	**Increment**	**Cumulative**
Category: Shops/Sheds/Pumps					
340.9	0	0	340.9	0	0
341.0	400	400	341.9	0	0
341.1	1,000	1,400	341.1	0	0
341.1	1,200	2,600	341.1	0	0
341.2	333	2,933	341.2	0	0
341.2	1,980	4,913	341.2	0	0
341.4	4,053	8,966	341.4	0	0
341.4	1,000	9,966	341.4	0	0
341.7	200	10,166	341.7	0	0
341.7	2,613	12,779	341.7	0	0
341.7	1,200	13,979	341.7	0	0
341.8	240	14,219	341.8	0	0
342.0	400	14,619	342.0	0	0
342.6	1,440	16,059	342.6	0	0
344.4	1,480	17,539	344.4	0	0
Category: Commercial Lodges/Cabins/Parking Lots					
340.9	0	0	340.9	0	0
341.1	0	0	341.1	0	0
341.4	0	0	341.4	25,650	25,650
341.4	0	0	341.4	8,400	34,050
341.5	5,133	5,133	341.5	0	34,050
341.7	351,200	356,333	341.7	4,433	38,483
341.7	223,100	579,433	341.7	0	38,483
341.8	0	579,433	341.8	6,000	44,483
342.0	89,983	669,416	342.0	5,400	49,883
342.3	155,133	824,549	342.3	0	49,883
342.6	194,200	1,018,749	342.3	5,600	55,483
343.2	0	1,018,749	343.2	4,033	59,516
344.4	591,590	1,610,339	344.4	14,583	74,099
Category: Private Cottages/Residences					
340.9	0	0	340.9	0	0
341.2	0	0	341.2	35,000	35,000
341.5	87,000	87,000	341.5	0	35,000
342.0	616,000	703,000	342.0	308,000	343,000
342.6	791,000	1,494,000	342.6	0	343,000
344.4	510,000	2,004,000	344.4	119,000	462,000

Table 16: Namakan Lake – Elevation versus Damage, (cont.)

Flood Damage per Event			Flood Damage per Week		
Elevation	Increment	Cumulative	Elevation	Increment	Cumulative
Category: Docks					
340.9	0	0	340.9	0	0
341.0	3,200	3,200	341.0	1,000	1,000
341.0	1,440	4,640	341.0	200	1,200
341.0	400	5,040	341.0	0	1,200
341.1	9,333	14,373	341.1	2,708	3,908
341.1	3,200	17,573	341.1	1,000	4,908
341.2	933	18,506	341.2	83	4,991
341.2	5,400	23,906	341.2	3,150	8,141
341.3	5,000	28,906	341.3	1,563	9,704
341.4	933	29,839	341.4	83	9,787
341.4	4,800	34,639	341.4	1,500	11,287
341.6	3,400	38,039	341.6	1,063	12,350
341.7	720	38,759	341.7	100	12,450
341.7	320	39,079	341.7	100	12,550
Category: Office/Showrooms					
340.9	0	0	340.9	0	0
341.8	6,000	6,000	341.8	0	0
342.0	6,000	6,000	342.0	0	0
342.6	6,000	18,000	342.6	0	0
344.4	12,000	30,000	344.4	0	0
Total					
340.8	0	0	340.8	0	0
340.9	0	0	340.9	0	0
341.0	3,200	3,200	341.0	1,000	1,000
341.0	1,840	5,040	341.0	200	1,200
341.0	400	5,440	341.0	0	1,200
341.1	10,333	15,773	341.1	2,708	3,908
341.1	4,400	20,173	341.1	1,000	4,908
341.2	1,266	21,439	341.2	83	4,991
341.2	7,380	28,819	341.2	38,150	43,141
341.3	5,000	33,819	341.3	1,563	44,704
341.4	4,986	38,805	341.4	25,733	70,437
341.4	5,800	44,605	341.4	9,900	80,337
341.5	92,133	136,738	341.5	0	80,337
341.6	3,400	140,138	341.6	1,063	81,400
341.7	920	141,058	341.7	100	81,500
341.7	354,133	495,191	341.7	4,533	86,033
341.7	224,300	719,491	341.7	0	86,033
341.8	6,240	725,731	341.8	6,000	92,033
342.0	712,383	1,438,114	342.0	313,400	405,433
342.3	155,133	1,593,247	342.3	0	405,433
342.6	992,640	2,585,887	342.6	5,600	411,033
343.2	0	2,585,887	343.2	4,033	415,066
344.4	1,115,070	3,700,957	344.4	133,583	548,649

3.2.3 Effects of Proposed Rule Curve Changes

Using the elevation-damage data shown in **Tables 15 and 16**, and the lake elevation data obtained from the "REGUSE" model, flood damages were computed for each of the alternatives. **Table 17** summarizes the total annual flood damages for each year in the simulation period 1958-96, as well as 1950, for all of the alternatives evaluated. There are several observations that can be made from the data in this table.

- With the exception of Alternative F1-IJC, which has lower overall damages than any of the other alternatives, the magnitude of the flood damages is fairly similar from one alternative to another. As noted above in **Section 3.2.2**, one of the reasons for these differences may be the rate of change in the damages that occurs for a relatively small change in lake elevations in some portions of the tables. However, the REGUSE simulation data does show that many of the alternatives would result in higher peak lake levels and longer durations of damaging lake levels than under the existing operation.
- Out of the total simulation period from 1958-96, flood damages occur in about 20% of the years. The flood damages that occur during this period range from as low as US$10,413 in 1964 up to US$481,539 for the highest year, 1968.
- The total flood damages for this period of record range from US$587,577 for Alternative F1-IJC, to US$914,550 for Alternative F1-SC, which is a total increase of US$326,973.
- The average annual damages for this period of record range from US$15,066 for Alternative F1-IJC, to US$23,450 for Alternative F1-SC, which is an average annual increase of US$8,384.
- Finally, for those alternatives where simulations were available for the 1950 record inflow year, the damages were significantly higher than what occurred in any of the other years in the 1958-96 period of record. The highest damages that occurred during any of these years were only about 3% of what occurred in the 1950 inflow year. The damages for the 1950 event under Alternative F1-IJC were US$11,025,137, and they were US$13,845,875 under Alternative F1-SC, which is an increase of US$2,820,738.

Table 18 shown below summarizes the flood damage information for the operating policy variants for the Base Case and proposed SC rule curves. This sensitivity analysis shows a relatively small range of variability in the flood damages for Alternatives F1-IJC (+0.2% to +1.2%) and F1-SC (-0.5% to –2.2%) under the F4 and F5 series of operating policy variants.

Table 17: Rainy and Namakan Lakes, Alternatives

Total Annual Flood Damages (US$)				
Year	**F1-IJC**	**F1-SC**	**C1**	**M1**
1958	0	0	0	0
1959	0	0	0	0
1960	0	0	0	0
1961	0	0	0	0
1962	0	0	0	0
1963	0	0	0	0
1964	10,413	14,042	10,413	14,042
1965	0	0	0	0
1966	61,669	100,463	96,188	96,188
1967	0	0	0	0
1968	363,912	481,539	469,072	467,362
1969	0	0	0	0
1970	18,596	43,985	43,985	43,985
1971	0	0	0	0
1972	0	0	0	0
1973	0	0	0	0
1974	24,566	109,245	56,726	56,726
1975	0	0	0	0
1976	0	0	0	0
1977	61,669	46,776	45,660	46,218
1978	0	0	0	0
1979	0	0	0	0
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	14,184	10,413	10,413	10,413
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
Total	587,577	914,550	829,147	831,624
Average	15,066	23,450	21,260	21,324
1950	11,025,137	13,845,875	13,537,195	13,537,195

Table 18: Rainy and Namakan Lakes, Operating Policy Variants

Total Annual Flood Damages (US$)						
Year	Alternative	IJC Variants		Alternative	SC Variants	
	F1-IJC	F4-IJC	F5-IJC	F1-SC	F4-SC	F5-SC
1958	0	0	0	0	0	0
1959	0	0	0	0	0	0
1960	0	0	0	0	0	0
1961	0	0	0	0	0	0
1962	0	0	0	0	0	0
1963	0	0	0	0	0	0
1964	10,413	10,413	10,413	14,042	16,024	10,413
1965	0	0	0	0	0	0
1966	61,669	61,669	72,627	100,463	95,617	100,463
1967	0	0	0	0	0	0
1968	363,912	363,057	360,493	481,539	481,539	466,105
1969	0	0	0	0	0	0
1970	18,596	18,596	18,596	43,985	43,985	43,985
1971	0	0	0	0	0	0
1972	0	0	0	0	0	0
1973	0	0	0	0	0	0
1974	24,566	24,566	24,566	109,245	109,245	109,245
1975	0	0	0	0	0	0
1976	0	0	0	0	0	0
1977	61,669	61,669	61,669	46,776	46,776	45,660
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	0	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	14,184	16,024	14,184	10,413	10,413	10,413
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	0	0	0	0	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	32,569	32,569	33,424	108,087	106,594	108,087
Total	587,577	588,562	595,971	914,550	910,194	894,370
Average	15,066	15,091	15,281	23,450	23,338	22,933
1950	11,025,137	N/A	N/A	13,845,87	N/A	N/A

3.3 RECREATION-TOURISM

3.3.1 Background

Tourism generates a substantial economic benefit to the region surrounding Rainy and Namakan lakes. For example, it is estimated that tourism based on the Rainy Lake fishery is responsible for approximately 250 full or part-time jobs and 24 tourist establishments on the Minnesota side of the lake, and another 58 jobs and 22 tourist operations on the Ontario side of the lake. The fishery generated approximately US$5.7 million (1990 dollars) in gross revenues in the local area. This was distributed as US$1.15 million in Ontario, and US$4.55 million in Minnesota, as shown in **Table 19** below. This information was the most recent information available that was specific to the Rainy Lake area.

Table 19: Gross Revenues from Rainy Lake Tourist and Commercial Fishing Industries (1990 US$)

Tourism Industry	Ontario	Minnesota	Total
Commercial Fishing	$92,650	$17,000	$109,650
Tourist Industry	$1,054,850	$4,530,500	$5,585,350
Total	$1,147,500	$4,547,500	$5,695,000

For Namakan Lake, it is estimated that tourist anglers generate approximately 113 full or part-time jobs. Additionally, there are 47 tourist establishments on the Minnesota side of the lake, and 2 tourist establishments on the Ontario side of the lake that rely on the Namakan Lake fishery. The fishery generated approximately US$3 million (1990 dollars) in gross revenues to the local area. Most of this revenue is contributed by tourists who fish on Namakan Lake. About 1% of the total revenues are produced by the commercial fishery.

There are a number of recent studies estimating recreational use in the area, prepared by the National Park Service and agencies within Minnesota and Ontario. The National Park Service (NPS) reports annual visitation for Voyageurs National Park, which includes most of Rainy Lake and the Namakan chain of lakes. The number of recreation visits rose from 164,000 in 1983 to a high of 245,000 in 1990, and remained around 240,000 to 245,000 through 1994. The number of fishing visits averaged around 130,000 annually during the first half of the 1990's, and the number of persons on houseboats averaged 27,000 annually. Most of the visits occurred between May and September.

The Minnesota Department of Natural Resources (MDNR) has conducted creel surveys on these lakes regularly since 1983. The 1994 (summer season) survey recorded 67,000 angler trips on Kabetogama Lake, 22,000 angler trips on Namakan Lake, and 34,000 angler trips on Rainy Lake. This amounts to 123,000 total angler trips, and equates to approximately 500,000 angler hours. (This figure is very close to the NPS estimate for Voyageurs, but there are differences in the region and time periods covered by each survey.) Most of the anglers on Kabetogama Lake and Namakan Lake were non-local Minnesotans, whereas most anglers on Rainy Lake (Minnesota waters) were local Minnesota residents. A 1985 MDNR regional survey of the Edge-of the-Wilderness Area (including Voyageurs and the Boundary Waters Canoe Area (BWCA)) estimated regional fishing hours at 21 million. Rainy Lake and the Namakan chain of lakes therefore accounts for roughly 2.4 % of regional fishing activity.

Although the fishery information presented is the most recent information available, it is thought to be a conservative estimate of the revenues, since this data is somewhat dated, and tourism has continued to increase in the area.

3.3.2 Effects of the Proposed Rule Curve Changes

Postulation of potential future impacts resulting from adoption of any rule curve alternative is highly subjective, and dependent upon forecasting future trends and reliance on sectoral components of an information base that is not available. For these reasons, impacts of changes in the rule curves on recreation and tourism were not quantified. However, an attempt was made to give a qualitative assessment of the potential changes that might result from the adoption of these proposed alternatives compared to the Base Case condition.

The proposed rule curve changes have a wide range of different effects on tourism in the region. One of the goals under the F1-SC alternative and many of the other alternatives was to begin refilling the lakes earlier in the spring in order to provide for more favorable conditions for fish spawning, better access to boat docks, and improved navigation near the start of the fishing season. This would have a beneficial effect on resorts and tourism-related businesses earlier in the year.

In the November 1993 Rainy Lake and Namakan Reservoir Water Levels International Steering Committee Report, it is estimated that this would result in additional direct revenues of up to about US$800,000. This assessment was based on a similar approach to what was used above in **Section 3.3.1** of estimating total gross revenues associated with the fishery of US$3 million. The assessment identified the number and type of recreation providers and the weekly rates they receive for various goods and services (lodging, boat rentals, retail supplies, etc.). Under the existing rule curves, the report estimated that there is a 40 % reduction in potential expenditures for the first three weeks of the fishing season resulting in annual gross revenue losses to local businesses of approximately US$800,000.

This approach for considering the effects to recreation resulting from rule curve changes has resulted in a figure that should be considered an upper bound of the extent of monetary effects. First, it assumes there is enough un-met demand to generate this level of visitor response annually. This may be true, but it is undocumented through time (Occupancy rates were very high during the 1995 season based on local reports). Estimates of changes in demand should also consider substitution effects, since increased visitation at Rainy/Namakan resorts may come at the expense of other resorts in the region. Additionally, using retail sales as a measure of loss overstates the monetary effects because there are costs associated with providing the goods and services. The local economic effects should be considered net of such production expenses.

One potential negative impact to tourism that might result from this action is the possible damage to boat docks that might occur from the shifting of ice buildups that have formed around the docks during the winter. If the lakes are refilled earlier in the spring before the ice around these structures has melted, damage to the docks could result depending on how quickly the lakes are refilled. It is also theorized in this report and others that an earlier spring rise in water levels would result in an improvement in the quality of the fishery on both lakes, and that this would also result in a direct benefit to the tourism economy. Examples of alternatives that would result in higher spring water levels include F1-SC on Rainy and Namakan lakes, as well as C1 and M1 on Namakan Lake.

Another trend that can be observed through most of the alternatives evaluated in this report is slightly lower lake levels during the summer months. This change is proposed for several reasons such as fish and wildlife habitat improvement by attempting to simulate the natural level regime, reduced erosion, and better beach access. In terms of tourism, it seems that depending upon the amount the lake levels were lowered, it could have a negative impact in tourism-related areas such as navigation and dock access, but possibly a positive impact for other areas such as beach access. Examples of alternatives that result in lower summer water levels on Rainy Lake are F1-SC and M1. On Namakan Lake, alternatives F1-SC, C1 and M1 all result in lower water levels on Namakan Lake.

A third trend that can be seen in the proposed alternatives is a reduced overwinter drawdown compared to the existing operation. Based upon the studies by fisheries and environmental experts, this reduced drawdown is extremely beneficial to the fishery, amphibians and turtles, benthic organisms, macro-invertebrates, and wildlife. The reduced drawdown also provides higher water levels in the spring for navigation, which yields positive benefits for tourism. On Rainy Lake, all of the alternatives result in about the same level of overwinter drawdown as the existing rule curves. However, on Namakan Lake, alternatives F1-SC, M1 and C1 all result in less overwinter drawdown than the existing rule curves, which should be beneficial from an environmental standard.

In summary, the effects in this resource category are mixed depending on the time of the year. Higher spring water levels that may result from many of the alternatives would be beneficial to the fishery, according to fisheries experts. Higher levels would also allow navigation and access to boat docks closer to the start of the fishing season opening, which would have a positive effect on tourism. Examples of alternatives that would result in higher spring water levels include F1-SC on Rainy and Namakan lakes, as well as C1 and M1 on Namakan Lake. Reduction of the winter drawdown on Namakan Lake under most of the alternatives provides positive benefits to the fishery and would indirectly benefit tourism. During the summer months, many of the alternatives result in slowly declining lake levels, which might have a negative effect on tourism due to potential problems with navigation and access to some areas. Examples of alternatives that result in slowly declining lake levels include F1-SC and M1 at both Rainy and Namakan lakes, and C1 on Namakan Lake.

3.4 Recreation-Navigation

3.4.1 Background

Both Rainy and Namakan lakes are used extensively for navigation, primarily for recreational use such as boating and fishing. Namakan Lake is also used on a limited basis as a transport route for personal, business, and recreational use, particularly by Native Americans. Further information on this use for Native American Transportation is found later in this document in **Section 3.8**. Historically, the lakes have also been used for the booming of logs and navigation of large tugboats through shallow channels and bays. However, this practice ceased in the mid-1970s, and is no longer a relevant factor.

On Rainy Lake, the elevation on which all navigation charts are based is 337.4 meters. On Namakan Lake, information obtained from the Lac La Croix First Nation area residents and tourist operators on Sand Point and Crane lakes suggests that the rule curve should not go below 340.5 meters during the navigation season, from about May through September.

3.4.2 Effects of the Proposed Rule Curve Changes

The effects in this resource category are similar to those in tourism and can only be defined qualitatively. Higher spring water levels would be beneficial for navigation early in the season. However, lower late summer levels would potentially have a negative effect on navigation by limiting access to the shallower areas of both lakes, particularly by sailboat.

The primary navigation season extends from about May-September. **Tables 20 and 21** show the average monthly lake elevations for the primary months in the navigation season for Rainy and Namakan lakes, respectively. These tables show that the average monthly lake elevations for all of the alternatives are relatively close. For Rainy Lake, the maximum difference in the average monthly lake elevations for any of the alternatives is 0.22 meters lower in September for Alternative F1-SC compared to the Base Case, Alternative F1-IJC. For Namakan Lake, the maximum difference is 0.79 meters higher in May for Alternative C1, and as much as 0.25 meters lower in September for F1-SC, C1 and M1, compared to F1-IJC.

In general, the average monthly elevations for both lakes tend to be higher during the early part of the navigation season in May-June and lower during July-September. Higher lake elevations in the early part of the navigation season, particularly in May, would improve spring navigation and possibly allow for earlier access to some areas closer to the start of the fishing season. Lower lake levels during the period from July through September could have a negative effect on navigation and limit access to some of the more shallow areas of the lakes, particularly by sailboat.

For Rainy Lake, the average monthly lake elevation is slightly below the navigation chart elevation of 337.4 meters during the month of May for Alternatives F1-IJC, C1 and M1, and during the month of September for Alternative F1-SC. F1-SC is the only alternative that provides average May water levels greater than 337.4 meters on Rainy Lake. For Namakan Lake, the average monthly lake elevation is above the desired minimum elevation for navigation of 340.5 meters during all months except May, for all alternatives. During May, most of the alternatives are only slightly below this level, with the exception of F1-IJC, which is almost one meter below it.

Table 20: Rainy Lake Average Monthly Elevation (meters), Alternatives

Base	Altern.	May			June			July			August			September		
			Difference			Difference			Difference			Difference			Difference	
		(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%
F1-IJC		337.28			337.55			337.62			337.60			337.60		
	F1-SC	337.47	0.19	0.06	337.64	0.09	0.03	337.56	-0.06	-0.02	337.46	-0.14	-0.04	337.38	-0.22	-0.07
	C1	337.28	0.00	0	337.58	0.03	0.01	337.64	0.02	0.01	337.62	0.02	0.01	337.61	0.01	0
	M1	337.28	0.00	0	337.57	0.02	0.01	337.61	-0.01	0	337.53	-0.07	-0.02	337.45	-0.15	-0.04

Table 21: Namakan Lake Average Monthly Elevation (meters), Alternatives

Base	Altern	May			June			July			August			September		
			Difference			Difference			Difference			Difference			Difference	
		(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%
F1-IJC		339.68			340.56			340.81			340.82			340.80		
	F1-SC	340.45	0.77	0.23	340.83	0.27	0.08	340.75	-0.06	-0.02	340.61	-0.21	-0.06	340.55	-0.25	-0.07
	C1	340.47	0.79	0.23	340.83	0.27	0.08	340.74	-0.07	-0.02	340.60	-0.22	-0.06	340.55	-0.25	-0.07
	M1	340.39	0.71	0.21	340.82	0.26	0.08	340.74	-0.07	-0.02	340.60	-0.22	-0.06	340.55	-0.25	-0.07

Tables 22 and 23 show the respective average monthly lake elevations for the operating policy variants during the primary months in the navigation season for Rainy and Namakan lakes. This data gives some measure of the variability in the lake levels under different operating policy variants which in turn gives some sense of the sensitivity of the results for F1-IJC and F1-SC to differing operating policy variants. For Rainy Lake, the sensitivity analysis showed that the variability in lake level under differing operating policy variants was generally 0.10m or less for F1-IJC and F1-SC, when regulated according to the F4 and F5 series of operating policy variants. For Namakan Lake, the sensitivity analysis showed that the variability in lake level under differing operating policy variants was generally 0.10 meters or less for F1-IJC and F1-SC, except for May levels under the F1-IJC Base Case which varied as much as 0.40 meters. This is expected due to the large winter drawdown under the Base Case.

Table 22: Rainy Lake Average Monthly Elevation (meters), Operating Policy Variants

Base	Variant	May			June			July			August			September		
			Difference			Difference			Difference			Difference			Difference	
		(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%
F1-IJC		337.28			337.55			337.62			337.60			337.60		
	F4-IJC	337.19	-0.09	-0.03	337.52	-0.03	-0.01	337.62	0	0	337.62	0.02	0.01	337.63	0.03	0.01
	F5-IJC	337.29	0.01	0	337.53	-0.02	-0.01	337.58	-0.04	-0.01	337.54	-0.06	-0.02	337.54	-0.06	-0.02
F1-SC		337.47			337.64			337.56			337.46			337.38		
	F4-SC	337.42	-0.05	-0.01	337.63	-0.01	0	337.58	0.02	0.01	337.50	0.04	0.01	337.44	0.06	0.02
	F5-SC	337.44	-0.03	-0.01	337.61	-0.03	-0.01	337.51	-0.05	-0.01	337.37	-0.09	-0.03	337.29	-0.09	-0.03

Table 23: Namakan Lake Average Monthly Elevation (meters), Operating Policy Variants

Base	Variant	May			June			July			August			September		
			Difference			Difference			Difference			Difference			Difference	
		(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%	(m)	(m)	%
F1-IJC		339.68			340.56			340.81			340.82			340.80		
	F4-IJC	339.44	-0.24	-0.07	340.48	-0.08	-0.02	340.80	-0.01	0	340.82	0	0	340.81	0.01	0
	F5-IJC	339.83	0.15	0.04	340.54	-0.02	-0.01	340.77	-0.04	-0.01	340.76	-0.06	-0.02	340.72	-0.08	-0.02
F1-SC		340.45			340.83			340.75			340.61			340.55		
	F4-SC	340.32	-0.13	-0.04	340.83	0	0	340.77	0.02	0.01	340.64	0.03	0.01	340.58	0.03	0.01
	F5-SC	340.43	-0.02	-0.01	340.79	-0.04	-0.01	340.68	-0.07	-0.02	340.54	-0.07	-0.02	340.48	-0.07	-0.02

3.5 WATER SUPPLY

3.5.1 Background

Water is withdrawn from Rainy and Namakan lakes for both commercial and private water supply uses. Permits are required for larger users (those withdrawing over about 3.8 million liters per year), while smaller users are not required to have a permit. The holders of these permits for larger water supply withdrawals and the maximum amount of water they are permitted to withdraw are shown in **Table 24**.

Table 24: Commercial Water Users on Rainy and Namakan Lakes

Entity	Purpose	Yearly Withdrawal Limit (million liters/year)
RAINY LAKE		
City of International Falls, Minnesota	Municipal and industrial water supply	1,500
Boise Cascade Corporation, International Falls, Minnesota	Pulp and paper manufacturing	94,600
Town of Ft. Frances, Ontario	Municipal and industrial water supply	6,200
Abitibi-Consolidated, Inc., Ft. Frances, Ontario	Pulp and paper manufacturing	34,540
NAMAKAN LAKE		
No commercial users with permits identified.		

(Note: Water withdrawal data for U.S. entities obtained from Minnesota Department of Natural Resources. Withdrawal information for Canadian entities obtained from the Town of Ft. Frances and Abitibi-Consolidated, Inc.)

Water is also withdrawn from the lakes for domestic water supply by an unknown number of lakeshore households and small resorts. Although the exact number of individual household users and quantity of water they use has not been quantified, it is a very common practice based upon discussions with representatives of various water resource agencies in the region. Data on small resorts using water from Rainy Lake was obtained and is described below in **Table 25**.

Table 25: Resorts Withdrawing Water from Rainy and Namakan Lakes

Entity	Purpose	Yearly Withdrawal Limit
RAINY LAKE		
a. Year-round resorts		
Island View Lodge	Resort	5.45
Thunderbird Lodge	Resort	5.53
Rainy Lake Lodge	Resort	1.51*
b. Seasonal resorts		
Camp Koochiching	Resort	1.74 (June-August)
Camp Idlewood	Resort	1.70 (May-September)
Sha Sha Resort	Resort	1.89 (May-September)
NAMAKAN LAKE		
None identified		

(Notes: The Rainy Lake Lodge only withdraws lake water from June-September, well water is used at other times. The source of this data is the Minnesota Department of Health)

3.5.2 Effects of Proposed Rule Curve Changes

Based on information presented in the Rainy Lake and Namakan Reservoir Water Level International Steering Committee's "Final Report and Recommendations (November, 1993)", water intake lines would only be disturbed under conditions of "extreme" drawdown. This has been confirmed based on discussions with local regulatory agencies and others involved with water withdrawals from the lakes. Since none of the alternatives involve this level of fluctuation, no further analysis of this potentially negative effect has been made.

There might be a slight negative effect that may be encountered with many of the proposed alternatives during the summer months. Since many of these alternatives result in lower lake levels during these months, the hydraulic head would be slightly lower on all of the pumps used by the various water users around the lakes. This could reduce the efficiency of the pumps and involve a slight increase in the cost of electricity required to run the pumps to withdraw the same amount of water.

Based on conditions encountered during the extreme low water conditions that occurred in 1998, there is another potential negative effect that may be exacerbated by alternatives that produce lower water levels than are presently experienced. In 1998, record low water conditions on Rainy Lake allowed damage to occur to the exposed lake withdrawal pipes for many of the smaller water users. Most of these users designed their systems to operate successfully throughout the range of normal water level fluctuations that might occur. Following the record low water conditions that occurred during the summer of 1998, ice formed on the lakes in the late fall and encapsulated many of the water lines in ice. Under normal water conditions, these lines would have been well below the level where the ice forms. In addition, there was an early snowfall that subsequently melted and resulted in an unusual snowmelt runoff of greater than 3 inches. As the lake levels increased due to this runoff, the lifting of the ice caused damage to the encapsulated water lines.

While the primary emphasis in this report is on the area upstream from the Rainy Lake Dam, there are also areas on the Rainy River downstream of the dam that might be affected by some of these changes. For example, the water intake for the town of Emo, and the intake to the Rainy River First Nations Sturgeon hatchery both experienced problems in 1998 due to unusually low river levels resulting from dry weather. The town of Emo added a low water intake elbow in October, 1998 which should solve their problems in the future should similar conditions occur. The sturgeon hatchery is still vulnerable, as the intake to the wet well was exposed and dry for a period of several months in 1998 and a temporary floating pump started to suck mud and had to be shut down. A well was drilled as an alternative supply, but it does not have the capacity desired for flow-through operation and water must be recycled. Disease and die-off of the fish stocks resulted because of water filtration and purification problems.

3.6 COMMERCIAL FISHING

3.6.1 Background

3.6.1.1 Rainy Lake

In 1996, there were four commercial fishing operations on six commercial fishing lots in the Ontario waters of Rainy Lake. Whitefish, northern pike, walleye, and recently, black crappie are the main species in the commercial fishery since the 1920s. All are under quota management since 1984. Fish are harvested in Ontario with gill nets and trap nets, with unlimited quotas available for course fish, including suckers, lake herring (cisco), bullhead, burbot, and mooneye. The commercial harvest of walleye was reduced by 97% from 1986 to 1996 through government buy-outs and trades for individual species quotas. Lake whitefish comprise the majority of the harvest, representing 53% of the total commercial catch in 1996, and 43% of the catch since 1990. The annual commercial catch of all fish species, including course fish, has averaged 49,700 kg per year for this same period. Commercial sport fish harvest on the Minnesota side of Rainy Lake was gradually reduced by gear restrictions and then eliminated with a legislative buy-out in 1985. There remains one commercial fishing operation that uses gill nets to harvest 17,100 kg per year of whitefish on the Minnesota side, south of Brule Narrows.

As described above in **Section 3.3**, it has been estimated that the Rainy Lake fishery generated approximately US$5.7 million (1990 dollars) in total gross revenues in the local area. US$1.15 million of this was in Ontario, and US$4.55 million was in Minnesota. Of these revenues, about US$92,650 were from commercial fishing in Ontario, and US$17,000 in Minnesota. Commercial fish production in Minnesota from Rainy Lake was 17,440kg in 1989, and was valued at about US$17,260. The 1989 Ontario commercial harvest from Rainy Lake had an estimated dockside value of US$92,990, based on a total quota of 54,500 kg of walleye, northern pike, crappie, whitefish, and sturgeon. This value has declined since 1989 with reduced levels of harvest. Whitefish accounted for all commercial fishing gross revenues in Minnesota. Less than 2% of the total Rainy Lake fisheries revenues are produced by the commercial fishery.

In the future, commercial fishing in the U.S. and Canada on both lakes will probably stay the same or decline, particularly for species such as walleye. This is because fisheries agencies such as the Ontario Ministry of Natural Resources have been actively purchasing fishing quotas and/or licenses since 1986 on a "willing seller" basis. The management intent in Ontario on Rainy Lake is to reduce the commercial walleye quota to zero, while maintaining a commercial fishing industry that is based primarily on whitefish, northern pike, and crappie. No changes are anticipated, with regard to commercial fishing, on the Minnesota side. It is expected that domestic consumption by aboriginal people will increase, as their population increases.

Any potential improvement in the fishery on the lakes could have a positive effect on the commercial fishing industry. However, because of the quotas that have been imposed by regulatory agencies on the harvest of several species, it is uncertain whether an improvement in the fishery would translate directly to an improvement in the commercial fishing industry. Positive impacts to navigation, such as raising the spring water levels with several of the alternatives, would also probably have a positive effect on commercial fishing. Conversely, negative changes such as lower summer lake levels that result from several alternatives may have a negative impact to commercial fishing as well. Overall, impacts to commercial fishing that would result from implementation of any of the rule curve alternatives are small.

3.6.1.2 Namakan Lake

Commercial fishing on Namakan Lake began in 1916-17. However, with the growth of the tourist trade, commercial fishing for walleye and northern pike was eliminated on Minnesota waters in 1946. One licensed commercial operator in Minnesota has fished the Minnesota side of the lake for lake whitefish. Ontario also currently licenses one commercial fisherman for Namakan Lake. In recent years, the commercial harvest under this license has approached, or met, established quotas for walleye, northern pike, lake whitefish, and sturgeon.

The Namakan Lake fishery generates approximately US$3.0 million gross revenue (1990 dollars) annually to the local area. Tourists who fish on Namakan Lake contribute most of this revenue. About 1% (US$30,000) of the total fisheries revenues are produced by the commercial fishery. Whitefish account for 33% of the gross revenues from commercial fishing, followed by walleye (25%). It has been estimated that the commercial fishery generates approximately four jobs.

3.6.2 Effects of Proposed Rule Curve Changes

The effects of the proposed rule curve changes have a wide range of different effects on commercial fishing on the lakes. First, it should be reiterated that the level of commercial fishing is either stable, or on the decline, depending upon what lake and fish species is being considered. Second, the magnitude of the gross revenues for commercial fishing relative to tourist fishing is very small.

One of the goals under the F1-SC alternative and many of the others was to begin refilling the lakes earlier in the spring in order to provide better access to boat docks and improved navigation near the start of the fishing season. This would have a beneficial effect on commercial fishing, because it would allow earlier access to the docks and many areas of the lakes as well. It is also theorized in this report and others that higher spring water levels would result in an improvement in the quality of the fishery on both lakes. If this is true, it would also result in a direct benefit to the commercial fishing industry. However, it should also be noted that the benefits might be limited due to quotas and restrictions that already exist in this industry.

Another trend that can be observed through most of the alternatives evaluated in this report is slightly lower lake levels during the summer months. This is proposed for several reasons such as aquatic and wildlife habitat improvement, reduced erosion, and better beach access. Similar to the tourist fishing industry, it seems that depending upon the amount the lake levels were lowered, it could have an overall negative impact on commercial fishing due to problems such as navigation and dock access.

A third trend that can be seen in the proposed alternatives that might have an effect on commercial fishing is a reduced overwinter drawdown compared to the existing operation. Since this is not the season for commercial fishing, it is not expected that this change would have a direct effect on this industry.

3.7 EROSION DAMAGES

3.7.1 Background

Erosion and damage to shoreline development is known to occur throughout the area, especially under conditions of high water in conjunction with strong winds. The November 1993 International Steering Committee report notes that shoreline erosion is especially problematic on the south shore of Sand Bay on Rainy Lake. However, discussions with representatives of local Soil and Water Conservation Districts in Koochiching and St. Louis counties did not indicate that there were a lot of requests from homeowners around Rainy Lake for assistance on erosion control projects. This finding is confirmed by the fact that shoreline erosion was reported as a significant concern by only a small number of respondents to a damage survey done by the International Steering Committee. Many residents have built breakwaters or have riprapped the shoreline to reduce damages.

Another consideration in this resource category is the fact that archaeological surveys conducted along these lakes have shown that there are numerous prehistoric and historic Indian cultural sites located along the shorelines. Information provided in the International Steering Committee Report indicates that about 75 % of the sites have been partially or totally destroyed by the rise in lake levels resulting from the construction of the dams.

3.7.2 Effects of Proposed Rule Curve Changes

It would be difficult to quantify shoreline damages with existing information, since there is no inventory of lakeshore characteristics, and the degradation by wave action is not included in the water level modeling effort. Qualitative differences, based on the expected number of days of high water, could be made. However, as stated in the previous section, discussions with representatives of the local Soil and Water Conservation Districts did not indicate a major problem with erosion. Damage to shoreline property, such as docks and boathouses, has already been treated in the Flood Damages category above using a similar analytical approach.

It is known that shoreline and archeological resources may be eroded due to high water levels in combination with high winds that may occur from summer storms. The levels at which such damage is estimated to commence are estimated to be within the range of 337.75 meters to 337.90 meters on Rainy Lake, and 340.95 meters to 341.10 meters. The existing IJC rule curves call for both Rainy and Namakan lakes to fill gradually until early July, and then for water levels to remain high throughout the summer and early fall. These levels are between 337.54 meters and 337.75 meters on Rainy Lake, and between 340.71 meters and 340.83 meters on Namakan Lake.

Although there are some archaeological and residential sites located around the shoreline that might be affected by erosion, no major additional problems with erosion were identified with any of the alternatives evaluated. As shown in **Tables 22 and 23**, the changes to water levels proposed in most of the alternatives are not thought to have a big effect in the area of erosion. However, in all of the alternatives except C1 (which has a very slight increase compared to F1-IJC), there is a slight decrease in the average lake elevations at both Rainy and Namakan lakes during the summer months. For example, on Rainy Lake, all of the alternatives are within 0.06 meters of each other in July, within 0.14 meters in August, and within 0.22 meters in September. On Namakan Lake, there are consistently lower water levels, ranging up to 0.25 meters lower in July through September. Another consideration in evaluating the impacts of these alternatives on erosion is the rate of change in the lake levels. Alternatives that tend to draw the lakes down more rapidly may also increase erosion due to slumping of the banks and steeper shoreline areas around the lake that are not rock, such as the black Bay area. For example, Alternative F1-IJC results in fairly stable lake levels at both lakes during the summer period from July through September. Conversely, all of the other alternatives (except C1 on Rainy Lake) tend to fill the lakes in June or July and then draw them down by as much as 0.28 meters by September.

3.8 NATIVE AMERICAN TRANSPORTATION

3.8.1 Background

The effects of the regulation of Namakan Lake at Kettle Falls and Squirrel Falls extend upstream to the Loon Portage on the Loon River, a tributary to Namakan Reservoir. People of the Lac La Croix First Nation, tourism businesses, and recreationists use the Loon River for navigation between Crane and Sand Point lakes and isolated parts of the upper watershed on Loon Lake and Lac La Croix. The people of the Lac La Croix First Nation travel this route for personal, business, and recreational reasons. They have indicated to the International Steering Committee that restriction of boat access via the Loon River affects their livelihood, their safety with regard to medical emergencies, and their cost of living. The movement of anglers upstream to the Lac La Croix tourism resorts from Crane Lake is also important to their livelihood. This is because a majority of the men in the Lac La Croix First Nation are employed as fishing guides at these resorts.

Springtime navigation by boat and motor up the Loon River is difficult until Namakan Lake reaches elevation 340.5 meters above sea level, as measured at the Kettle Falls Dam. Under the existing rule curve, this water level is not attained until the second or third week of June. The navigation problems are most critical at Loon Narrows, where there are extensive mud flats, and at an area known as “56 Rapids”, which is another mile and a half (2 kilometers) upstream. Passage is difficult at “56 Rapids” until the water level reaches an elevation of 340.5 meters, after which the rapids can be run, unless river flow is low due to drought conditions.

3.8.2 Effects of Proposed Rule Curve Changes

As stated above, the critical water level for navigation by the people of the Lac La Croix First Nation appears to be elevation 340.5 meters, as measured at the Kettle Falls Dam. Under the existing rule curve, this elevation is typically not attained until the second or third week of June. Review of data from the REGUSE model for the other alternatives shows that the proposed rule curves, under Alternatives F1-SC, C1 and M1, result in Namakan Lake attaining the critical navigation elevation of 340.5 meters. about two to four weeks earlier than it would have under the existing rule curves (F1-IJC). This elevation is generally attained by about the middle of May under these alternatives rather than early to mid-June. Data showing the percentage of time each year the reservoir is at, or above this elevation for the various alternatives is shown in **Table 26**.

Table 26: Namakan Lake – Percentage of Time Lake Level Exceeds Elevation 340.5 Meters, Alternatives

Base Alternative	Time Exceeded (%)	Comparison Alternative	Time Exceeded (%)	Difference (%)
F1-IJC	36	F1-SC	36	0
		C1	35	-2.78
		M1	35	-2.78

Water-based transportation by Native Americans is expected to be improved under the proposed rule curve. This improvement is based on expected increases in spring water levels, allowing easier access to and from tributary lakes and rivers in the upper reaches of the basin.

Table 27 shows the percentage of time each year that Namakan Lake is at, or above this elevation for the various operating policy variants. This table shows that the variability of Alternative F1-IJC ranges from a 2.8% reduction in the amount of time that the lake is above the desired elevation of 340.5 meters for operating variant F4-IJC, to an 8.3% reduction for operating variant F5-IJC. The variability of Alternative F1-SC ranges from no reduction in the amount of time that the lake is above the desired elevation of 340.5 meters for operating variant F4-SC, to a 33.3% reduction for operating variant F5-SC.

Table 27: Namakan Lake – Percentage of Time Lake Level Exceeds Elevation 340.5 Meters, Operating Policy Variants

Base Alternative	Time Exceeded (%)	Comparison Alternative	Time Exceeded (%)	Difference (%)
F1-IJC	36	F4-IJC	35	-2.78
		F5-IJC	33	-8.33
F1-SC	36	F4-SC	36	0
		F5-SC	24	-33.33

3.9 Wild Rice Harvest

3.9.1 Background

Wild rice is an important renewable resource which grows in the shallow portions (water depth of less than 1.2 m.) of freshwater lakes and slow moving rivers. In addition to its commercial value, the harvest of wild rice has been an important part of the cultural and social activity of Aboriginal Peoples in Ontario as well as Native Americans in Minnesota.

The bays and inlets of Rainy Lake serve as one of the major wild rice growing areas within the region. The total available crop of wild rice varies widely from year to year, depending upon fluctuations in water levels and the weather.

The harvesting of wild rice is mostly carried out with harvest methods including mechanical harvesters as well as manually with canoe and flail. Although the use of mechanical harvesters is slowly increasing, canoe and flail is still the most common method of harvest. It should be noted that the average harvesting efficiency of mechanical harvesters is relatively low, at about 10-15 % of the total available crop.

Wild rice is a high value crop, and the product is a specialty item for which premium prices are paid. With the expanding popularity of wild rice, competition between buyers has increased and all available harvest has typically been purchased.

It is known that in order to achieve optimum production of the wild rice, there are several characteristics that are desirable in terms of lake levels. In the spring, an early rise in the lake levels can drown out the wild rice, therefore a more gradual rise is beneficial to encourage growth. Once the wild rice has gotten established, periodically variable water level conditions are desirable to reduce weed concentrations where the wild rice is grown. Another desirable characteristic is high enough water levels in the fall when the rice is harvested to allow access.

An attempt was made to get information on the economic value of the wild rice harvest in the U.S. and Canada, however, only a very limited amount of information was available, and just for Canada. In general terms, it is known that in good crop years, a good portion of the income for some of the native peoples comes from rice harvesting. As stated above, it is also an important part of their cultural and social activity.

3.9.2 Effects of Proposed Rule Curve Changes

As part of the development of the proposed SC rule curves, a single purpose optimization curve for wild rice was developed. All of the rule curve alternatives evaluated in this report, including the existing IJC rule curves, produce water levels that are as much as two feet higher through the late spring and summer months that the optimized single purpose wild rice curve presented in the Steering Committee's report.

Lower absolute water levels, combined with slowly rising water levels, are critical in the spring and early summer to promote growth to avoid drowning and uprooting of the plants during the floating leaf stage. In this regard, Alternative F1-SC may be most advantageous of all the alternatives for Rainy Lake, since it produces the earliest spring rise followed by slowly declining levels beginning in June at the time when the floating leaf stage is most active. Under Alternatives F1-IJC, C1 and M1 Rainy lake levels continue to rise through the end of June, increasing the potential for uprooting the young plants during the floating leaf stage.

Since all of the alternatives investigated as a part of this analysis result in higher water levels during the spring compared to the existing operation, they would all have a negative effect during this period in terms of wild rice growth.

Another consideration is that Alternatives F1-SC and M1 evaluated in this report result in mostly lower water levels during the summer months compared to Alternative C1 and the existing condition (F1-IJC). According to the optimized single purpose wild rice curve presented in the Steering Committee Report above, it is desirable to have lower water levels during this period, as long as water levels are adequate to allow access for harvesting in the fall. From this standpoint, the operation under Alternatives F1-SC and M1 would be beneficial for wild rice as compared to Alternatives F1-IJC and M1.

In summary, the optimized single purpose rule curve for wild rice production would require major changes to the operation of the lake, and would probably result in significant effects in other categories. Overall, compared to the Base Case condition (F1-IJC), it appears that Alternative F1-SC provides positive benefits to wild rice, while Alternatives C1 and M1 maintain the status quo.

4. SUMMARY

The results of this analysis have shown that the effects of the proposed changes in the existing rule curves for Namakan and Rainy lakes will vary widely depending on the alternative and resource category being considered. There are significant negative effects in some categories, and beneficial effects in others. To the extent possible, quantitative analysis was performed to estimate the effects; however, this was not possible in all categories being considered. The overall effects in each of the resource categories are summarized in the sections that follow.

4.1 SOCIOECONOMIC PROFILE

The area surrounding Rainy and Namakan lakes is well established as a destination for a wide range of outdoor recreation pursuits. In order to better understand the broader economic and social characteristics of the region, and their possible sensitivity to issues involved with potential changes to levels and flows on Rainy and Namakan lakes and adjoining waters, these characteristics are summarized in the next two sections. The socioeconomic profile information is provided for the surrounding area in the United States, followed by the surrounding area in Canada.

4.1.1 Rainy Lake and Surrounding Area in the United States

Socioeconomic information was obtained for the City of International Falls, Minnesota and the surrounding Koochiching County. These areas were selected because they represent the major population and economic center adjacent to the lakes in the U.S. International Falls is the major center for government services in the region and plays a pivotal role in the trading area that contributes significantly to the local economy. It is also a major point of entry into the U.S., on the border of the Province of Ontario and the State of Minnesota. Koochiching County extends from near the town of Rainy River on the west, to Voyageurs National Park on the east.

In 1990 the population of International Falls was 8,325 and the population of the surrounding Koochiching County was 16,292. The population trends in the area show a population increase since 1980 of about 48% in International Falls, and a population decrease of about 7.8% in Koochiching County. The 1993 unemployment rate was 5.3% for International Falls, and 10.9% for Koochiching County. There were 6,506 workers in the Koochiching County labor force in 1993, and this is projected to decline by 15.5% by the year 2020. The major employer in the county is the pulp and paper mill owned by Boise Cascade Corporation, with about 1,200 employees, followed by the International Falls School District and United Health Care, with about 300 employees each.

4.1.2 Rainy River District and Surrounding Area in Canada

Information was gathered for the Town of Fort Frances, Ontario, and the surrounding area, which is known as the Rainy River District. These areas were selected because they represent the major population and economic centre adjacent to the lakes in Canada. They were also selected because they were the primary areas for which socioeconomic data was available in the region.

Fort Frances is the major centre for government services in the region and plays a pivotal role in the trading area that contributes significantly to the local economy. It is also a major point of entry into Canada, on the border of the Province of Ontario and the State of Minnesota. The Rainy River District is a large region that extends from the town of Rainy River on the west, to the eastern edge of Quetico Provincial Park on the east, and from Nestor Falls on the north, to the border between Canada and the U.S. on the south.

The 1990 population of Fort Frances was 8,891, and for the Rainy River District it was 22,997. The population of Fort Frances has been relatively stable, fluctuating around 9,000 people from 1976 to 1990. The unemployment rate is 10.1% in Fort Frances, which is slightly higher than the unemployment rate of 9.9% in the Rainy River District. The total labor force in Fort Frances was 4,570 in 1991. The major employer in Fort Frances is the pulp and paper mill owned by Abitibi-Consolidated, Incorporated, which has about 900 employees. The next largest employer is the Rainy River Board of Education, with about 450 employees.

Together, the towns of Fort Frances and International Falls provide a broad spectrum of facilities, services, and activities that enhance the potential for economic development in the region.

4.2 HYDROPOWER

The hydropower projects that would be affected by the alternatives evaluated in this report are located at the site of the International Dam at the outlet of Rainy Lake on the U.S./Canadian Border between Fort Frances, Ontario, and International Falls, Minnesota. The Canadian power plant, owned and operated by Abitibi-Consolidated Incorporated, has a total generating capacity of 12.8 MW, with an average annual generation of 59,800 MWh. The U.S. power plant, owned and operated by Boise Cascade Corporation under FERC license #5223, has a total generating capacity of 11.3 MW, with an average annual generation of 67,200 MWh. The value of power produced by both plants is US$5.1 million per annum.

The power generated by these power plants is used to supplement the power needs of the two pulp and paper mills. Because the demand for power from both of these plants exceeds their power generating capability at all times, all of the energy that can be generated is of value in reducing their reliance on outside sources of power. On an annual average basis, these hydropower projects supply about 10% of the total power required to run the plants.

The hydropower economic analysis was accomplished using data generated by the REGUSE model runs for the period 1958-1996. This data, combined with pricing information to determine the cost of replacement energy purchased from local utilities, was used to determine the total power cost associated with the lost generation for the various alternatives.

When compared to the existing rule curves, all of the alternatives result in a decrease in hydropower energy production, particularly in the winter months when it is most costly to replace. The average annual energy produced by both plants under the existing rule curves (Alternative F1-IJC) is about 121,700 MWh. The average annual decrease in energy produced by the plants is 2,400 MWh under Alternative C1, 5,900 MWh under Alternative M1 and 9,000 MWh under Alternative F1-SC. The additional yearly average cost of replacing this power is US$114,000 under Alternative C1, US$261,000 under Alternative M1 and US$376,000 under Alternative F1-SC. These costs could vary significantly in individual years depending on water conditions and future power replacement costs.

4.3 FLOOD DAMAGES

The flood damage analysis employed a conventional approach to assessing damages based on developing elevation-damage relationships and determining flood damages based on historical flood levels. Two primary types of data were used in performing this analysis. The first was estimates of annual flooding, which were based on simulated water levels obtained from simulations conducted by Environment Canada using the "REGUSE" computer model for the years 1958-1996 and 1950. The second type of data was elevation-damage relationships that were used to determine the damages associated with different levels of flooding.

Annual damages were calculated for each of the years 1958-1996, and separately for the large flood event experienced in 1950. Average annual damages were calculated for the 1958-1996 period for the four rule curve alternatives evaluated using a simple arithmetic average of the annual values. The 1950 event was not included in the average because it is not representative of the period modeled, but is representative of a much longer time period. The 1950 event produced almost 19 times as much damage as the total damages produced by all the floods in the 1958-1996 period. Examination of the 1950 event is useful to provide insight into the potential for increased flood damages under the various alternatives for an extreme event.

Elevation-damage data was obtained from a previous assessment of flood damage potential on the Rainy/Namakan Lake System, which was completed in July 1993 by Acres International Limited under contract to Boise Cascade Corporation. At the request of the Corps of Engineers, Acres International provided additional information about the nature of the flood damage estimates to supplement what was used in their previous analysis. This new information provides an insight into the types of damage that occur at any given elevation, and demonstrates the relative importance of each damage category in comparison to the whole for any level of flooding. Damage categories considered in the analysis include: docks, shops/ sheds/ pumps, offices/showrooms, commercial lodges/cabins/parking lots, and private cottages/residences. Additionally, the zero-damage elevation for each damage category is identified. Interviews conducted by the Corps of Engineers with local officials suggest that the zero damage points identified by the ACRES study are consistent with the personal experiences of lakeshore residents.

All of the alternatives evaluated resulted in increased flood damages when compared to the existing condition (F1-IJC). Flood damages occur for all of the alternatives in about 20% of the years in the 1958-96 period of record analyzed. The average annual flood damages for the 1958-96 simulation period are US$15,066 for the Base Case condition (F1-IJC), US$21,260 for Alternative C1, US$21,324 for Alternative M1 and US$23,450 for the rule curves proposed by the International Steering Committee (F1-SC). The damages estimated for the 1950 event under Alternative F1-IJC were US$11 million, US$13.5 million under Alternatives C1 and M1 and US$13.8 million under Alternative F1-SC.

4.4 RECREATION-TOURISM

Tourism based on the fishery generates a substantial economic benefit to the region surrounding Rainy and Namakan lakes. It is estimated that tourism based on Rainy Lake is responsible for approximately 250 full or part-time jobs at 24 tourist establishments on the Minnesota side of the lake, and another 58 jobs and 22 tourist operations on the Ontario side of the lake. The fishery generated approximately $5.7 million (US$ 1990) per annum in gross revenues in the local area surrounding Rainy Lake (US$1.15 million in Ontario, and US$4.55 million in Minnesota).

For Namakan Lake, it is estimated that approximately 113 full or part-time jobs are generated by tourist anglers. Additionally, there are 47 tourist establishments on the Minnesota side of the lake, and 2 tourist establishments on the Ontario side of the lake that rely on the Namakan Lake fishery. The fishery generated approximately $3 million (US$1990) in gross revenues to the local area. Most of this revenue is contributed by tourists who fish on Namakan Lake. Less than 1% of the total revenues are produced by the commercial fishery. In comparison to the combined Rainy-Namakan fishery which generated an estimated US$8.7 million in economic activity in 1990, the fishery in nearby Lake of the Woods generated an estimated Cdn$54.3 million (US$46.2 million) in economic activity in 1990.

There are a number of recent studies estimating recreational use in the area, prepared by the National Park Service and agencies within Minnesota and Ontario. The National Park Service reports annual visitation for Voyageurs National Park (VNP), which includes most of Rainy Lake and the Namakan chain of lakes. The number of recreation visits rose from 164,000 in 1983 to a high of 245,000 in 1990, and remained around 240,000 to 245,000 through 1994. The number of fishing visits averaged around 130,000 annually during the first half of the 1990's, and the number of persons on houseboats averaged 27,000 annually. Most of the visits occurred between May and September.

The Minnesota Department of Natural Resources has conducted creel surveys on these lakes regularly since 1983. The 1994 (summer season) survey recorded 67,000 angler trips on Kabetogama Lake, 22,000 angler trips on Namakan Lake, and 34,000 angler trips on Rainy Lake. This amounts to 123,000 total angler trips, and equates to approximately 500,000 angler hours. Most of the anglers on Kabetogama Lake and Namakan Lake were non-local Minnesota residents, whereas most anglers on Rainy Lake (Minnesota waters) were local Minnesota residents. A 1985 MDNR regional survey of the Edge-of the-Wilderness Area (including VNP and the Boundary Waters Canoe Area) estimated regional fishing hours at 21 million. Rainy Lake and the Namakan chain therefore accounts for roughly 2.3 % of regional fishing activity.

Although the fishery information presented is the most recent information available, it is thought to be a conservative estimate of the revenues, since this data is somewhat dated, and tourism has continued to increase in the area. Postulation of potential future impacts resulting from adoption of any rule curve alternative is highly subjective, and dependent upon forecasting future trends and reliance on an information base by sectoral components that is not available. For these reasons, impacts of changes in the rule curves on recreation and tourism were not quantified. The International Steering Committee had estimated annual benefits of $800,000 to the fishery/tourism sector if the SC curves were implemented because of the earlier spring rise and an increased number of sports fishermen that would utilize the tourist facilities available. This number cannot be confirmed based on the information available, but is felt to represent the upper possible limit of possible economic benefits. However, an attempt was made to give a qualitative assessment of the potential changes that might result from the adoption of these proposed alternatives compared to the existing condition.

The effects in this resource category are mixed depending on the time of the year. Higher spring water levels that may result from many of the alternatives would be beneficial to the fishery, according to fisheries experts. Higher levels would also allow navigation and access to boat docks closer to the start of the fishing season opening, which would have a positive effect on tourism. Examples of alternatives that would result in higher spring water levels include F1-SC on Rainy and Namakan lakes, as well as C1 and M1 on Namakan Lake. Reduction of the winter drawdown on Namakan Lake under most of the alternatives provides positive benefits to the fishery and would indirectly benefit tourism. During the summer months, many of the alternatives result in slowly declining lake levels, which might have a negative effect on tourism due to potential problems with navigation and access to some areas. Examples of alternatives that result in slowly declining lake levels include F1-SC and M1 at both Rainy and Namakan lakes, and C1 on Namakan Lake.

4.5 Recreation-Navigation

Both Rainy and Namakan lakes are used extensively for navigation, primarily for recreational use such as boating and fishing. Namakan Lake is also used on a limited basis as a transportation route for personal, business, and recreational use, particularly by Native Americans. Historically, the lakes have also been used for the booming of logs and navigation of large tugboats through shallow channels and bays. However, this practice ceased in the mid-1970s, and is no longer a relevant factor.

On Rainy Lake, the elevation on which all navigation charts are based is 337.4 meters. On Namakan Lake, information obtained from the Lac La Croix First Nation, area residents, and tourist operators on Sand Point and Crane lakes suggests that the rule curve should not go below 340.5 meters during the navigation season from about May through September.

The effects in this resource category are similar to those in tourism and can only be defined qualitatively. Higher spring water levels would be beneficial for navigation early in the season. However, lower late summer levels would potentially have a negative effect on navigation by limiting access to the shallower areas of both lakes, particularly by sailboat.

Regarding early spring water levels, F1-SC is the only alternative that provides average May water levels greater than 337.4 meters on Rainy Lake. Average May water levels under Alternatives F1-IJC, C1, and M1 are slightly below 337.4 meters on Rainy Lake. None of the alternatives provide average May water levels up to the desired level of 340.5 meters on Namakan Lake. However, all of the alternatives except F1-IJC are relatively close to the desired level.

Regarding late summer water levels, all of the alternatives provided water levels greater than 337.4 meters on Rainy Lake and 340.5 meters on Namakan Lake, except for Alternative F1-SC on Rainy Lake, which provided average September water levels just slightly below 337.4 meters. Alternatives F1-IJC and C1 provided the highest average September Rainy Lake levels, while Alternative F1-IJC provided the highest average September Namakan Lake levels.

4.6 WATER SUPPLY

Water is withdrawn from Rainy and Namakan lakes for both commercial and private water supply uses. Permits are required for larger users (those withdrawing over about 3.8 million litres per year), while smaller users are not required to have a permit. The holders of these permits for larger water supply withdrawals include the City of International Falls, Minnesota and Boise Cascade Corporation in the U.S. and the Town of Fort Frances, Ontario and Abitibi-Consolidated Incorporated in Canada. No commercial water users have been identified on Namakan Lake. Water is also withdrawn from both lakes for domestic water supply by an unknown number of lakeshore households and small year-round and seasonal resorts. There are only two year-round resorts on Rainy Lake that have an average annual withdrawal large enough to require a permit.

Water intakes on both lakes would primarily be affected only in conditions of extreme drawdown. Since none of the alternatives evaluated result in this type of drawdown, there would not be an effect. However, slightly lower lake levels do result from many of the alternatives during the summer months when the majority of the water supply withdrawals are made. Lower lake levels would reduce the head on the pumps of all of these users, which would reduce the efficiency of the pumps and increase the cost of electricity required to pump the water. The magnitude of these changes is expected to be fairly small.

4.7 COMMERCIAL FISHING

In 1996, there were four commercial fishing operations on six commercial fishing lots in the Ontario part of Rainy Lake. Whitefish, northern pike, walleye, and recently black crappie are the main species in the commercial fishery since the 1920s. All are under quota management since 1984. Unlimited quotas are available for coarse fish, including suckers, lake herring (cisco), bullhead, burbot, and mooneye.

The commercial harvest of walleye was reduced by 97% from 1986 to 1996 through government buy-outs and trades for individual species quotas. Lake whitefish comprise the majority of the harvest, representing 53% of the total commercial catch in 1996, and 43% of the catch since 1990. The annual commercial catch of all fish species, including coarse fish, has averaged 49,700 kg per year for this same period.

Commercial sport fish harvest on the Minnesota side of Rainy Lake was gradually reduced by gear restrictions and then reduced significantly with a legislative buy-out in 1985. There remains one commercial fishing operation that uses gill nets to harvest an average of about 17,000-kg per year of whitefish south of Brule Narrows.

The commercial fishery was valued at US$92,650 in Ontario, and US$17,000 in Minnesota. Commercial fish production from Rainy Lake was 17,440 kg in 1989, and was valued at about US$17,260. The 1989 Ontario commercial harvest from Rainy Lake had an estimated dockside value of US$92,990, based on a total quota of 54,500 kg of walleye, northern pike, crappie, whitefish, and sturgeon. This value has declined since 1989 with reduced levels of harvest.

Whitefish accounted for all commercial fishing gross revenues in Minnesota. Less than 2% of the total Rainy Lake fisheries revenues are produced by the commercial fishery.

Commercial fishing on Namakan Lake began in 1916-17. However, with the growth of the tourist trade, commercial fishing for walleye and northern pike was eliminated on Minnesota waters in 1946. Currently, there are two licensed commercial operators on Namakan Lake, one in Minnesota and one in Ontario. About 1% (US$30,000) of the total Namakan fisheries revenues (US$3.0 million) are produced by the commercial fishery. Whitefish account for 33% of the gross revenues from commercial fishing, followed by walleye (25%). It has been estimated that the commercial fishery generates approximately four jobs.

In the future, commercial fishing in the U.S. and Canada on both lakes will probably stay the same or decline, particularly for species such as walleye. This is because fisheries agencies such as the Ontario Ministry of Natural Resources have been actively purchasing fishing quotas and/or licenses since 1986 on a “willing seller” basis. The management intent in Ontario on Rainy Lake is to reduce the commercial walleye quota to zero, while maintaining a commercial fishing industry that is based primarily on whitefish, northern pike, and crappie. No changes are anticipated, with regard to commercial fishing, on the Minnesota side. It is expected that domestic consumption by aboriginal people will increase, as their population increases.

Any potential improvement in the fishery on the lakes could have a positive effect on the commercial fishing industry. However, because of the quotas that have been imposed by regulatory agencies on the harvest of several species, it is uncertain whether an improvement in the fishery would translate directly to an improvement in the commercial fishing industry. Positive impacts to navigation, such as raising the spring water levels with several of the alternatives, would also probably have a positive effect on commercial fishing. Conversely, negative changes such as lower summer lake levels that result from several alternatives may have a negative impact to commercial fishing as well. Overall, impacts to commercial fishing that would result from implementation of any of the rule curve alternatives are small.

4.8 EROSION

Erosion and damage to shoreline development is known to occur throughout the area, especially under conditions of high water in conjunction with strong winds. Erosion is especially problematic on the south shore of Sand Bay on Rainy Lake. However, discussions with representatives of local Soil and Water Conservation Districts in Koochiching and St. Louis counties indicated that there were not a lot of requests from homeowners around Rainy Lake for assistance on erosion control projects. This finding is confirmed by the fact that shoreline erosion was reported as a significant concern by only a small number of respondents to a damage survey done by the International Steering Committee. Many residents have built breakwaters or have riprapped the shoreline to reduce damages.

Another consideration in this resource category is the fact that archaeological surveys conducted along these lakes have shown that there are numerous prehistoric and historic Indian cultural sites located along the shorelines. Information provided in the International Steering Committee Report indicates that about 75 % of the sites have been partially or totally destroyed by the rise in lake levels resulting from the construction of the dams. Although there are some archaeological and residential sites located around the shoreline that might be affected by erosion, no major additional problems with erosion were identified with any of the alternatives evaluated.

4.9 NATIVE AMERICAN TRANSPORTATION

The effects of the regulation of Namakan Lake at Kettle Falls and Squirrel Falls extend upstream to the Loon Portage on the Loon River, a tributary to Namakan Reservoir. People of the Lac La Croix First Nation, tourism businesses, and recreation interests use the Loon River for navigation between Crane and Sand Point lakes and isolated parts of the upper watershed on Loon Lake and Lac La Croix. The people of the Lac La Croix First Nation travel this route for personal, business, and recreational reasons. They have indicated to the International Steering Committee that restriction of boat access via the Loon River affects their livelihood, their safety with regard to medical emergencies, and their cost of living. The movement of anglers upstream to the Lac La Croix tourism resorts from Crane Lake is also important to their livelihood. This is because a majority of the men in the Lac La Croix First Nation are employed as fishing guides at these resorts.

Springtime navigation by boat and motor up the Loon River is difficult until Namakan Lake reaches elevation 340.5 meters above sea level, as measured at the Kettle Falls Dam. Under the existing rule curve, this water level is not attained until the second or third week of June. The navigation problems are most critical at Loon Narrows, where there are extensive mud flats, and at an area known as “56 Rapids”, which is another mile and a half (2 kilometers) upstream. Passage is difficult at “56 Rapids” until the water level reaches elevation 340.5 meters, after which the rapids can be run, unless river flow is low due to drought conditions.

Water-based transportation by Native Americans / First Nations is expected to be improved under Alternatives F1-SC, C1 and M1. This improvement is based on expected increases in spring water levels, allowing easier access to and from tributary lakes and rivers in the upper reaches of the basin.

4.10 WILD RICE

Wild rice is an important renewable resource which grows in the shallow portions (water depth of less than 1.2 meters) of freshwater lakes and slow moving rivers. In addition to its commercial value, the harvest of wild rice has been an important part of the cultural and social activity of Aboriginal Peoples in Ontario as well as Native Americans in Minnesota.

The bays and inlets of Rainy Lake serve as one of the major wild rice growing areas within the region. The total available crop of wild rice varies widely from year to year, depending upon fluctuations in water levels and the weather. Wild rice is a high value crop, and the product is a specialty item for which premium prices are paid. With the expanding popularity of wild rice, competition between buyers has increased and all available harvest has typically been purchased.

As part of the development of the proposed SC rule curves, a single purpose optimization curve for wild rice was developed. All of the rule curve alternatives evaluated in this report, including the existing IJC rule curves, produce water levels that are as much as two feet higher through the late spring and summer months than the optimized single purpose wild rice curve presented in the Steering Committee's report. Alternative F1-SC may be most advantageous of all the alternatives for Rainy Lake, since it produces the earliest spring rise followed by slowly declining levels beginning in June at the time when the floating leaf stage is most active. Under Alternatives F1-IJC, C1 and M1 Rainy lake levels continue to rise through the end of June, increasing the potential for uprooting the young plants during the floating leaf stage.

Overall, compared to the Base Case condition (F1-IJC), it appears that Alternative F1-SC provides positive benefits to wild rice, while Alternatives C1 and M1 maintain the status quo.

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