# WATER MANAGEMENT STRATEGIES
# FOR
# THE LOWER SEINE RIVER

by

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WATER MANAGEMENT STRATEGIES FOR THE LOWER SEINE RIVER

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## ABSTRACT

It is the concern of public interest groups and landowners along the lower Seine River that man made water control structures and excessive water withdrawals are contributing to persistent low summer flows and water levels in the lower Seine River. The shortage of water is leading to conflict among water users and having a negative impact on the river environment. This study addresses these concerns in the process of developing water management strategies to alleviate significant problems.

Public and professional consultation combined with the application of fundamental hydrological, hydraulic and resource management principles, were utilized to delineate and quantify problems and to develop water management strategies.

Analysis of flow records revealed that there has been a downward trend in summer flows at the Seine River
outlet since the early 1960's. Operation of the Seine River Diversion, a leaking inverted syphon, untimely water withdrawals and agricultural land development were found to be factors contributing this downward trend.

Recommendations include establishing a Seine Water Management Authority comprised of public, private and government representatives. This group would be responsible for implementing the water management strategies which include both supply and demand side management proposals.

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# CHAPTER I

# INTRODUCTION

## 1.0 PREAMBLE

Water has been described as the lifeblood of our environment. All forms of life, plant or animal, depend on water for survival (Canada, 1985). The management of water must therefore be carried out with the understanding that water is a fundamental component of any ecosystem (Dowdeswell, 1984).

Water management strategies vary depending on climatic conditions. The climate in Manitoba is such that we experience precipitation extremes which are cyclic in nature. Consequently, water management must deal with the impacts of both flooding and drought.

Within Manitoba, measures have been undertaken to alleviate the effects of these naturally occurring climatic events (WRB, 1988). This process frequently involves controlling river flows. For example, the Red River Floodway was constructed to protect the City of Winnipeg from damage caused by Red River flooding. To alleviate the impacts of drought, an extensive network of dams and storage reservoirs has been constructed throughout southern Manitoba (Whitney, 1990).

In the process of controlling water, water managers can have a pronounced influence on the water regime being manipulated. Reduced streamflow resulting from diversion of rivers causes changes in the ecology of the water body itself and to its riparian lands (Goldman et aI, 1973) One of the major criticisms of water management in Canada has been the failure to adequately address the impact that water manipulation has on other resources (Keating, 1986). The Rafferty Alameda project in Saskatchewan is a current example.

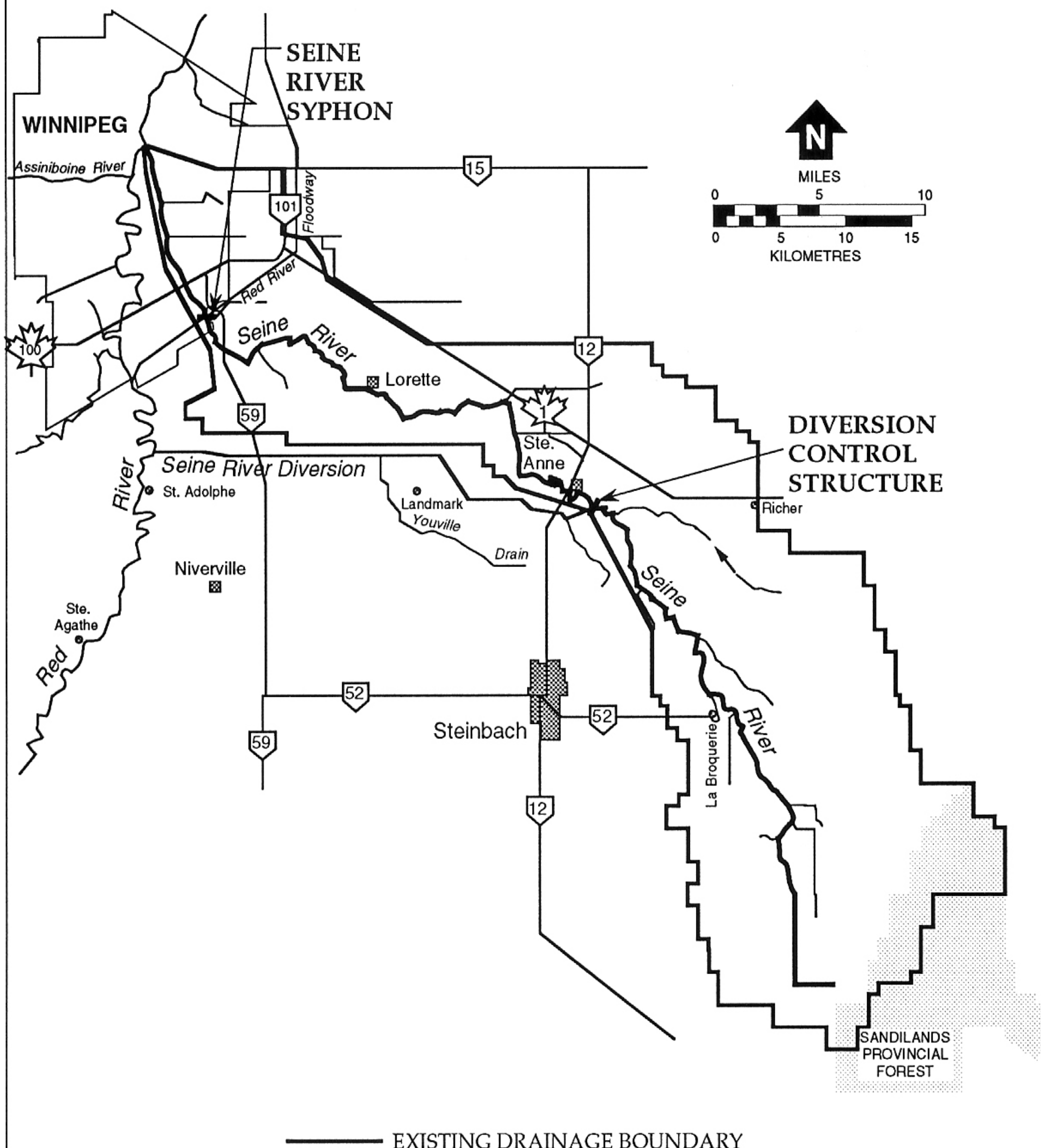
Typically, public concern over water issues increases during the wet and dry extremes (Canada, 1985). Such was the case during the late 1980's and 1990 when Manitoba experienced one of the most severe droughts since the thirties. It is during such a period that the effects of poor water management become apparent because when there is an adequate supply of water, the impact of pollutants can be diluted and water losses within the system can go unnoticed (SCSA, 1979). The Seine River, in southern Manitoba, did not escape public scrutiny during this most recent dry period.

## 1.1 BACKGROUND

The headwaters of the Seine River watershed are located in the vicinity of Marchand, a village situated approximately 95 kilometers southeast of Winnipeg. From this area the river flows in a northwesterly direction to join the Red River in Winnipeg, as shown in Figure 1.

The total existing drainage area of the Seine River at its outlet into the Red River is approximately 1470 square kilometers (Manitoba, 1974, Manitoba, 1976). During flood conditions, flows generated from the 967 square kilometer drainage area upstream of Ste. Anne, are diverted west into the Red River just north of Ste. Adolphe (WRB, 1964).

The 35 kilometer diversion, known as the Seine River Diversion, was constructed in 1960 to provide flood protection to Ste. Anne and the downstream communities. A gated control structure located just upstream of Ste. Anne regulates how much water




# SEINE RIVER STUDY AREA

Figure 1

goes down the diversion and how much continues down the Seine (WRB, 1961). Additional flood protection is provided to Winnipeg where the Red River Floodway intersects the Seine River. When the floodway was constructed an inverted syphon was installed under the floodway to allow flows of up to 4.3 cubic meters per second (ems) to continue down the Seine. Higher flows are diverted into the floodway by a series of culverts (Acres, 1978).

Construction of the Seine River Diversion and the installation of the inverted syphon enables water managers to control Seine River flows and thereby influence other resources such as wildlife and aquatic life which depend on the river for habitat and water. Consequently, proper operation and maintenance of these structures is essential if the needs of all resources are to be met.

## 1.2 PROBLEM DESCRIPTION

In the summer of 1990 significant public concern was expressed regarding what had been termed the "deplorable" condition of the Lower Seine River (from the Village of Ste. Anne downstream to the Red River). A Winnipeg resident group entitled "Save Our Seine" (S.O.S.) had been instrumental in bringing these views forward. The group was formed in early September, 1990 (S.O.S., 1990). Another S.O.S. group with similar concerns formed in Lorette, a village located on the Seine River approximately 10 river kilometers southeast of the Red River Floodway Formation of the Lorette group indicated that problems were surfacing in both the urban and the rural portions of the watershed.

Among the concerns of the S.O.S. organizations are the issues of water quantity and water quality. The groups' views on these issues were brought to the attention of city, provincial and federal government representatives at a public meeting organized by the S.O.S. on October 24,1990 (Fleming, 1990).

It is the opinion of the S.O.S., and many landowners along the Seine, that man-made water control structures are restricting the amount of water flowing in the river. Included among these structures are the Seine River Diversion control structure, the inverted syphon and a number of water retention weirs, some licensed and some not. The S.O.S. believes that water is being routed into the diversion when it should be allowed to continue downstream. They also believe that the inverted syphon is malfunctioning and that water which should be continuing down the Seine is leaking into the floodway.

The S.O.S. is also concerned that too much water is being withdrawn from the river to irrigate three golf courses bordering the Seine in the City of Winnipeg. The group contends that the overwithdrawal is leaving too little water to adequately maintain a healthy river environment (S.O.S. 1990).

Closely related to the problem of water quantity is the problem of water quality. Over the years the province has received a number of complaints regarding Seine River pollution. These complaints range from garbage dumping and chemical pollution to the release of untreated sewage into the river (S.O.S., 1990).

The combination of low river flows and poor water quality is having negative effect on the Lower Seine River environment. Although human manipulation over the water regime may be aggravating this situation, these problems have culminated during a severe drought.

Resolution of the water quantity problems along the Seine River has been hampered because the problems were not adequately identified or quantified. The Manitoba Department of Environment recently completed a water quality study on the Seine River but, until now, no studies have been conducted to address the low flow and low level problems.

**1.3 OBJECTIVES**

The purpose of this study was to develop water management strategies which minimize the negative impact that man-made water control structures and water withdrawals have on summer flows along the Lower Seine River (from the Village of Ste. Anne to the Red River). The study included, but was not limited to, achievement of the following objectives:

1. To assess the historical flow trends at the Seine River outlet and to determine the river's supply capabilities;

2 To establish the flow required to meet the biophysical needs of the river environment (in stream flow needs);

3. To determine the impact that withdrawals are having on flows;

4. To determine the impact that man-made water control structures are having on flows;

5. To work with the stakeholders in addressing their concerns, providing a mutually educational experience and sound recommendations; and

6. To develop water management strategies which provide for human use of water without jeopardizing the ability of the river to function as a natural ecosystem.

## 1.4 STUDY LIMITATIONS

The following limitations to this study should be noted:

1. It was not the intent of this study to assess the impact of low river flows on the biophysical resources dependent on the river for survival. Rather, it was assumed that significantly low flows would negatively impact such resources.

2. The degree to which summer flows could be expected to increase was limited by a number of factors including: technology (water cannot be manufactured), the natural flows of the river, and economics (money may not be available to undertake measures necessary to increase flows).

3. Preliminary designs and cost estimates were prepared for proposed structural measures, however, no attempt was made to quantify the economic benefits of such strategies.

# CHAPTER II

# A LITERATURE REVIEW OF WATER MANAGEMENT

## 2.0 INTRODUCTION

Since release of the Bruntland Report in 1985, many governments have displayed their interest in resource sustain ability (Canada, 1990). Sustainability is a prerequisite to survival and it is generally recognized that it must be achieved in fairly short order (Dorcey, 1990).

Water resources is considered by many to be one of the key areas of concern if sustainability is to be achieved (Bajard, 1990). The problems related to Canada's water are well articulated in a book by Keating (1986), and a book by Foster and Sewell (1981). Both of these publications express concern regarding the future availability of quality water in Canada.

## 2.1 WATER QUANTITY

The problems associated with low flows are not unique to the Seine River. In fact, water scarcity in the prairies is one of the issues consistently referred to in the literature. Yet studies show that residents of the Canadian prairies are the biggest water users in the country (Foster and Sewell, 1981, Canada, 1985, Tate, 1990). One of the reasons commonly cited for this paradox is that Canadians have a general misconception about the amount of water available for use in Canada (Canada, 1985, SCC 1988, McMillan, 1990).

Superficially it would appear that there is an abundant supply of water available for human use. Approximately 7.6 percent of Canada is covered by fresh water. To put this into perspective the nation's rivers and lakes contain enough water to flood the entire country to a depth of more than two meters (SCC, 1988).

Scrutinizing the situation more closely reveals that the nation may not be as water rich as it appears when it comes to meeting human needs. Although there is an abundance of water, it is frequently in the wrong place or available at the wrong time. In Manitoba, for example, the highest river flows generally occur in the spring and the highest human demand for water is in the summer. Furthermore, 90 percent of the population and most of our valuable agricultural land are located in the south while most of the water is in the central and northern regions (WRB, 1988).

### 2.1.1 WATER SUPPLY AND WATER DEMAND

Two studies have been completed regarding water supply and water demand for the Seine River watershed. The first study was a Water Demand Study completed in 1984 (WRB, 1984a). This study reviewed the existing water rights licenses to determine the amount of water being withdrawn from the river. An estimate was then made to establish what the future demand for water would be. The results of the study indicated that a minimum reliable flow of 0.15 cm/s to 0.3 cm/s would be required to maintain a live stream, meet existing demands, and provide for a small increase in demand.

The Seine River Water Demand study did not establish what the in stream flow needs of the river were (WRB, 1984a). Instream flow needs are the amount of water required to meet the needs of instream flow uses such as maintaining aquatic life (Bayha, 1975). It is usually defined as a percentage of mean annual flow which should be preserved for in stream purposes and not allocated for out of stream use (Canada, 1985).

Hatfield and Smith (1985) outline a number of methods for determining instream flow needs, noting the shortcomings of each. They point out that determining in stream flow needs requires a great deal of judgment and cannot withstand excessive scrutiny. As well, the methods developed are for larger streams which have more reliable firm summer flows than the Seine River.

The Seine River Water Demand Study demonstrated that the flows in the river were insufficient to provide a reliable water supply for withdrawal purposes. Consequently, a study was undertaken by the Prairie Farm Rehabilitation Administration to examine options for increasing summer flows in the river (PFRA, 1989). Four options were examined: damming the river and storing the water in a reservoir, building a weir and pumping into a dugout, diverting from flowing groundwater wells, and draining water from a bog located in the river's headwater region. The PFRA study concluded that the most economically feasible method of supplementing flows would be to divert groundwater from naturally flowing wells at an estimated cost of between $100,000 and $250,000 (1989 dollars). The findings from the PFRA study have not been acted upon and it was recognized that the recommended option would require a detailed hydro-geological study.

Dealing with water allocation and use issues can be very controversial because of the competition among different users. This competition becomes particularly acute during times of drought (Canada, 1985). In the Seine River situation, there are potential areas of conflict between riparian land owners and those who withdraw water from the river for out of stream use.

## 2.2 WATERQUALITY

Water quantity and water quality are directly linked by nature due to the assimilative properties of water (Env. Canada, 1988). The Science Council of Canada noted that “the availability of an adequate supply of usable water underpins our whole economy” (SCC, 1988). The key word in this quotation is “usable”, for water quantity and quality are also linked by human use of the resource. Having an adequate supply of water is of little value if that water is not of sufficient quality to meet the requirements of its intended use (SCSA,1979). For example, water which is suitable for hydro generation may be unsuitable for irrigation.

A water quality study on the Seine River was completed by Manitoba Environment in July of 1991. The study was conducted in preparation for public hearings held by the Manitoba Clean Environment Commission to establish water quality objectives for the lower Red River watershed and its tributaries. The hearings, completed in January of 1992, were conducted to determine current and future water uses within the study area and to establish water quality objectives to protect the water for these uses. This level of protection should be reflected in the water quality objectives established for the watershed.

The Manitoba Environment report proposes that the Seine River be classified to protect a number of water uses including secondary recreation (Gurney, 1991a). This category refers to activities such as canoeing and hiking, where contact with the water is usually’ incidental. One of the water quality parameters associated with the Secondary Recreation Classification is fecal coliform concentrations.

The Seine River is used as a receiving stream for approximately 44 land drainage sewers which discharge during precipitation events and spring runoff. These waters may contain high levels of fecal material originating from domestic pet deposits on city streets, lawns etc. The river also receives infrequent discharges from one combined sewer overflow outfall and 13 emergency sanitary sewer overflow outfalls from the City of Winnipeg (Wardrop & Tetres, 1991). Other potential sources of fecal coliform material include runoff from livestock operations bordering the river upstream of Winnipeg, animal and waterfowl fecal deposits, and backwater from the Red River.

Infrequent exceedences of the fecal coliform counts as related to the Manitoba Surface Water Quality Objectives for Secondary Recreation, have been recorded by Manitoba Environment (Gurney, 1991b). One or all of the factors mentioned above may have resulted in these elevated counts.

In June of 1992 the Manitoba Clean Environment Commission released its report on the findings of the public hearing process. The report outlines 14 recommendations including one to classify the Seine River for secondary recreation during dry weather conditions. Under such conditions the City of Winnipeg's sewer outfalls would not be discharging. Classification for wet weather conditions was postponed until further studies are undertaken regarding the water quality impacts of combined sewer outfalls. The study, to be completed by July of 1997, must also provide details of the remedial measures required to reduce the impacts (C.E.C., 1992).

## 2.3 HUMAN IMPACT

The construction of dams, diversions and dykes are examples of man's direct influence on a water regime (Hare, 1984). Most modifications to a river system, either for flood control or land drainage, will result in a response from the river to the imposed changes.

Alterations to the flow regime can cause erosion and/or sedimentation, not only in the modified reach, but upstream and downstream of it (Hey and Masce, 1990). Examples of such impacts in Manitoba are indicated in the Churchill River Study and the Dauphin Lake Study (Sask. 1976, WRB, 1989).

Human influence on the water regime is not confined to in-channel modifications; land based activities also affect the water regime. Urbanization is a major factor influencing river flows. When urbanization takes place the physiographic characteristics of the watershed are altered. Large impervious surfaces, such as parking lots, replace native vegetation thereby decreasing infiltration (Hare, 1985). Storm sewers are constructed to facilitate runoff from roads and rooftops result in faster runoff and higher peak flows in the river (Lazaro, 1979).

Recognizing the impact of urbanization on river flows, the City of Winnipeg hired Acres Consulting Services Ltd. to determine flood risk along the Seine River from the Red River Floodway to the Red River. The 1:160 year event is the level of flood protection that the Red River Floodway provides for the City of Winnipeg. The Acres study concluded that floods having a return period as high as the design 1: 160 year flood event would remain at levels below the general ground surface adjacent to the Seine River (Acres, 1978). The flood damages associated with 1:160 year flood event should therefore be minimal within the area covered by the Acres study.

The impact of urbanization goes beyond increasing peak runoff and velocity. Under urban conditions less water seeps into the ground and lowered groundwater reserves can result. The river loses its source of water between storms (Hare, 1985).

## 2.4 INCREASING LOW FLOWS

River flows can be enhanced by either increasing the river's supply of water, or decreasing the demand for water. The literature indicates that water management has traditionally focused on increasing supplies (Canada, 1985, Tate, 1990). This has been accomplished primarily by structural means such as building a dam to reserve spring runoff water for use later in the year when demand is higher. This is known as supply management (Anderson and Robinson, 1985).

The literature suggests that we are now reaching the point where most of the cost effective water supply schemes have been completed, and escalating construction cost are prohibiting further construction of such schemes. This, combined with the increasing awareness of Canadians regarding the environmental implications of such projects, is causing water managers to focus on managing demand rather than managing supply (Canada, 1985, Tate, 1990).

Water demand management is defined as any measure which reduces or reschedules average or peak withdrawals from surface or groundwater sources, while maintaining or mitigating the extent that return flows are degraded (Tate, 1990). One of the most effective, yet controversial water demand management techniques, is water pricing.

With the recognition that implementing water pricing would have extensive political, economical and practical implications, there is majority agreement among water management experts that water pricing is an essential component to achieving water quantity and quality sustainability (McMillan, 1990, Tate, 1990). The underlying theme is that water is wasted because it is free and that pricing would be an effective mechanism to educate water users about their consumption rates.

McMillan (1990) noted that the price of water in Europe is four times higher than in Canada and per-capita use in Europe is less than half that of Canada. The need for more realistic pricing is so widely agreed upon that it is one of five strategies to be used by the federal government to achieve the goals of the Federal Water Policies (Canada, 1987). The concept is also being promoted in Manitoba's Draft Water Policy Application document (WRB, 1991). It should be noted that this policy application document has not been approved by Cabinet.

## 2.5 FLOODING

Though current concerns along the Seine River focus on low flows, the river does have a history of flooding. Three studies have been completed regarding flooding on the Seine River. One study was completed by the Prairie Farm Rehabilitation Administration which investigated flood control proposals on the Seine River (PFRA, 1956). This study recommended construction of the Seine River Diversion, a project which was completed in 1960.

The second study was the Acres (1978) investigation determining the ability of the Seine River to contain a 1:160 flood event through Winnipeg. The third study was a Flood Risk Mapping study conducted for the unincorporated Village of Lorette (WRB, 1984b). The purpose of this study was to delineate the area within Lorette which would be expected to flood during a 1:100 year event.

The Lorette Flood Risk Study found that the risk of flooding in Lorette has diminished since the construction of the Seine River Diversion. However, there was some minor damage reported from flooding which occurred in 1974 and 1979 as a result of spring runoff.

## 2.6 TRENDS IN WATER MANAGEMENT

A major development in water management planning is the movement from a comprehensive approach to an integrated approach (da Cuna, et.al1987). An integrated approach involves paying attention to a smaller number of variables rather than trying to address all aspects of water management at once. In this manner the time taken to address problems is significantly shortened. Though some aspects of a problem may be overlooked, the emphasis is placed on areas which will result in appreciable change (Mitchell, 1990).

The literature supports undertaking water management activities on a watershed basis (WRB, 1988, Canada, 1985, Powell, 1981). One of the main reasons for utilizing the watershed as the planning unit is because activities in the upper reaches of a watershed affect the lower reaches (Brooks et. aI, 1991). For example, water withdrawn and consumed by an upstream user is unavailable to a downstream user. Similarly, upstream waste disposal may affect the quality of water available to the downstream user.

The literature generally supports public involvement in resource management. Schwass (1985) strongly supports the concept noting that public participation clarifies issues, softens one-sided viewpoints and facilitates the resolution of differences. Other benefits of public participation suggested by Connor (1988) include the addition of data by local residents more familiar with the local area than the experts, and the addition of technical expertise often held by residents of a project area. McKinney (1990) warns, however, that one should not assume that public knowledge is correct as there have been several occasions where the public has misunderstood the principles and practices of water management.

## 2.7 CONCLUSIONS

The literature available on water management is extensive, attesting to the importance of the resource. Review of the studies completed on the Seine River served to identify gaps which require further research and provided direction and focus for this study. This factor is reflected in the study objectives.

Most of the Seine River studies reviewed were single purpose, addressing particular problems for particular river reaches. None of the previous studies approached water management from a holistic perspective considering both human needs and the biophysical needs of the river.

Review of other literature related to water management revealed that water must be managed in an integrated manner, placing emphasis on the source of the problem. The Seine River scenario is such that there is a shortage of water which may be aggravated by human manipulation of the water regime and society's use of the river, both of which may be negatively affecting the usefulness of the river for future generations.

Among the publications written by water management experts, there was general consensus that water management must place more emphasis on managing water demand rather than just water supply. Factors influencing the demand management trend include the current environmental consciousness of society and the current economic climate.

# CHAPTER III

## METHODS

Four basic methods were employed to develop sound water management strategies:

- Personal interviews and meetings with: experts in the field of water resource and environmental management, concerned citizen groups, government officials, and water rights license holders.

- Review of literature pertaining to: water resource management, previous Seine River studies and other water management studies of a similar nature, rural and urban development plans, provincial acts, regulations and policies pertaining to water, technical drawings and maps, operational procedures of structures located on the river, water rights licenses and Manitoba surface water quality criteria.

- Field inspections by vehicle, snowmobile and canoe.

- Existing and newly collected data were used to conduct hydraulic and hydrologic analysis utilizing methods prescribed in standard engineering texts and the Manitoba Water Resources Hydraulics Design Manual. Computer modeling was undertaken when necessary.

The following is a description of the methods utilized to achieve the study objectives. The details of the technical procedures used in the study are kept brief to avoid redundancy. A thorough description of these procedures is provided throughout the text where these procedures were applied.

**Objective 1:** To assess historical flow trends in the Seine River, hydrographs were developed utilizing data from Water Survey of Canada gauging stations. The Manitoba Water Resources hydrograph and duration plot computer programs were used to generate these graphs. Drainage areas were determined by using a grid method on the Manitoba Water Resources Watershed Maps 8 (1976) and 9 (1974). Drainage areas within the Floodway were planimetered from City of Winnipeg District No.5 Land Drainage Sewer and Combined Sewer Maps, both revised in 1991.

**Objective 2:** Instream flow needs were determined by reviewing the related literature and by consulting with Manitoba Fisheries Branch staff.

**Objective 3:** To determine the impact that water withdrawals were having on flows, a review of water rights licenses was undertaken and interviews were conducted with Water Resources Branch staff, local residents, municipal officials, and individuals from Seine River interest groups. Field inspections and interviews with users were conducted to assess the method, magnitude and purpose of the withdrawal. This information was used in conjunction with instream flow needs to determine if withdrawals were detrimentally affecting flows.

**Objective 4:** To determine the impact that man-made water control structures were having on flows, the water control structures of concern were analyzed. These included: water retention weirs, the Seine River Diversion Control Structure, and the Seine River inverted syphon. These are discussed separately below. Water Retention Weirs: These structures were located by reviewing existing water rights licenses, consulting with local Seine River interest groups, municipal representatives, Water Resources Branch staff and individuals identified during the consultation process.

Once the weirs were located, field inspections were conducted in the company of Water Resources Branch staff familiar with the potential impact of such structures. At each weir site cursory measurements were made of the weir dimensions relative to the cross¬ sectional area of the river.

Based on the measurements taken, and observation of flow over the weir, a decision was made regarding the potential impact of the structure. If the structure was suspected of aggravating flooding, a detailed hydraulic analysis of the weir was undertaken. This was done using standard engineering methods and formulas described in texts. In two instances backwater analysis was undertaken to determine the impact of the weirs. The Hec II backwater computer program was used in these instances (details in Appendices A and B). The river cross section information required to undertake this analysis was obtained from surveys previously completed by the Manitoba Engineering and Construction Branch.

*Seine River Diversion Control Structure:* The operating procedures were reviewed to determine how the Diversion Control Structure was supposed to be operated. The Reservoir Regulation Engineer from the Water Resources Branch was then interviewed to determine how the structure is actually operated. Criteria were then established to guide the operation of the structure. This information was utilized in combination with a hydraulic analysis of the structure to establish new gate settings which would allow more water to flow down the Seine River before diversion flow commences.

The control gates were adjusted to the new setting in the spring of 1991 and flows along the river were observed throughout the summer to determine whether adjustments were required.

Construction drawings were used to undertake the hydraulic analysis of the Seine River Diversion Control Structure. These included the Manitoba Water Resources Branch drawing File No's 16-1-3013 and 16-1-3014. The Seine River Diversion channel details were obtained from File No. 16-1-1016.

No construction drawings of the overflow structure were found on the Water Resources files, although the crest elevation of the structure is known from previous studies. Consequently, it was necessary to take measurements of the structure to determine its crest width and side slopes. Drawings of dam #6 in Ste. Anne were obtained from the Village Works Foreman.

The headwater rating curve for the gated control structure was determined using a computer program for calculating the head loss through corrugated metal pipes (cmps or culverts) operating under outlet control. An 1150 mm diameter cmp was used in this program to simulate the headwater caused by the 50 cm opening on each of the 1500 mm diameter cmps as they are equivalent areas.

Inverted Siphon: The siphon was sealed off at the upstream and downstream ends and the rate that the water level dropped within the structure was measured. The degree of leakage was then calculated based on the rate of water level drop and the volume of the siphon. Siphon details were obtained from the Engineering and Construction Branch drawing File No. 11-5-3014.

Objective 5: To facilitate stakeholder input, this study was guided by a working group comprised of S.O.S.-Winnipeg executive members, affected M.L.A's and the Special Assistant to the Minister of Natural Resources. The S.O.S.-Winnipeg's objectives for higher flow and a cleaner river, were assumed to represent the general Winnipeg public in this matter.

Due to the expansiveness of the study area, the general public in the rural area was represented by elected municipal and provincial officials, as well as S.O.S.-Lorette.

A number of public participation strategies were employed during the course of this study including meetings, letters, individual interviews and field trips. Letters were sent to the Rural Municipalities within the watershed informing them of the general nature of the study and soliciting their input. A subsequent meeting was held with the R.M. of Tache council to introduce the study and to solicit their concerns and ideas. The Village of Ste. Anne was represented by the Village Foreman.

A number of meetings were held with the working group described earlier and with S.O.S. Lorette. The purpose of these meetings was to share information, obtain general direction for the study and discuss terms of reference. Additional meetings were held with the working group to keep members apprised of the study and to discuss new developments. It is anticipated that further meetings will be held upon completion of this report as various recommendations are implemented.

Individual interviews were held with the water licensees to review their operations, share concerns and present alternatives.

**Objective 6:** The development of water management strategies was largely based on the results of the analysis associated with the first five objectives. It was also based on technical soundness, a consideration of natural biological and physical processes, and the input of the involved publics.

Both supply and demand water management strategies are proposed. Two structural alternatives are proposed to increase water flows and levels in the river through the City of Winnipeg. Preliminary designs and cost estimates were conducted for these alternatives based on standard Manitoba Water Resources Branch and Fisheries Branch design practices and in consultation with the appropriate staff from these agencies.

# CHAPTER IV

# SEINE RIVER FLOWS

## 4.0 AVAILABILITYOFDATA

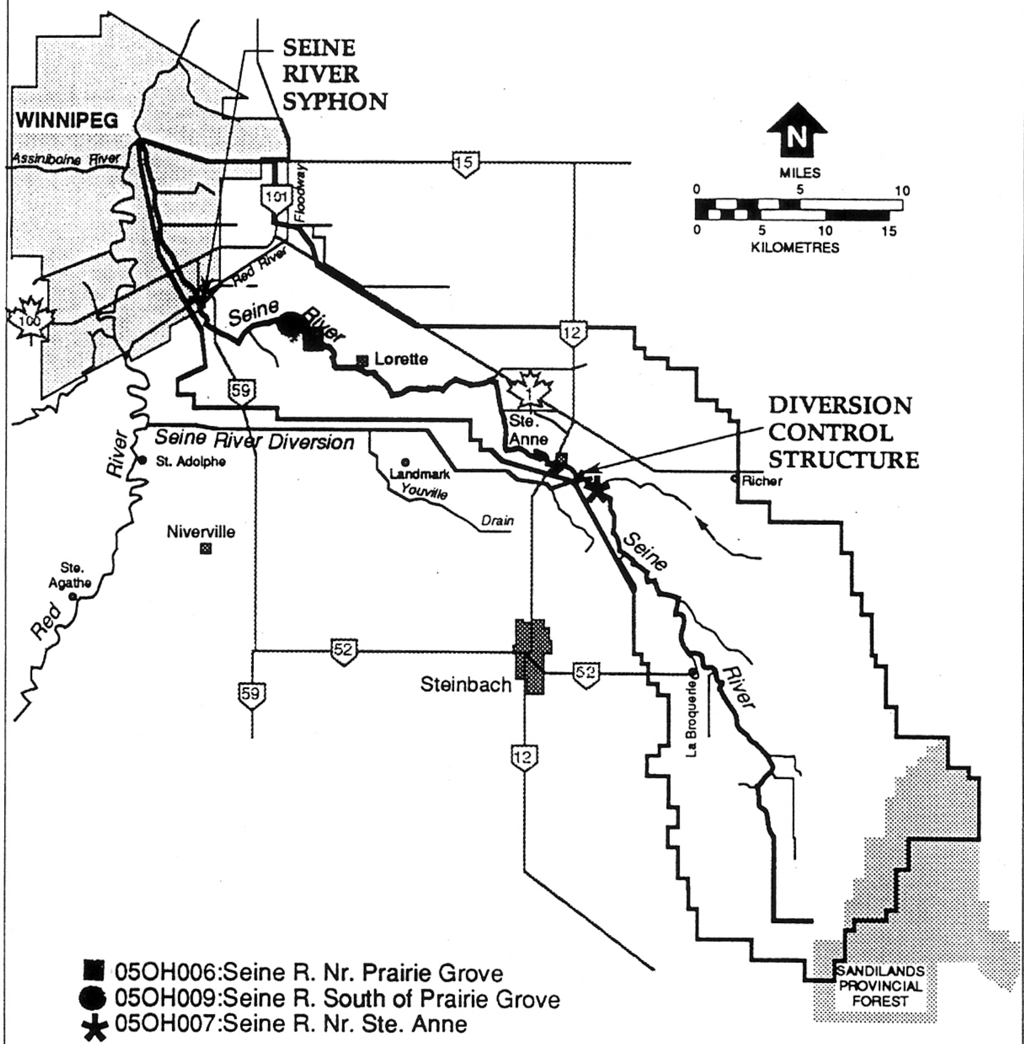
The streamflow data utilized in the analysis of Seine River flows was obtained from Water Survey of Canada, which maintains a number of streamflow recording stations within the study area. These stations arc shown on Figure 2.

Streamflow was recorded from 1942 to 1986 at the Seine River near Prairie Grove station (O50HOO6). From 1986 to present flows have been recorded at the South of Prairie Grove station (O50HOO9), three river kilometers downstream of the original Prairie Grove station. A recording station is also located near Ste. Anne (050HOO7) upstream of the Seine River Diversion inlet. Flows have been recorded at this station from 1964 to the present.

Flow data is recorded at all operating stations on a continuous basis through the open water months. A database of the mean daily and wean monthly flow data for these stations is maintained at the Manitoba Water Resources Branch. This database was accessed for use in this study.

## 4.1 HISTORICAL FLOWS

To determine whether Seine River flows have been decreasing over the period of record, a hydrograph Was developed for the Seine River at its outlet into the Red River. Data from Prairie Grove station 050HOO6 was combined with the data from the station South of Prairie Grove (050HOO9) to establish a continuous period of record from 1942




STREAMFLOW GAUGE STATIONS

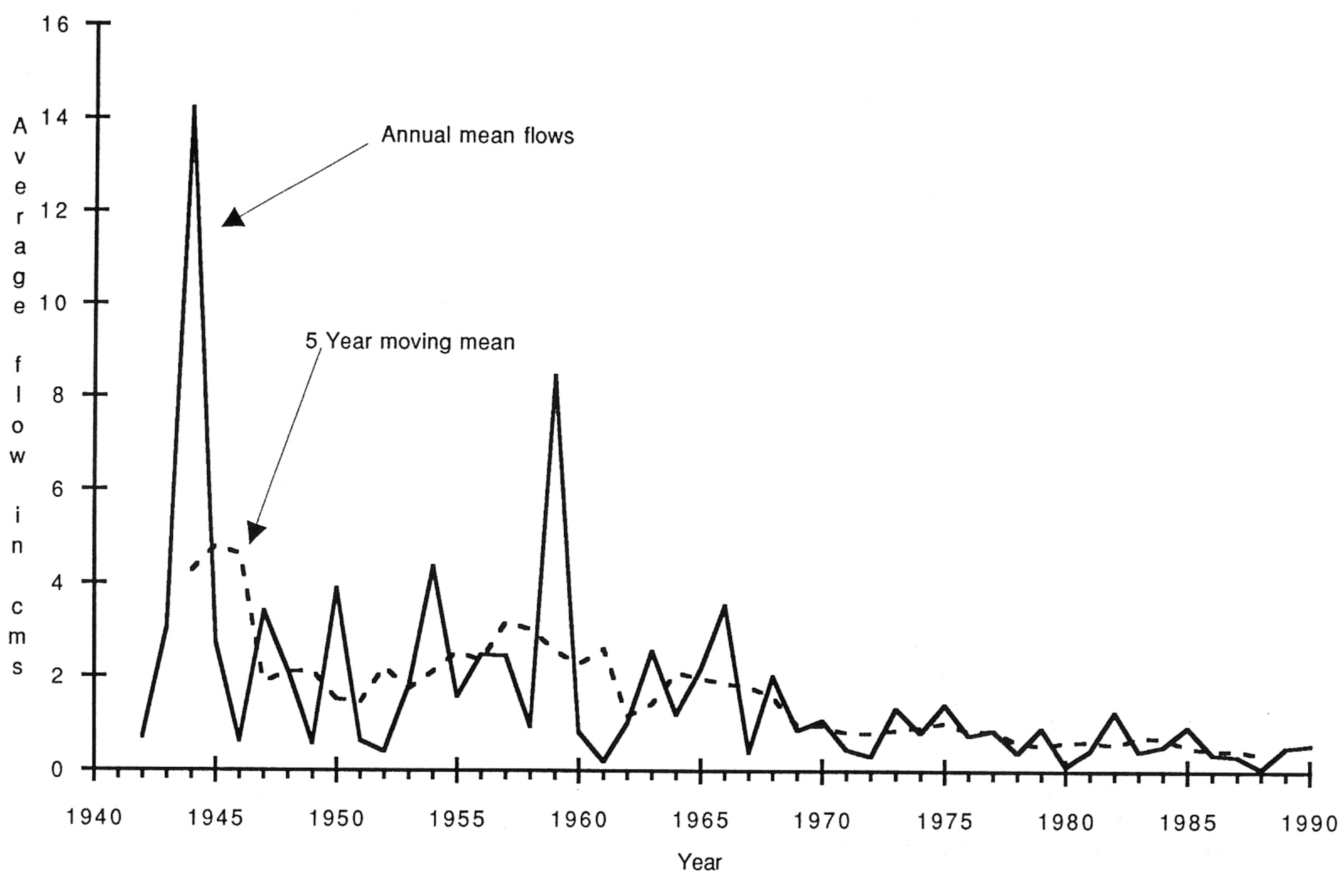
Figure 2

to 1990. Because there was little inflow between the two stations, no correction factor was utilized when the data was combined.

To determine flows at the Seine River outlet a multiplication factor was applied to the Prairie Grove flows to reflect the inflow between these two locations. This factor was based strictly on the proportional increase in drainage area between Prairie Grove and the outlet. The drainage area at Prairie Grove is approximately 966 km , and the drainage area at the outlet into the Red River is approximately 1185 km . Consequently, flows at the Prairie Grove Stations were multiplied by a factor of 1.226.

If this study was concerned with peak flows through the City of Winnipeg, adjustments would be required to account for the affect of urbanization on runoff downstream of Prairie Grove. This is not the case, however, as this study is primarily concerned with low flows through the city.
The hydrograph developed for the Seine River at its outlet into the Red River Is presented in Figure 3. The graph shows two plots, each developed from mean monthly data for the summer months of June through September for the period of record from 1942 through 1990. These months were chosen because it is during these months that the problems associated with low flows arc being experienced.

The Annual Mean plot demonstrates the variation in flows, which can occur between years, but docs not depict trends well. Consequently, a five-year moving average was plotted. The five-year moving average decreases the impact of single year anomalies and smoothes the plot, thereby making it easier ‘0 detect a trend. A distinguishing feature of the moving average plot is the consistent downward trend in flows from 2.61 cm/s in 1961 to 0.37 cm/s in 1988.




SEINE RIVER FLOWS (JUNE TO SEPT) AT OUTLET FIGURE 3

### 4.1.1 INFLUENCING FACTORS

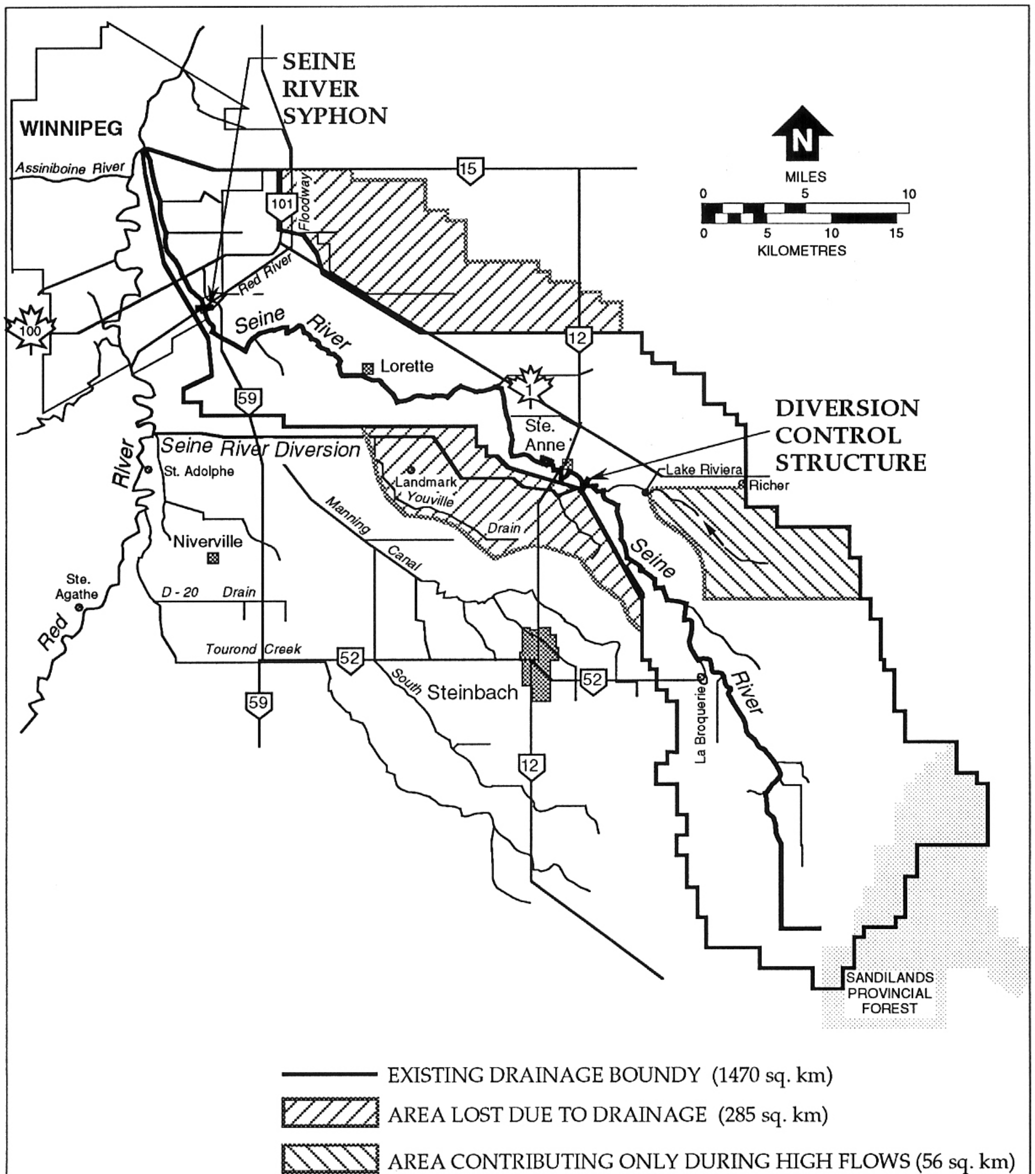
Several factors could be contributing to the downward trend in Seine River flows. Many of these, such as water control structures, arc dealt with in separate sections of this report so they will not be dealt with here. The purpose of this section is to identify less obvious influencing factors, which have probably contributed significantly to the decrease in flows.

Though precipitation may influence stream flow, no attempt was made to establish the relationship between precipitation and flows. This decision was made for two reasons. Firstly, precipitation is only one variable influencing surface runoff, so a direct relationship between precipitation and runoff cannot be fully determined without considering variables such as storm duration, storm intensity and antecedent soil moisture conditions. Secondly, precipitation cannot be influenced by water management techniques, so no strategies could be developed to alleviate precipitation shortages.

#### 4.1.1.1 AGRICULTURAL DRAINAGE

Examination of the hydrograph in Figure 3 revealed that tile downward trend inflows began in 1961. This was the same time that the Seine River Diversion went into operation. The Red River Floodway was constructed shortly thereafter. Once constructed, these channels offered a convenient and economic outlet for local agricultural drainage works.

Figure 4 Indicates the Seine River watershed drainage area before and after construction of the Seine River Diversion and Red River Floodway. Due to the impervious nature of




**SEINE RIVER DRAINAGE DESCRIPTION**

Figure 4

the clay soils which comprise much of the watershed, ponding of water can lead to delayed seeding and crop losses. For these reasons drainage systems have been constructed throughout the Red River Valley to alleviate crop loss due to water ponding.

After the Seine River Diversion went into operation, the Youville Drain was constructed to provide agricultural drainage to 122 sq. km in the Seine River watershed. This drain outlets into the diversion and flows east into the Red River. Its drainage area is therefore permanently lost from the Seine River Watershed.

Similarly, after the Red River Floodway was constructed, the Prairie Grove drain was built which drained 163 sq. km of the Seine River watershed into the floodway. Thus more drainage area was permanently lost from the Seine River System. A total of 285 sq km have been diverted from the Seine River Watershed via the Youville and Prairie Grove drainage systems.

#### 4.1.1.2 RECREATIONAL DEVELOPMENT

In 1958 the owner of section 15-7-7E, southeast of Ste. Anne, received a water rights license to construct a dam, which intercepted a creek that drained into tile Seine River. The area behind the darn was dredged to impound water for recreational purposes. The resulting lake is known today as Lake Riviera. The surface area of the lake is approximately 3.6 hectares and the maximum depth is about 14 m. The area surrounding Lake Riviera was subdivided in 1989 into approximately 130 lots, which are currently for sale.

The relevance of this lake to Seine River flows is that the creek, which was intercepted to form the lake may no longer be contributing to the Seine River during the summer period. The creek in question drains a 56 sq. Ian bog area upstream of Lake Riviera. This area may have historically contributed to the base flow of the Seine River, as such areas normally drain slowly and feed the receiving stream for extended periods of time following spring melt or a summer storm. The creek is also groundwater fed and may be capable of flowing for most of the summer, thereby providing base flow to the Seine River. This was ascertained from the fact that lake levels are supplemented by a flowing well, which would drain into the creek if not for Lake Riviera.

The dam at Lake Riviera has a series of culverts allowing lake water to pond to a certain elevation before flowing into the creek downstream. On the two separate occasions that the site was visited in the summer of 1991, these culverts were blocked with plywood. This nullifies the creek's ability to feed the Seine River downstream, even after the design elevation of the lake has been reached (i.e. the elevation corresponding to the outlet culvert inverts).

Lake Riviera levels are also supplemented by groundwater. Once lake elevations drop to approximately 1m below the culvert inverts, groundwater is pumped at a rate of 1 million gallons a week to raise lake levels. This pumping has not been authorized by the Manitoba Water Resources Branch which is the water rights licensing body for the province.

#### 4.1.2 IMPACT ON FLOWS

Water flow records are not available for die creek downstream of Lake Riviera. Consequently. It is difficult to quantify the effect the lake may be having on Seine River flows. However, observations by a long time resident located along the creek downstream of Lake Riviera indicated that creek flows have diminished since the lake was formed. The resident noted that after the lake was formed he had to move his pump intake further into the creek bed because the water levels had dropped. This, combined with the observed blocked culverts, lead to the conclusion that the 56 sq. km drainage area upstream of Lake Riviera is not contributing to the Seine River summer flows.

Adding the 56 sq. km drainage area intercepted by Lake Riviera to the 285 sq. km area which bas been diverted for agricultural drainage, yields a total of 341 sq. km which, are no longer contributing to Seine River summer flows as shown in Figure 4. This represents a 23 per cent loss of drainage area from natural conditions.

A detailed hydrologic study would be required to determine the exact impact that the 23 per cent drainage area loss would have on Seine River summer flows. However, logic would dictate that the lost drainage area would be a significant factor contributing to the downward trend in the Seine River hydrograph since 1961. This is particularly true considering that a portion of the lost area is swampland, which would drain relatively slowly and supplement Seine River base flows during the summer months.

### 4.2 PROPOSED STRATEGIES

The following water management strategies are proposed to address the problems associated with the lost drainage area:

1. The Manitoba Department of Natural Resources should prohibit drainage works which, would result in water being diverted outside of the existing Seine River Watershed.
2. The Manitoba Water Resources Branch should undertake an assessment to ensure that the Lake Riviera resort operates its outlet structure in accordance with its licensed full supply level. The resort should not be allowed to block the lake outlet culverts to supplement levels at the expense of all Seine River users downstream of the lake. The

Manitoba Water Resources Branch should also investigate the unauthorized groundwater withdrawals taking place at the resort.

# CHAPTER V

# WATER CONTROL STRUCTURES

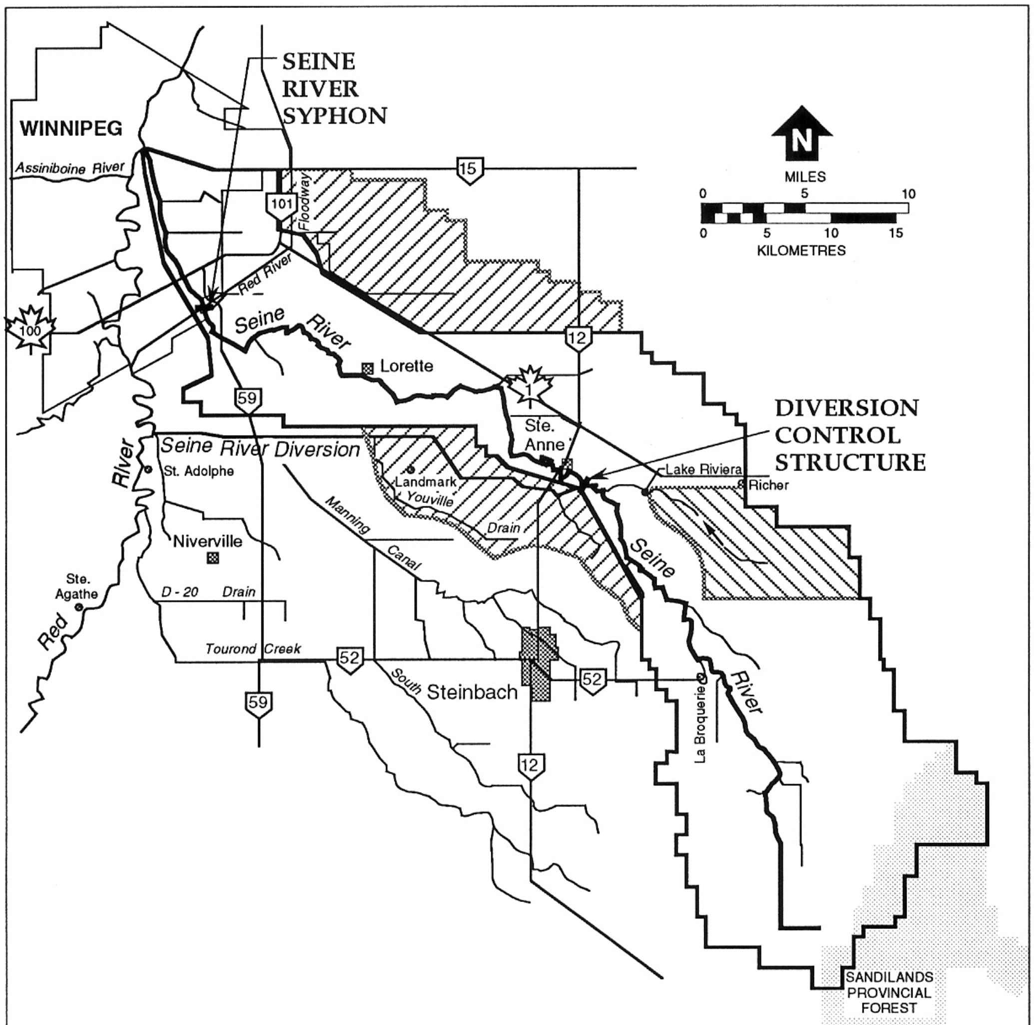
## 5.0 GENERAL

Stakeholder meetings and personal interviews revealed the concern that man-made water control structures arc causing reduced summer flows in the Seine River. Three areas were investigated in response to this concern: the impact of small dams, the operation of the Seine River diversion and the functioning of the Seine River Siphon.

## 5.1 SMALL DAMS

Field investigations, public contact, and review of water rights licenses revealed that there arc six small dams located along the Seine River (not including Lake Riviera dam). These dams have been constructed for various reasons including the following: to impound water for withdrawal purposes, to enhance the aesthetic characteristics of the river corridor, and to provide better conditions for recreational activities such as canoeing. The location of the small dams is shown in Figure 5. For discussion purposes the dams have been numbered from 1 to 6.

To legally construct a dam along the Seine River a Water Rights License must be acquired from the Manitoba Water Resources Branch. Dam #4, in Ste. Anne, is the only licensed dam along the Seine and an application to license dam # I in Lorene Is currently being reviewed. Though the Water Resources Branch Is aware of the unlicensed dams, the current practice is to Ignore such developments unless complaints regarding the structures are received. This is an ineffective method




EXISTING DRAINAGE BOUNDY (1470 sq. km)
AREA LOST DUE TO DRAINAGE (285 sq. km)
AREA CONTRIBUTING ONLY DURING HIGH FLOWS (56 sq. km)

**SEINE RIVER DRAINAGE DESCRIPTION**

Figure 4

of dealing with the unlicensed dams since complaints are not usually received until the damage is done (for example, a dam that is so high that it causes undue flooding). As well, with no inventory of the darns, the branch is incapable of determining the cumulative effects that such structures are having on water levels.

Most of the darns are constructed of earth, gravel and rock which has been dumped into the river for the purpose of pooling water. These darns are not impervious and water trickles through the structures. The exception is darn #6 in Ste. Anne which is comprised of rock and gravel covering 6-760 mm diameter culverts to allow for riparian flow.

Two concerns regarding small darns were investigated: the aggravation of low flow conditions by impoundment of too much water, and the darns being so high that they cause upstream flooding.

### 5.1.1 IMPACT ON LOW FLOWS

The first concern, the reduction of flows because of the darns, was voiced by stakeholders on a number of occasions. This concern was based on the perception that once the darns were put in place, flows downstream would be permanently decreased. In fact, flows would only be decreased if significant withdrawals were made from the water impoundment created by the darn, or if significant evaporation were to take place.

Withdrawals are only taking place behind dam #1 in Lorette, and darn #5 in Ste. Anne. These withdrawals are not large enough to significantly affect Seine River flows as will be discussed in the Water Demand section of this report.

Regarding evaporation, all the darns except the Lake Riviera darn rely solely on channel capacity for storage. No lakes are formed by these darns, consequently the surface area is quite limited. Furthermore, the channel behind most of the dams has a tree canopy, and is not exposed to as much sunlight as a lake. For these reasons there is not expected to be much more evaporation than would occur if the dams were not in place.

In light of the above factors, the small dams located along the Seine River were not found to be contributing to lower flows. Once constructed, the open channel behind the dam fills up and the water begins to spill over the dam. Inflow into the ponded area equals outflow over the dam.

### 5.1.2 IMPACT ON FLOODING

As a guiding criteria for determining an acceptable dam height, it was assumed that the dam should be at an elevation which would not influence the upstream water surface once the bankfull stage has been reached. The dam should completely drown out under such conditions and function similar to a rock in the river bottom. By following this criteria, the small dams would not jeopardize the flood protection level currently provided to riparians.

To determine the potential impact that the dams would have on flooding, an on-site assessment was made of each dam. This assessment was undenaken with the aid of Mr. Bruce Webb, P. Eng., Manitoba Water Resources Branch. Three of the six dams (#3, #4 and #5) were less than 1.3 m in height and only marginally reduced the cross sectional capacity of the channel. These dams would not aggravate flooding as they completely drown out when flows approach the bankfull stage. Under such conditions the dams would simply function as a bump in the river bottom. This was confirmed in the field when flows were approximately 112 bankfull capacity and the maximum headwater measured was only 0.15 m. It follows that these dams will have little or no effect on flows once the bankfull stage is reached, and that they meet the established criteria regarding the influence of small dams on flooding.

The three remaining dams include dam #6 in Ste. Anne and dams #1 and #2 in Lorette. The Ste. Anne dam is high enough to potentially aggravate flooding, but it is located just downstream of the diversion control structure so any flooding could easily be controlled. The impact of this dam is dealt with more thoroughly in the Seine River Control Structure section of this report.

Dam #1, the furthest downstream dam in Lorette, has caused a good deal of concern to a number of citizens in the community. These concerns center around the height of the dam and its potential to aggravate flooding. Furthermore, the dam is causing water to pond to an elevation which is so high that water is submerging the base of trees located along the river bank. Continued submersion could cause the trees to die, a factor which is unacceptable from an environmental perspective. As well, the dead trees would eventually fall into the river and exacerbate log jamming problems and the loss of bank stabilizing tree roots could cause increased erosion.

A site inspection of dam #1 led to some skepticism as to whether the existing structure could meet the desired criteria. Consequently, a thorough hydraulic analysis was undertaken to determine the impact of this dam. What follows is a summary of the steps undertaken in this analysis. Details are contained in Appendix A.

To determine whether the downstream Lorette dam was causing flooding, the existing capacity of the Seine River had to be determined. This was accomplished using the Hec II backwater computer program. This analysis revealed that the existing capacity of the Seine River was approximately 13 cms. Consequently, the Lorette dam #1 should be set at an elevation which would not affect the upstream water surface for this flow.

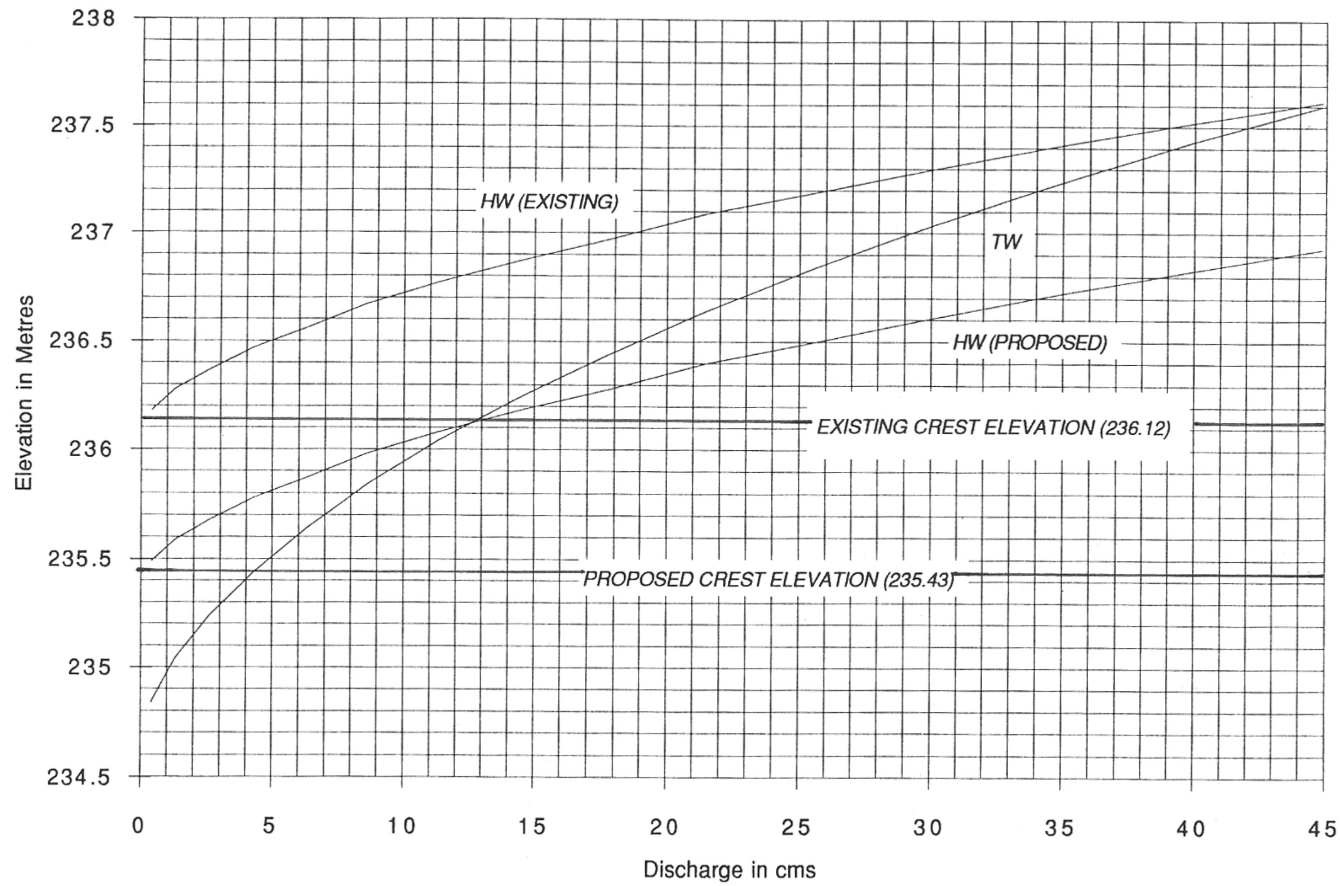
A rating curve for the existing structure was developed to determine whether the dam would completely drown out under the 13 cm/s flow condition. This rating curve is shown in Figure 6. The headwater rating curve for the existing structure represents the water surface elevation upstream of the dam for various flows based on the broad crested weir formula. The tailwater rating curve represents the water surface elevations downstream of the dam which would result if no dam were in place. Where the two curves cross is termed the point of complete drown out. At the flow corresponding to this point, the channel becomes the controlling factor in determining the river's water surface elevations and the dam has no influence.

The rating curve for the existing dam (crest elevation 236.12 m) shows that the dam does not drown out until approximately 45 cm/s. This indicates that the dam is affecting the Seine River water surface at flows higher than the bankfull capacity of 13 cm/s.

To determine an appropriate dam elevation, the headwater elevations for the target flow of 13 cm/s were calculated for various dam crest elevations. Utilizing this method it was determined that if the dam was lowered 0.69 m, to an elevation of 235.43 m, it would no longer affect the upstream water surface elevation at a flow of 13 cm/s.

The head water rating curve for the proposed dam elevation is plotted on Figure 6. This figure shows that the dam will completely drown out at approximately 12 cm/s which is just below the estimated existing channel capacity as determined by backwater analysis.

Dam #2 is located in Lorette just upstream of dam #1 as indicated on Figure 5. This dam was mistakenly constructed in the wrong location by the R.M. of Tache. The R.M. had intended to construct it where dam #1 is now located. Upon discovering the mistake, the R.M. decided to leave the dam in place and simply construct a new dam in the proper location downstream (dam #1).




**RATING CURVE FOR DAM #1 IN LORETTE** **FIGURE 6**

Since construction of the mislocated dam (dam #2) in the fall of 1990, the Manitoba Water Resources Branch has received complaints that the dam is too high. One riparian is concerned that the dam will cause flooding to his property and that it poses a danger to local children who have been playing on the structure.

Field investigations revealed that the mislocated dam has very little effect on upstream water surface elevations because these water levels are governed by the downstream dam (dam #1) under most flow conditions. However, if dam #1 was lowered by 0.69 m, control of water levels would transfer to the upstream dam (dam #2). Consequently, adjustments would have to be made to the upstream dam as welL Given that the upstream dam was mistakenly placed and that complaints have been raised concerning the dam, it should be removed. The dam is essentially redundant anyway because water will be raised to the proper level by dam #1.

The purpose indicated on the ~ater rights application for dam #1 in Lorette is to provide water for fire-fighting purposes. Under the proposed conditions (i.e. lowering the downstream dam and removing the upstream dam) the water supply needs for fire¬ fighting would still be met. The instream channel storage capacity was determined to be 17 cubic decameters. This value was arrived at by calculating the cross-sectional area of the channel which would be inundated if the downstream dam were lowered 0.69 m. and the upstream dam removed. Under such conditions the water level would no longer be inundating trees along the riverbank.

### 5.2 SEINE RIVER DIVERSION

The Seine River Diversion was constructed between 1958 and 1960 to provide flood control on the Seine River from Ste. Anne to Winnipeg. A diversion dam, located just upstream of Ste. Anne, controls flows on the lower Seine River by directing water

through two gated 1500 mm diameter cm/s. The gates are adjustable, allowing the operator to vary discharge through the pipes from zero flow to full flow. The operation
of the Seine River Diversion Control Structure is the responsibility of the Manitoba Water Resources Branch.

The Seine River Diversion is designed to allow water to pond behind the diversion dam to an elevation of 251.16 m, the height of the rock crib overflow structure located at the inlet of the Seine River Diversion. Above this elevation flow is split, some passes through the gated pipes on the Seine River, and the rest goes over the rock crib into the diversion which flows to the Red River downstream of St. Adolphe.

The manner in which the Seine River Diversion Control Structure is operated significantly affects summer flows downstream of Ste. Anne. Many stakeholders are concerned that the control structure gates are not opened wide enough in the summer to allow adequate flow in the Seine River downstream of Ste. Anne.

Small gate openings cause more water to pond behind the control structure than wider gate openings and more flow is directed down the diversion and permanently lost from the Seine River system. This can result in flows along the Seine River downstream of the diversion which are inadequate for the river to flush itself, resulting in a buildup of silt and debris in the riverbed over time.

To address these concerns a review of the operation procedures for the Seine River Diversion was undertaken. The objective of this review was to develop procedures which would allow the river flows to reflect, as closely as possible, those flows which would occur in nature, while at the same time maintaining flood protection at and downstream of Ste. Anne.

### 5.2.1 HISTORICAL OPERATION

Operation of the Seine River Diversion control structure is such that the gates are completely closed in the spring and all water from upstream of Ste. Anne is directed down the diversion channel. This operation provides spring flood protection at and downstream of Ste. Anne. During this portion of the year, flow downstream of Ste. Anne is comprised of surface runoff from the 686 sq. km drainage area between Ste. Anne and the Seine River outlet into the Red River.

The operating procedures for the control structure stipulate that once the threat of spring flooding has passed, and water in the Seine River has receded sufficiently, the control gates are opened to allow a flow of up to 1.40 cm/s to pass through the structure and continue down the Seine River (WRB 1961).

Conversations with Water Resources staff revealed that typically the gates have been opened approximately 25 cm during the summer months. It was unknown what flow the 25 cm opening corresponded to though it was known that it would be considerably less than 1.4 cm/s. The flow was unknown because no rating curve had been developed for the control structure since dam #6 had been constructed in Ste. Anne, and this dam was known to affect flows through the gated control structure.

### 5.2.2 MODIFIED OPERATION

In May of 1991, a field investigation of the Seine River Diversion Control Structure was undertaken. The gate openings at that time were approximately 25 cm on each of the two 1500 mm diameter cm/s. In the company of Mr. Bruce Webb, P. Eng. Manitoba Water Resources Branch, the gates were opened to approximately 50 cm per cmp. This adjustment was to serve as a field test to determine the effect of opening the control structure to this degree.

Historically complaints of high water levels along the river have first been received from the communities of Ste. Anne and Lorette, as they are the major rural settlements downstream of the diversion control structure. Levels are closely monitored by riparian residents whose property may be threatened during periods of high flow.

Since the communities of Ste. Anne and Lorette seem to be the most sensitive to flooding, it was reasoned that if the gate settings did not aggravate flooding in these communities, there would be no problems elsewhere. The ideal setting would produce flows through these communities which approached bankfull capacity just when the water upstream of the control structure was high enough to initiate flow down the diversion. As will be demonstrated later, once diversion flow is initiated, increased flow upstream of Ste. Anne will have little effect on flows downstream of Ste. Anne because most of the incoming water will be diverted.

Under the above conditions bankfull capacity downstream of Ste. Anne would provide maximum flushing conditions and the diversion would serve its purpose of preventing flooding. Essentially the diversion would be providing flood protection to society, while minimizing the effect on the river environment.

To properly establish operating procedures for the control structure it was necessary to develop a rating curve for the structure. This would allow the operator to determine how much water was being routed down the diversion and how much was being allowed to pass through the gated pipes for a given gate setting and flow condition.

In developing a rating curve for the control structure three major factors had to be considered. The first factor was the small dam (dam #6) located approximately 2.4 km downstream of the two gated control pipes. This dam is an earth, rock and gravel structure with 6-760 mm diameter cm/s having their upstream inverts placed at elevation 249.78 m (Ste. Anne 1991). The inverts of the control structure's two 1500 mm diameter gated cm/s is 247.88 m. Since the inverts of the small culverts through dam #6 are higher than the inverts of the gated culverts at the control structure, the dam influences the tailwater of the control structure culverts.

To determine the impact of the dam on the control structure tailwater, a backwater analysis was conducted from upstream of dam #6 to the outlet of the control structure pipes. This was done for various flows so that a tail water rating curve could be developed for the control structure. The details regarding the backwater analysis are located in Appendix B.

The second factor influencing flows through the control structure is the gate opening on the control culverts and the headwater elevation which results from that opening. Using an assumed gate opening of 50 cm and the tailwater rating curve from the backwater analysis, a headwater rating curve was developed for the control structure.

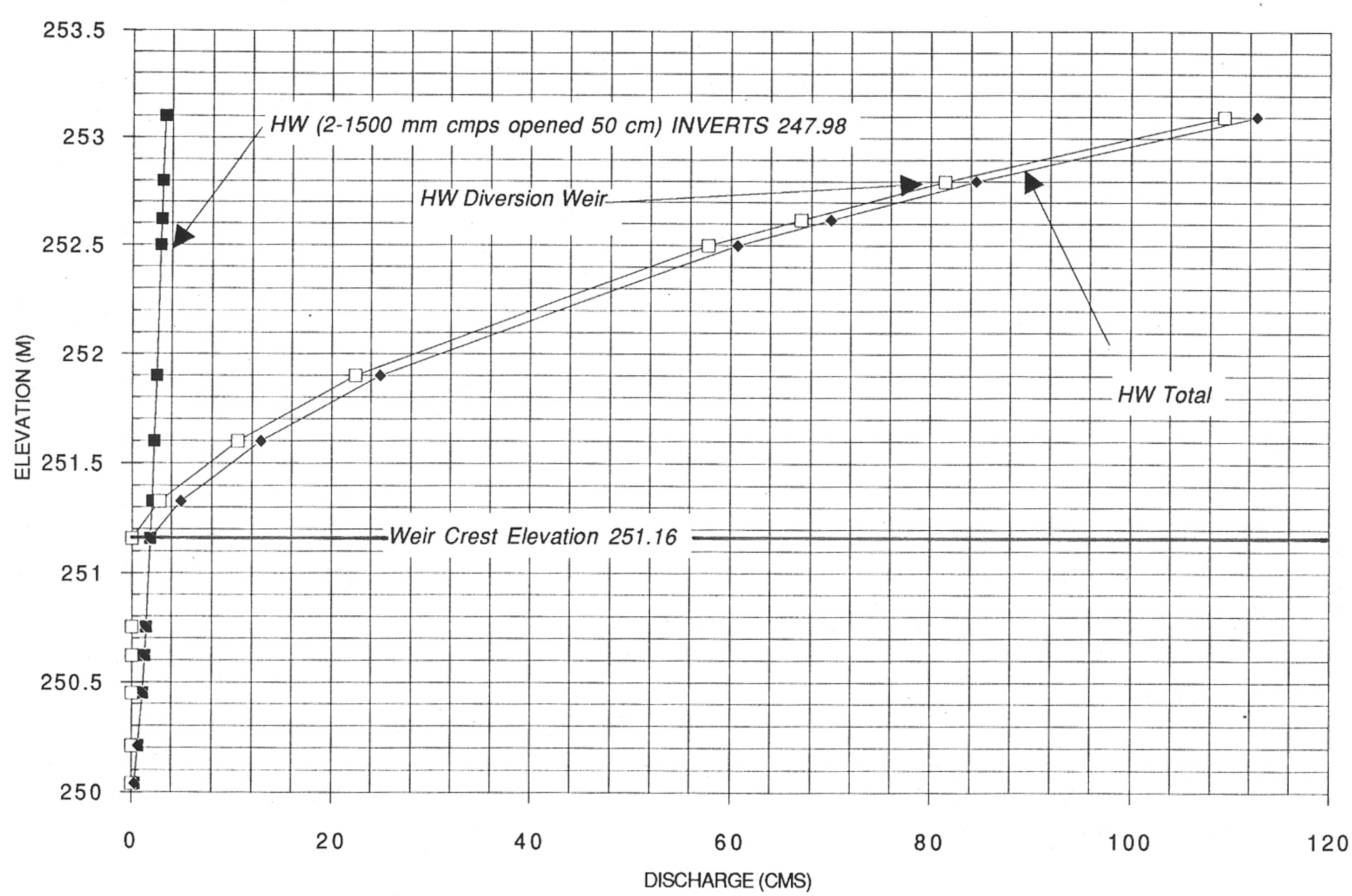
The third factor influencing the operation of the Seine River Diversion Control Structure is the amount of flow going down the diversion. The total flow upstream of the control structure is the flow passing through the gated culverts plus that going into the diversion. A rating curve was developed for the entrance structure to the diversion. This structure, constructed of rock and sheet piling, functions as a broad crested weir.

Details of the diversion channel downstream of the overflow structure were available from drawings, thus a tailwater rating curve for the structure could be developed. The headwater rating curve was determined using the broad crested weir formula. This is the formula utilized by the Manitoba Water Resources Branch when assessing the hydraulic performance of this type of structure.

Figure 7 is a rating curve developed from the analysis described above. It shows the amount of flow through the control structure when the gate opening of each culvert is set at 50 cm. A second rating curve on Figure 7 indicates the water level over the diversion weir under varying flow conditions. The figure also gives a total rating curve which combines flows through the control structure and over the diversion weir so that headwater elevations can be determined for any given flow.

With a 50 cm gate opening on each culvert, approximately 1.90 cm/s is allowed to flow through the control structure before diversion flow is initiated. Calculations were also conducted to determine the flow that would result from the 25 cm gate opening which has been traditionally utilized. This assessment revealed that 0.65 cm/s would pass through the 25 cm openings before diversion flow was initiated. This is one third the discharge that a 50 cm opening would pass before water is diverted.

An important factor depicted in Figure 7 is that once water begins flowing into the diversion (HW=251.1m, discharge approximately 1.9 cm/s) any increases in flow are almost entirely routed down the diversion, with very little additional water passing through the gated control structure. This is due to the large capacity of the diversion relative to the capacity of the gated control structure. Consequently, when bankfull capacity is being approached along the Seine River downstream of Ste. Anne, and diversion flow has commenced upstream of Ste. Anne, a heavy rainstorm in the upper watershed would not aggravate flooding downstream of Ste. Anne as most of the inflow would be routed down the diversion.




RATING CURVE FOR SEINE RIVER DIVERSION CONTROL STRUCTURE FIGURE 7

The question remains as to whether the 50 cm gate setting on the control culverts is the most appropriate setting. The desired condition is to have bankfull capacity approached at the same time as diversion flow begins.

Fortunately, the appropriateness of the 50 cm setting was verified in early July of 1991. At that time, significant precipitation occurred and water levels through the village of Ste. Anne had risen substantially. A field investigation of the situation revealed that no flooding was being experienced through the village of Ste. Anne. The village operations manager had, however, expressed concern that another large rainstorm in the upper watershed could trigger flooding through the community. This was highly unlikely as flow was already being routed down the diversion so increased inflow from the upper watershed would have little impact on the water surface elevations through Ste. Anne.

Flow through Ste. Anne at that time was estimated to be 2.00 cm/s. This discharge was arrived at by measuring the depth of flow through the culverts in the dam downstream of the diversion control structure (dam #6). Total flow measured at the Ste. Anne streamflow recording station (050HOO9) just upstream of the control structure was 5.31 cm/s. This suggests that flow down the diversion at that time was approximately 3.40 cm/s. This is consistent with the rating curve developed upstream of the control structure.

After observing water levels through Ste. Anne, and finding no incidence of flooding, site inspections of the river were conducted downstream of Ste. Anne to the Red River Floodway. Levels along this route were fairly constant, being 0.3 m to 0.6 m from bankfull. This indicated that the gate settings were providing a reasonable flushing flow.

To ensure that the proposed gate openings would not significantly affect flooding through Lorette, a backwater analysis was conducted, adding the flow through the gated control structure to the estimated bankfull capacity through the community. As previously mentioned, the maximum discharge through the gated culverts, when opened 50 cm, would be approximately 1.9 cm/s. The backwater analysis indicated that when the Seine River at Lorette is flowing at bankfull (13.00 cm/s), adding another 1.9 cm/s to the flow would only raise the water level 0.13 m. This demonstrates that the 50 cm gate opening would not significantly raise the water level in Lorette during high flow conditions and thereby not aggravate flooding.

The above analysis revealed that the 50 cm gate setting provides maximum flushing flows without aggravating flooding downstream of Ste. Anne. It must be recognized, however, that the operation of the diversion control structure should not be based on preventing flooding upstream of dam #6 in Ste. Anne. The operation of the structure should be based on allowing maximum flushing flows without aggravating flooding. If these flows cause flood concerns for Ste. Anne upstream of dam #6, the dam should be lowered to an elevation which would not affect the upstream water surface during periods of high flow. If the dam were lowered, the diversion control structure gate openings would have to be decreased to maintain a 1.90 cm/s flow downstream of Ste. Anne, otherwise some flooding could result.

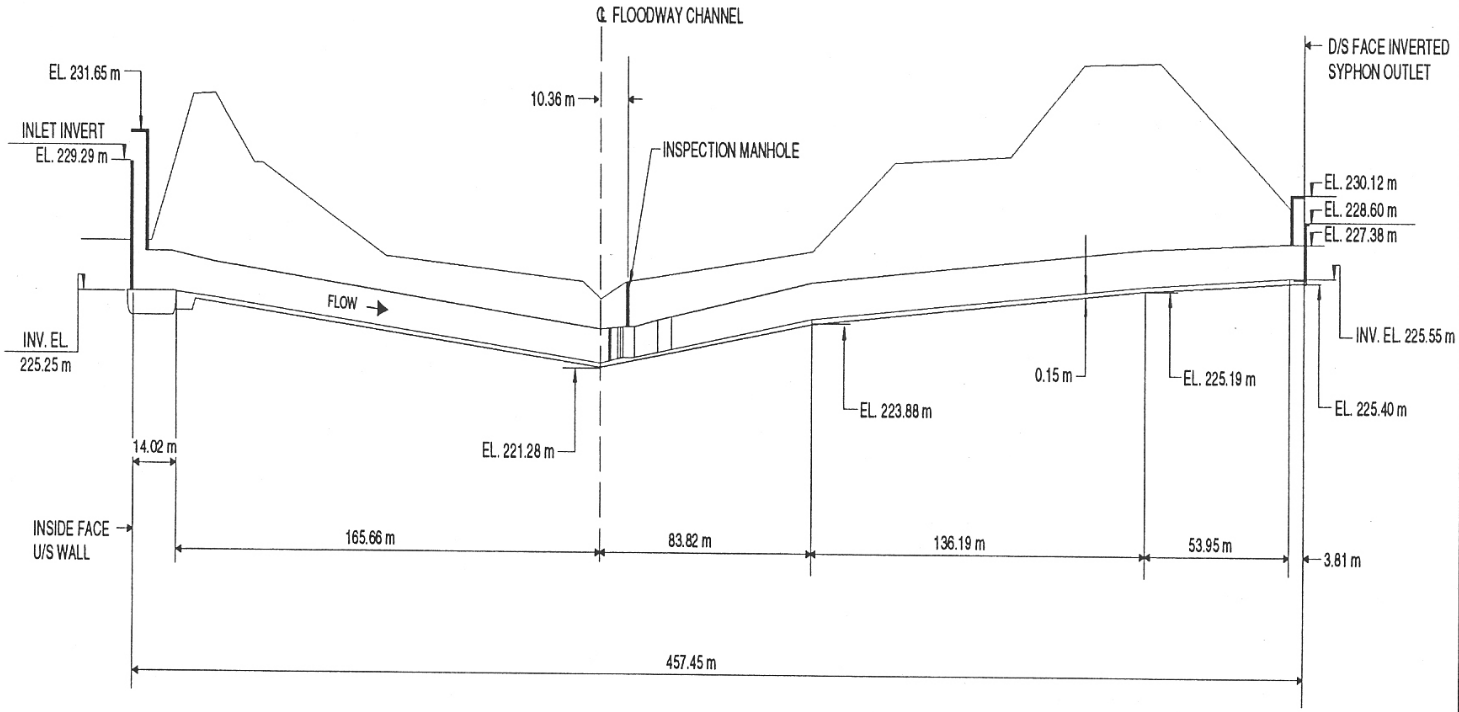
## 5.3 THE SEINE RIVER SIPHON

Concerns have been expressed regarding the condition of the Seine River Siphon and the possibility that it is leaking. The siphon has some history of leaking and measures. were undertaken in the 1980’s to repair the problem. The following photo shows the upstream side of the siphon and the overflow structure.

The siphon entrance is located on the left side of the photo. The entrance is comprised of a concrete box opening with a steel grate to prevent debris from entering the siphon. After entering the box, the water flows into a 1500 mm diameter cmp which passes beneath the floodway. Once a flow of 4.3 ems has been reached, the water surface has risen to the lip of the overflow structure shown on the center and right side of the photo. At this elevation flow is split between the siphon, which outlets into the Seine River downstream of the flood way , and the overflow structure, which outlets into the Red River Floodway.

### 5.3.1 THE LEAK TEST

Figure 8 shows a profile of the siphon. The elevation of the upstream entrance sill of the siphon is 229.29 m and the downstream sill is 228.60 m. If the upstream entrance box and downstream exit box were sealed off, the water surface elevations within each box would equalize at which point there should be no further change in the water level, provided the siphon was not leaking. This stabilization of the water surface elevation should occur at an elevation of 228.95 m, midway between the upstream and downstream sill elevations.




**PROFILE OF SEINE RIVER SYPHON**

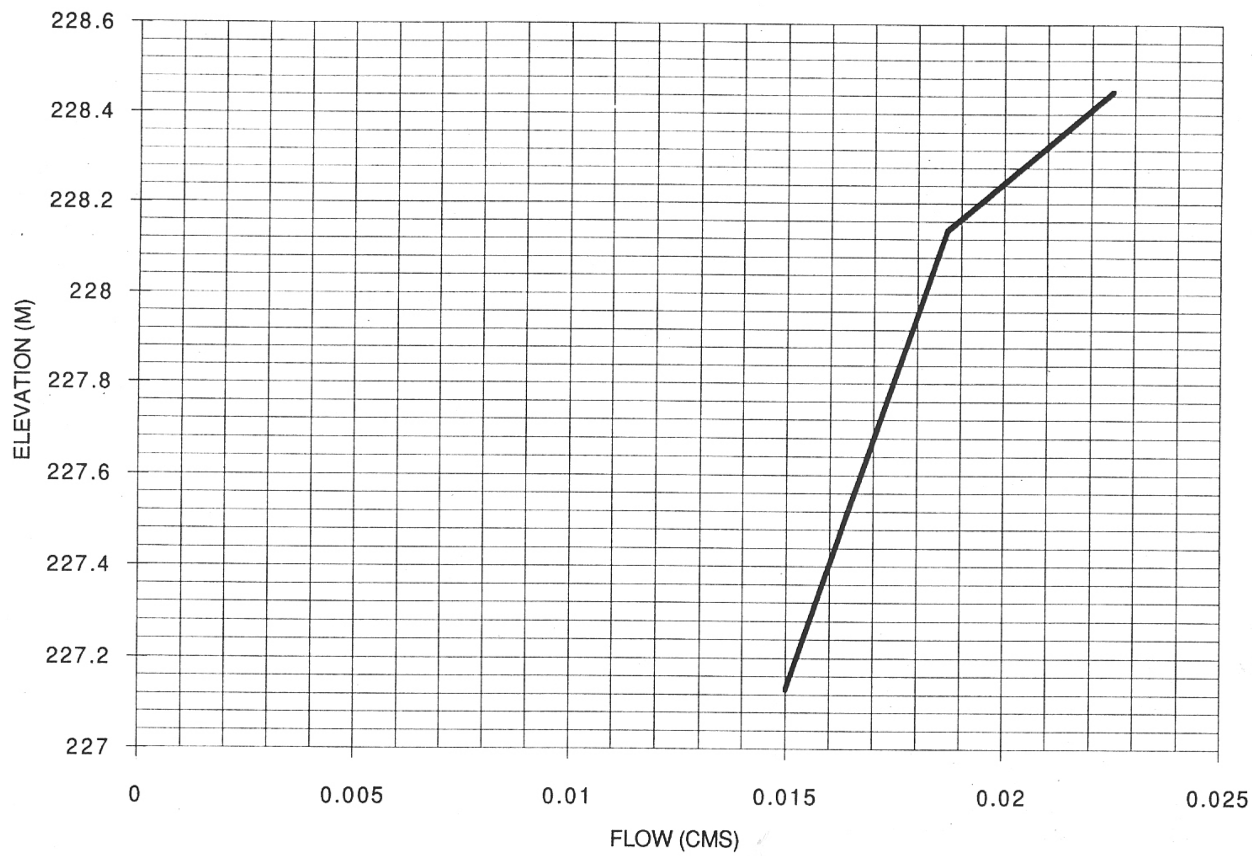
**FIGURE 8**

The above process was used to determine if the Seine River Siphon was leaking. On August 14/91, with the aid of Water Resources staff, the inlet and outlet boxes to the siphon outlet were sealed off and the rate at which the water level dropped in the downstream concrete box was measured against time. It was found that, after the water levels equalized at the siphon ends, the water level continued to drop. This indicated leakage was occurring.

The rate that the water level dropped was measured from the outlet sill (228.60) to the top of the horizontal section of the siphon (227.38). Figure 9 is a plot of the rate of water loss between these elevations. The figure indicates that the rate of leakage is directly related to the height of water in the pipe; the higher the level, the greater the leakage. This is understandable since the amount of leakage would be dependent upon the amount of pressure inside the pipe which is in turn dependent upon water levels (hydraulic head). Consequently, as water levels decrease, so does the rate of leakage.

The volume of leakage was calculated using the decreases in water level in the downstream box once the inlet and outlet were sealed. Figure 9 indicates that the maximum loss measured was 0.023 cm/s which occurred between elevations 228.6 m and 228.29 m. The implication of the 0.023 cm/s value is that once flows into the siphon are less than 0.023 cm/s there will be no flow at the outlet of the siphon.

A loss of 0.023 cm/s flow would not be considered very significant under high flow conditions, but this investigation was primarily concerned with low flow conditions. Under low flow conditions, a loss of 0.023 cm/s (23 l/sec) may be critical to the biological life dependent on the river given that this flow is 33% of the instream flow needs.




**SEINE RIVER SYPHON LEAKAGE RATE** **Figure 9**

To rectify this problem a more thorough investigation of the siphon will be required. The siphon should be dewatered and inspected by the Manitoba Water Resources Branch, the agency responsible for maintaining the structure. A previous problem of siphon leakage was repaired by fitting an expandable coupler with a neoprene gasket to the inside of the siphon. Whether or not such a solution would work in this instance would depend on the nature and extent of the problem, a factor which can only be ascertained by inspection.

Repair of the siphon will be at the discretion of the Manitoba Water Resources Branch with the understanding that the problem will probably get worse with time. If no repairs are undertaken, the leak test should be conducted on a yearly basis so the problem can be monitored. If repairs are undertaken, the test should be conducted every two or three years to ensure the structure continues to function properly.

### 5.3.2 BLOCKAGE OF SIPHON INLET

While monitoring the performance of the siphon during the summer of 1991, another problem came to light. Debris collects against the inlet grill of the siphon and restricts the amount of water which can enter. Because of the restricted flow into the siphon, water levels increase faster than normal. Water ponds upstream until it reaches the elevation of the overflow sill, whereupon it spills into the Red River Floodway. The end result is that water which should be flowing in the Seine River downstream of the siphon and through the City of Winnipeg, is inadvertently diverted into the floodway.

No data was collected regarding the frequency of the above occurrence though some general statements can be made in this regard. From May, 1991 through July, 1991 a current metering program was undertaken upstream and downstream of the siphon in an attempt to establish how much the siphon was leaking under various flow conditions. Unfortunately this method was not accurate enough to detect losses with an acceptable degree of accuracy. It was, however, during this investigation that the debris accumulation problem at the inlet of the siphon was observed.

In order to meter at the inlet of the structure the debris had to be removed from the grill. Since the frequency of metering was approximately once a week, the amount of debris accumulated at anyone time was not great enough to cause water to pond to the elevation of the overflow sill. However, when the monitoring program was abandoned in July, and approximately five weeks had elapsed between visits to the site, enough debris had collected to severely inhibit flow through the siphon. The inlet was so plugged that the upstream water surface had risen to the point where water was spilling into the overflow structure and going into the floodway rather than through the City of Winnipeg.

The siphon inlet was cleaned at that time and another problem with the siphon was observed. A large snapping turtle had become entangled in the debris at the siphon inlet and was found dead as pictured below.

It should also be noted that much of the debris collecting at the siphon inlet is a result of human activities. During a snowmobile inspection of the river in the winter of 1991, it was observed that there was a lot of tree cutting taking place along the river. Trees which overhang the river are cut to improve snowmobile and canoeing conditions along the river. In some instances this wood is removed and used for firewood. However, there was also evidence of attempts to burn the wood on the river. Logs which do not completely burn, float down river in the spring and some reach the siphon inlet. This type of activity is innocent enough; people simply don't understand what the cumulative effects of their activity can be. The intention here is to bring the problem to light so that the word may spread through public interest groups, municipal councils and individuals who read this report.

## 5.4 PROPOSED STRATEGIES

The following strategies are proposed regarding Seine River water control structures:

1. The downstream dam in Lorette (dam #1) is aggravating flooding by causing increased water surface elevations for flows above the bankfull stage. The dam should be lowered 0.69 m so that it completely drowns out at the bankfull stage and does not cause any more flooding than would occur if no dam was in place.

2. The upstream dam in Lorette (dam #2) should be completely removed because it is serving no beneficial purpose not being provided by dam #1. On the contrary, it is the cause of considerable concern within the community regarding the safety of children and its potential to aggravate flooding.

3. All dams along the river should be licensed under the Water Rights Act. Submissions for a license should be accompanied by plans of the dam so that a

hydraulic analysis can be undertaken to determine the effect the dam will have on water surface elevations. It would also allow the Water Resources Branch to maintain an inventory of such structures so their cumulative effect can be determined at the time of licensing.

4. The Seine River Diversion Control Structure should be operated at gate settings of 50 cm on each pipe during the summer months. This setting would allow 1.90 cm/s to flow through the diversion control structure before diversion flow commences (three times more than historical operations allowed). A 1.90 cm/s flow provides adequate flushing downstream of Ste. Anne without aggravating flooding. Should this level of operation result in flooding upstream of dam #6 in Ste. Anne and not downstream, the dam should be lowered to an elevation which would not cause upstream flooding. The gate settings on the control structure would have to be adjusted accordingly.

5. The Seine River Siphon is leaking approximately 0.023 cm/s. To determine the cause, the siphon should be dewatered and inspected. The necessary repairs would be

at the discretion of the Manitoba Water Resources Branch with the recognition that the leaking will probably increase over time as the siphon deteriorates. If the siphon is not repaired, it should be tested for leaks on a yearly basis to monitor the problem. If it is repaired it should be tested every 2 or 3 years to ensure that leaking is under control.

6. The collection of debris at the siphon inlet is inhibiting flow through the siphon and entangling aquatic life such as snapping turtles. To resolve these problems a log boom should be placed across the river approximately 50 m upstream of the structure. This would intercept debris approaching the siphon. A regular maintenance program should be established to remove debris from the log boom and from the siphon inlet. The log

boom would have to be removed in the fall and replaced in the .spring to avoid ice damage.

7. Logs resulting from tree cutting along the river during the winter are contributing to the blockage of the siphon entrance. The parties involved in these activities should be made aware of the problems which result from not removing the logs from the ice once they are cut. The R.M.'s and local interest groups, such as S.O.S. Lorette, could dispense information regarding this matter.

# CHAPTER VI

## WATER DEMAND, SUPPLY AND ALLOCATION

The objective of this portion of the study was to assess the demand for water in terms of in stream flow needs and water withdrawals. This information can then be compared with the supply capabilities of the river to determine whether the Seine River is capable of meeting the demands being placed on it.

### 6.0 WATER DEMAND

Water demand is comprised of the amount of water required to meet the needs of the biological resources dependent upon the river (in stream flow needs) plus the amount of water required for human use. It is assumed in this study that when water quantities are limited, priority is given to meeting instream flow needs.

#### 6.0.1 INSTREAM FLOW NEEDS

Determining the instream flow needs required for biological resources is a very complicated matter requiring a good deal of judgment and expertise (Hatfield and Smith, 1985). Consequently the advice of Mr. Marc Gaboury, Fisheries Biologist for the Manitoba Fisheries Branch, was sought. Upon discussing various potential methods of determining instream flow needs it was determined that a method utilizing historical flows would be most appropriate given the scope of this study and the limited biological data available on the Seine River.

The approach utilized to establish instream flow needs was based upon the premise that flows prior to the initial operation of the Seine River diversion in 1961 were a more accurate indication of natural flows than flows since that time. This is due to the influence the diversion has had in regulating flows and the agricultural drainage activities which have taken place since the diversion was constructed.

Flow records at the Prairie Grove station have been collected from 1942 to the present. It was assumed that an acceptable value for instream flow needs would be the minimum mean monthly flow between June and September, for the period from 1942 to 1961. This flow would reflect the minimum flow conditions for which aquatic life was expected to survive in the relatively natural flow regime. It follows that this would be the logical threshold condition for which these species could be expected to survive today.

Mr. Gaboury pointed out that he has used a similar method for determining in stream flow needs in the past. It should be mentioned however, that in the Seine River instance, the period of record utilized does not predate man's influence on the Seine River. Some agricultural drainage had taken place prior to 1942 and some between 1942 and 1961. This development could be expected to have modified flow  somewhat. The flows cannot, therefore, be considered natural in the strictest sense. It is, however, assumed that the flows prior to 1961 would be a much better indicator of natural flows than flows since that time.

Review of the mean monthly flows (June-Sept.) recorded at Prairie Grove Gauging Station between 1942 and 1961 revealed that the lowest minimum mean monthly flow was 0.056 cm/s in September of 1955. This flow was not an anomaly for the period of record. A minimum mean monthly flow of 0.058 cm/s was recorded in September of 1958 and a flow of 0.063 cm/s was recorded in September of 1953. Consequently, the value of 0.056 was selected to represent the minimum mean monthly flow (June through September) prior to 1961.

Minimum mean monthly flows for the same months are much lower for the period of record following 1961. A flow of 0.009 cm/s was recorded in 1961,0.012 cm/s in 1967 and flows of 0.0 cm/s were recorded in September during the drought years of 1988 and
1990. This is an indication that minimum flows along the river during the summer months have decreased significantly since 1961.

To accurately reflect the in stream flow needs downstream of Prairie Grove, the minimum monthly flow value prior to 1961 (0.056 cm/s) was multiplied by 1.226 to account for the drainage area feeding the Seine River between Prairie Grove and Winnipeg. This results in a flow of 0.069 cm/s which represents the insteam flow value utilized in this study.

**6.0.2 WATER WITHDRAWALS**

The Seine River supplies irrigation water for several small market gardens and five golf courses. All municipal and domestic water used within the study area is obtained from groundwater sources, which provide a plentiful supply of good quality water (WRB, 1991a).

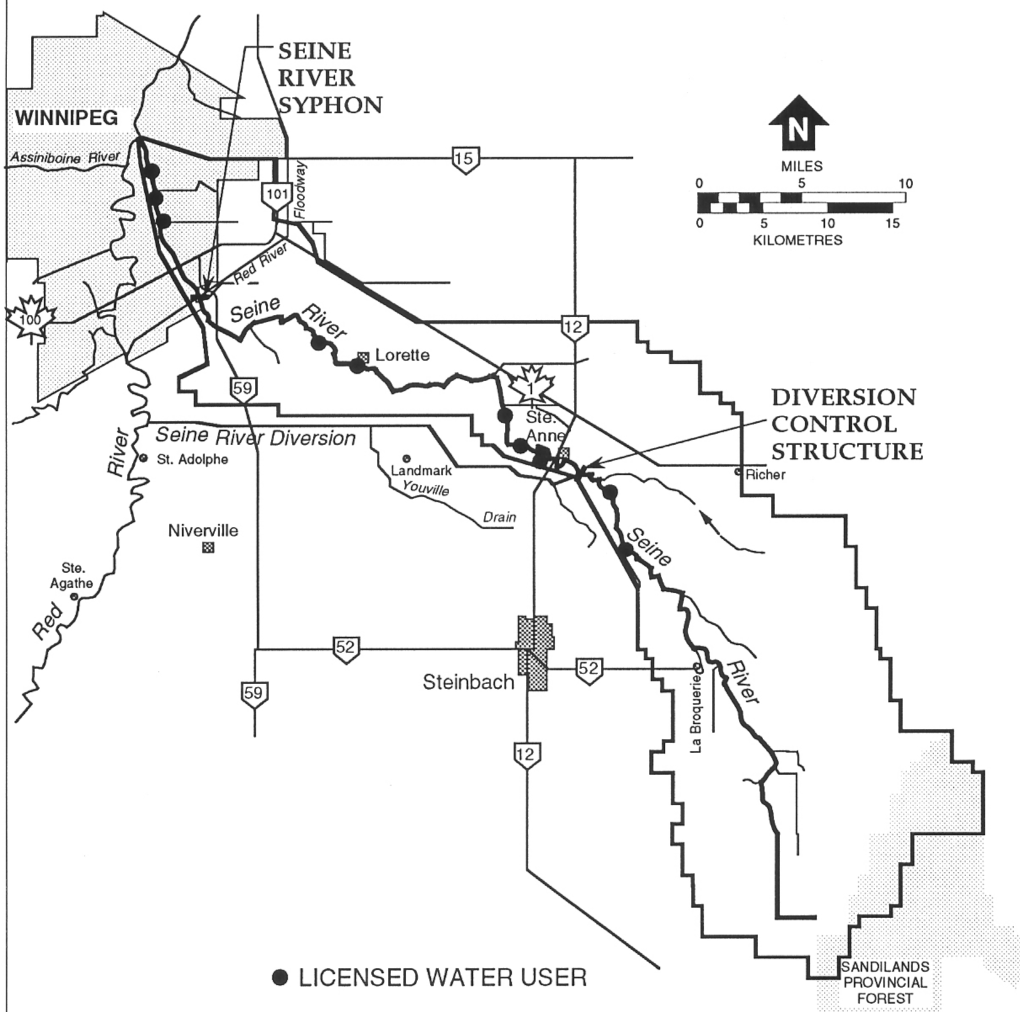
A total of ten water withdrawal licenses are currently issued for the Seine River. Table 1 is a list of the water users and the amount of flow they are licensed to withdraw. The amount of water allocated for withdrawal is determined by the Water Resources Branch at the time of licensing based on the pump capacity, and the purpose of the withdrawal.

**Table 1. Licensed Seine River Water Users**

| **Licensee** | **Licensed Withdrawal (ems)** |
|---|---|
| Windsor Park G.c. | 0.017 |
| R. Desrosiers | 0.040 |
| Niakwa G.C. | 0.054 |
| R. Grossman | 0.028 |
| J. Tytgat | 0.045 |
| E. Wyrzykowski | 0.028 |
| R. Chaput | 0.023 |
| R. Gauthier | 0.006 |
| F. Jeschke (Lorette G.c.) | 0.030 |
| St. Boniface G.c. | 0.050 |
| Total | 0.321 |

Figure 10 shows the location of the water users within the study area. An interview with each water user revealed some valuable information. Each user was questioned regarding the time of year that they pumped. The golf courses pump regularly from May through September. The other users only pump regularly during May and June and perhaps the early part of July.

None of the users had meters on their pumps but most could provide an accurate approximation of the amount of water being used based upon the application rate and duration of their pumping. The non-golf course irrigators typically irrigated for approximately 3 hours two times per week. Of greater concern is golf course irrigation which requires greater volumes of water and which places a demand on the Seine River during the lower flow months of July, August and September.




## SEINE RIVER LICENSED WATER USERS

Figure 1 0

The Niakwa golf course is the most upstream golf course along the Seine River within the city limits. Niakwa golf course pumps water from the Seine at an average rate of 200,000/day. Because the Seine River is a not a reliable source of water, Niakwa golf course has constructed storage reservoirs. This allows the golf course to fill the reservoirs during periods of high Seine River flow, and withdraw from the reservoirs during periods of low flow. As well, water storage is supplemented by a limited amount of well water. The well water is of low quality, consequently it must be mixed with the river water to be suitable for irrigation.

The Windsor Park golf course is located just downstream of Niakwa golf course. Under dry conditions Windsor Park golf course uses approximately 284,000 l/day, supplied entirely by the Seine River. The golf course has a dugout with a capacity large enough to allow them to fill the dugout from the Seine River during the day, and irrigate from the dugout at night.

St Boniface golf course is the furthest downstream water user along the Seine River. Historically the Seine River has been a very unreliable source of water for this golf course. During the dry summers of 1987 through 1989, St. Boniface golf course was limited to only watering greens on a regular basis. The flow simply was not available to meet the capacity of the pumping facilities. St. Boniface golf course has no water storage. They have attempted to drill for water on two occasions, but the quality of groundwater discovered was unsuitable for irrigation.

Two nine hole golf courses are located upstream of the floodway, one at Lorette and one just upstream of Ste. Anne. Though the golf course in Ste. Anne is not yet operational, a license has been issued for it to withdraw water. These golf courses place a smaller demand on water than the eighteen hole city golf courses.

All of the users interviewed stated that the amount of water they pumped was significantly lower than the quantity indicated on their water rights license. In many instances this was because the users did not pump at full capacity as their pumps were power take off driven and they could throttle down the tractor.

Each user was also questioned regarding the depth of flow in the river when they would no longer pump. The majority responded that they quit pumping when the depth of flow was too low to allow pumping without jeopardizing the pump (i.e. pumping silt etc.). Most were aware, however, that there was a cut-off flow stipulated on their license below which they are supposed to quit pumping.

To determine the water demand based on water withdrawal, the allocations for each water rights license were tallied. This amounted to a total of 0.321 cm/s as shown in Table 1. This value assumes a worst case scenario considering the low probability of all the users pumping at the same time. Furthermore, as already noted, many of the users indicated they do not pump at the maximum capacity of their pumps nor to the limit of their license.

Adding the instream flow requirements of 0.069 cm/s to the amount of water required for withdrawal purposes, results in a total demand of 0.390 cm/s. This is the demand placed on the river from May through June. From July through September the demand is 0.226 cm/s which reflects in stream flow requirements plus the demand of golf courses.

**6.1 WATER SUPPLY**

To determine the present supply capabilities of the Seine River, duration curves were plotted using the Manitoba Water Resources Branch duration curve plot program. This

program takes the mean daily flows for the period of record and sorts them, smallest to largest. A curve is then constructed indicating what percent of the time the daily flow is
expected to be less than a specified discharge.

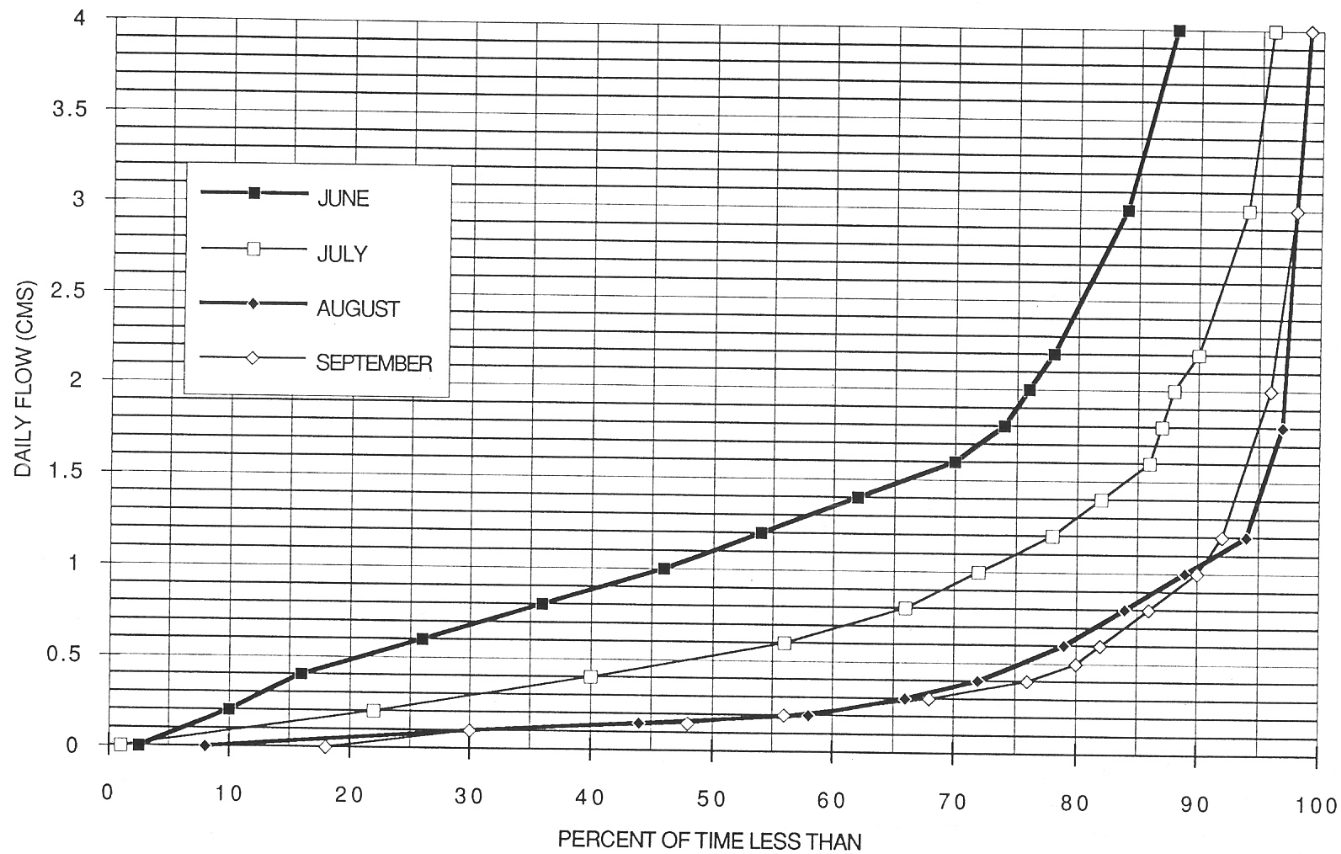
Figure 11 shows the duration curves plotted for this study. These curves are based on mean daily flow data collected at the Prairie Grove stations for the months of June through September from 1961 through 1990. As was the case with the hydrographs, the Prairie Grove data was multiplied by a factor of 1.226 to reflect the additional drainage area between Prairie Grove and the Seine River outlet.

Only the years from 1961 to 1990 were used to develop these curves in order to reflect the current flow conditions which have resulted from watershed development and flow regulation.

**6.2 LINKING SUPPLY AND DEMAND**

Using the June duration curve, the likelihood that the Seine River can satisfy the water demand when all of the users are pumping at the same time can be determined. The June curve indicates that the Seine River is capable of meeting the total demand of 0.39 cm/s approximately 84 percent of the time. This is considered to be a reliable source of water considering the unlikelihood that all the users will pump their limit at the same time.

The demand-supply situation changes during the period from July through September because regular water use during these months is confined to golf course irrigation. The total demand during these months was estimated to be 0.226 cm/s including in stream flow needs. The duration curves indicate flow would be greater than this value




**SEINE RIVER DURATION CURVE** **Figure11**

approximately 74% of the time in July, 40% of the time in August and 38% of the time in September. These values indicate that the Seine River is not a very reliable source of water for the purpose of golf course irrigation.

No irrigation schedule currently exists to control the timing of golf course withdrawal of Seine River water. An irrigation schedule should be established whereby the golf courses with storage capabilities pump during the day and irrigate at night. This would include the Niakwa and Windsor Park courses. St. Boniface golf course would then be scheduled to pump directly from the Seine River at night.

Placing the Winnipeg golf courses on an irrigation schedule would reduce peak water demand along the Seine River through the City of Winnipeg. Assuming all the golf courses utilized the same amount of water, peak water demand by City of Winnipeg golf courses would be reduced to approximately one-third of the current peak demand.

The implications of the supply-demand analysis go deeper than just indicating that the Seine is an unreliable source from July through September. It raises the issue of who gets the water when there is not enough to meet the total demand.

## 6.3 WATER ALLOCATION

The Manitoba Water Resources Branch is the water allocation authority in the province. Any party wishing to withdraw water from a surface or groundwater body at a rate greater than 25,000 liters/day must obtain a Water Rights License. Water must be allocated between competing users when supply is inadequate to meet demand. Such is the case along the Seine River, where the supply is inadequate to meet the demand on a seasonal basis.

To aid in making the allocation decisions within Manitoba, water use is divided into five categories based on the perceived value of water for each purpose. The following is a prioritized list of these purposes as outlined in the Manitoba Water Rights Act:

1. “domestic purposes” refers to the use of water, obtained from a source other than a municipal or community water system, at a rate of not more than 25,000 liters/day for household and sanitary purposes, for watering lawns and gardens and watering livestock and poultry.

2. “municipal purposes” refers to the use of water by a municipality or a community water distribution system for household and sanitary purposes, uses related to industry and for other purposes usually served by a municipal or community water distribution system;

3. “agricultural purposes” refers to the use of water at a rate of more than 25,000 liters/day for the production of primary agricultural products, but does not include the use of water for irrigation purposes;

4. “industrial purposes” refers to the use of water obtained from a source other than a municipal or community water distribution system, for the operation of an industrial plant producing goods or services other than primary agricultural products;

5. “irrigation purposes” refers to the use of water at a rate of more than 25,000 liters/day for the artificial application to soil to supply moisture essential to plant growth.

The allocation of water is not based solely on water use. In fact, a more important criteria is the date the user applies for a license. Manitoba uses a “first in time, first in right” allocation system, with the time being established by the date of application, not the date on which the license is issued. As a result of this policy, a lower priority user can obtain a water rights license ahead of a high priority user by applying for a license earlier.

Under the current allocation system, a water rights license does not guarantee the availability of a water supply. On unregulated streams (no storage reservoir) such as the Seine River, water is allocated on an availability basis.

To control water withdrawals when the amount of water available is insufficient to meet demand, cut-off flows are indicated on each user's water rights license. The cut-off flow is a threshold discharge below which the licensee's right to use water is lost because other users have prior right to the water remaining in the river (based on their application date).

Based on the time of application criteria, the highest priority user along the Seine River is the Niakwa golf course. This brings forth an important point. Where do in stream flow needs fit in? The Manitoba Water Resources Branch has no standard in this regard. This is a major weakness of the province's water allocation system. Based on the principles of a sustainable environment, instream flow needs should receive the highest priority. No water withdrawals should occur below the flow required to meet the instream flow needs.

As mentioned, the users of Seine River water indicated they paid little attention to the cut-off value, they simply pump until the flow is insufficient to feed the pump. It is asserted by the author that one of the major reasons the cut-off value is ignored is because there is no effective mechanism in place to provide users with an indication that they are pumping below their cut-off flow.

The water rights license stipulates a cut-off flow based on flows measured at the nearest gauging station, either Ste. Anne or Prairie Grove in the case of the Seine River. For example, the license for a water user located five miles downstream of Ste. Anne may stipulate a cut-off flow of 0.50 ems as measured at the Ste. Anne gauging station. If the user wished to know what the flow was at Ste. Anne on a given day, he/she would have to contact Water Survey of Canada. The problem is that flows are recorded on charts which are only checked once a week. Consequently, Water Survey of Canada is incapable of providing users with the information they require in order to know if they are pumping below their cut-off at any particular time. It is basically an unworkable system.

Mechanisms must be put in place to protect in stream flow needs and the rights of higher priority users when flows are too low to meet all the water demands. The user requires a benchmark corresponding to the depth of flow associated with his/her cut-off value. This benchmark should be located at or close to the pump intake.

Taking this concept one step further, a backwater analysis should be conducted from the Red River to the floodway for a series of discharges corresponding to the cut-off values of the golf courses. The pump intake for each golf course could then be permanently set at the elevation corresponding to their cut-off value. A similar process could be used for the golf courses upstream of the floodway using Mannings formula or, preferably, a backwater analysis if the survey information is available. No such mechanism is required for other users at this time since their pumping is not placing excessive demands on the river.

The process described above would provide users with a mechanism for knowing when flows are below their cut-off value and would help prevent pumping below that threshold value. This would effectively protect the rights of higher priority users and ensure that instream flow needs are not jeopardized by the over-withdrawal of water.

## 6.4 PROPOSED STRATEGIES

1. City golf courses utilizing the Seine River as a water source should be put on an irrigation schedule. This could be accomplished by capitalizing on the out of stream storage capabilities of the Niakwa and Windsor courses.

2. In keeping with the concept of sustainable resource use, Seine River water management practices should give instream flow needs the highest allocation priority. Once flows are below the in stream flow need value, no water withdrawals should be permitted.

3. Benchmark elevations should be established at or near the point of water withdrawal to indicate the stage below which the water user could no longer withdraw water. This elevation would correspond to the cut-off value stipulated on the water rights license. Backwater analysis could be used to establish this elevation where survey information is available, and the Mannings formula could be utilized in other circumstances. Consideration should also be given to staking the user's intake at the established elevation to ensure compliance with the cut-off flow.

# CHAPTER VII

# PUBLIC PARTICIPATION

## 7.0 GENERAL

Stakeholder involvement in this study proved to be beneficial in every respect. Valuable information regarding the history of the river, flooding, water use and technical data was obtained from a number of cooperative citizens, agencies and public organizations.

The working group, comprised of MLAs, representatives from S.O.S-Winnipeg, and a representative from the Ministry of Natural Resources, served to focus the study on areas of concern which required the greatest attention given a limited time period and budget. The working group setting facilitated a mutually educational experience that resulted in findings and recommendations which were consistent with the group's expectations. This occurred because the group was kept apprised of study undertakings, developments and findings as the study progressed.

By holding working group meetings on a regular basis throughout the study period, issues and concerns could be dealt with as they arose. Consequently, the findings and recommendations of this study should come as no surprise to those involved. Since those involved were assumed to represent the interests of the general public the chances of the study receiving favorable public acceptance should be increased.

One of the keys to achieving success in the working group setting was that there was a balance of representation by government, technical personnel and the public, all of whom were cooperative and sensitive to the views of others.

River management is an ongoing matter and those who live along the river can serve as the eyes and ears for water managers. Given the number of water related issues within the province, and the declining number of Water Resources Branch personnel, public involvement may be critical to improving river management. That would certainly appear to be the case in this situation, where relatively small changes to the management of the watershed could lead to significant improvements and a more satisfied public. The work is far from over as strategies have only been planned; they have not yet been implemented. Furthermore, new issues can be expected to arise in the future.

## 7.1 PROPOSED STRATEGIES

1. A Seine River Management Authority should be established with public representation from different areas of the watershed, the Manitoba Water Resources Branch, Manitoba Environment and the City of Winnipeg. There should also be representation from the private sector. Private enterprise users, such as non-city owned golf courses, rely heavily on the Seine River and their interests regarding its management must be represented. Working cooperatively, the purpose of the Seine River Management Authority would be to oversee the implementation of water management strategies, to provide recommendations pertaining to water related issues within the watershed and to promote sustainable resource use.

# CHAPTER VIII

# STRUCTURAL PROPOSALS

## 8.0 INTRODUCTION

There are two major water quantity problems related to the Seine River in the City of Winnipeg: insufficient flows and low water levels. To address these problems preliminary designs and cost estimates were prepared for two construction proposals.

The first proposal involves pumping water from the Red River into the floodway where it would flow by gravity to the location of the Seine River siphon. At the siphon location a lift station would pump the water into the siphon where it would then outlet into the Seine River downstream of the floodway and flow through Winnipeg.

The purpose of this proposal would be to provide a constant flow (minimum 0.042 cm/s) during periods of low Seine River flow. This would improve the ability of the Seine River to meet water withdrawal demand without jeopardizing instream flow needs. It would also improve the general condition of the river during no flow periods by providing a constant flow of water.

The purpose of the second proposal is to increase water levels in the Seine River through the City of Winnipeg. It involves the construction of a series of  1m high dams which would pool water from the Seine River outlet to the Red River Floodway. These dams were designed in a manner which would improve fish habitat by providing riffle areas for spawning. As well, during periods of little or no flow, aquatic life would not be restricted to the very small natural pools created by low spots in the river bottom, since the pools created by the dams would be much larger. Nesting habitat for waterfowl would also improve, due to the pond like setting created by the dams.

Each of the above proposals is described in more detail in the following sections.

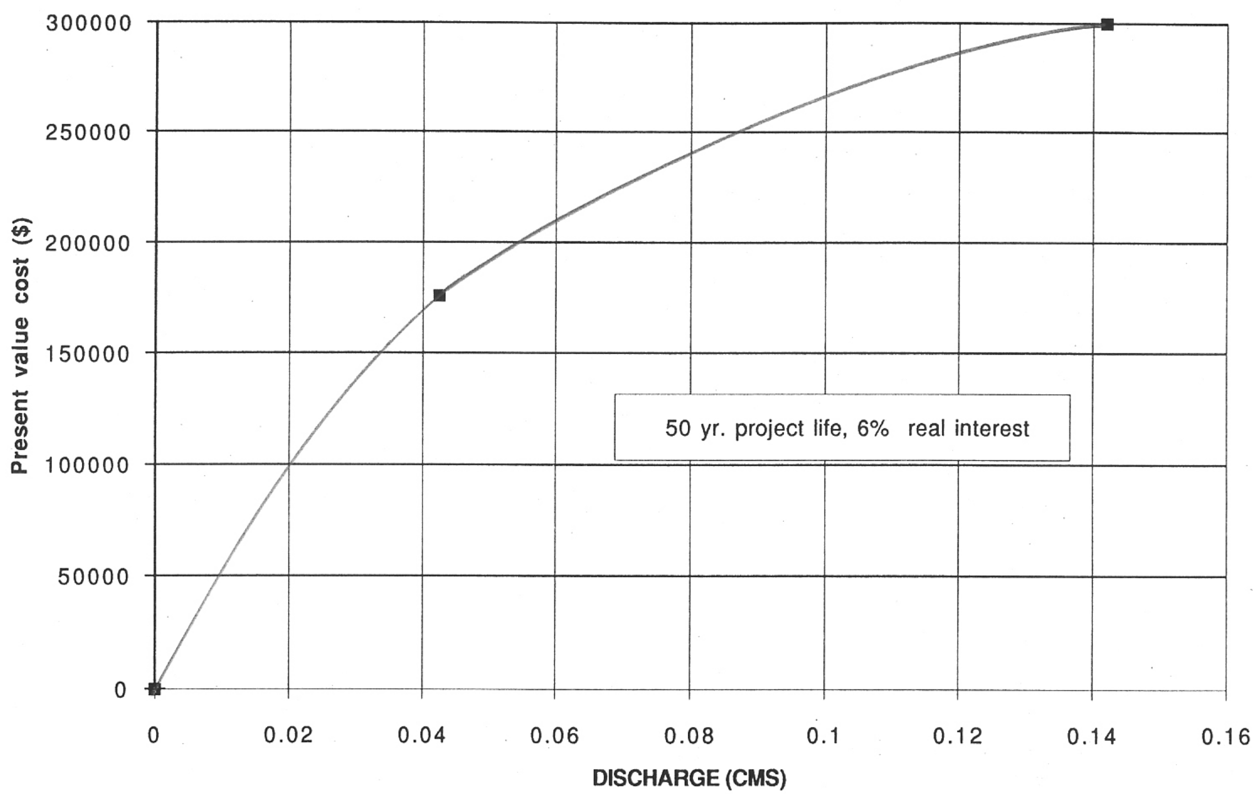
**8.1 SUPPLEMENTING FLOW**

Two major questions had to be addressed when considering supplementing Seine River flows. The first question concerned the amount of water required, i.e. how much water should be diverted? The second question involved the water source, i.e. where should the water come from?

The minimum amount of water to be diverted was determined to be 0.042 cm/s. This value was chosen because it would satisfy the demands of the golf courses in the City of Winnipeg provided the courses follow a staggered withdrawal irrigation schedule. If this demand is met, the problem of excessive withdrawals causing lower Seine River flows would be largely alleviated.

There may be a desire to divert more than the proposed 0.042 cm/s. In anticipation of cost inquiries regarding the higher volume diversions, a cost curve for various sized diversions from 0.042 cm/s to 0.142 cm/s was produced. This curve is shown in Figure 12.

The cost curve indicates that the total present value of the 0.042 cm/s diversion would be $ 175,600, and the total present value of the 0.142 cm/s diversion would be $300,000.
These costs, including maintenance costs, are based on a 50 year project life and a 6% real interest rate. Design details and cost estimate information are located in Appendix C.




RED RIVER TO SEINE RIVER DIVERSION COST FIGURE 12

The Red River was chosen as the source of water for a number of reasons. Firstly, much of the infrastructure required for diverting the water is already in place, that being the Red River Floodway. Secondly, the Red River was the only reliable source of water identified. Thirdly, the Seine River outlets into the Red River so any diverted water not withdrawn would be eventually returned to its source. Finally, the quality of water being diverted should not be significantly different than that of the Seine River at the Floodway because the diversion intake is upstream of Winnipeg's South End Sewage Treatment Plant. Furthermore the land uses in each watershed are similar (agriculture).

Water loss along the diversion route, caused by seepage from the floodway channel, was assumed to be negligible because the floodway is comprised of relatively impermeable clay soil.

The inlet portion of the diversion would draw water from the Red River and pump it into the low flow channel of the Red River Floodway. This would require one lift station on the east edge of the Red River, upstream of the floodway control structure. The lift station would be a 1.22 m diameter, 6.7 m high concrete manhole. The electric pump and operating controls would require a permanent hydro installation near the manhole.

The water in the Red would have to be raised approximately 5.5 m and then pumped 310 m horizontally into the floodway low flow channel. The water would then flow east by gravity towards the intersection of the Seine River and the Red River Floodway (Seine River Siphon location).

At the location of the Seine River siphon, a weir would be installed in the low flow channel of the floodway 13 m upstream of the siphon. This weir would block the diverted water in the floodway and form a pool upstream of the weir. The water in this pool would be pumped out of the floodway and into the siphon. It would then outlet from the siphon downstream of the floodway and subsequently flow by gravity through Winnipeg.

The dam would be a rock structure with a steel membrane to protect the weir from ice flow damage and make the structure impermeable. The crest of the weir would be 1.2 m above the bottom of the floodway low flow channel. A similar structure is located on Sturgeon Creek in Winnipeg. The Sturgeon Creek structure features a gated culvert through the weir so the impounded water can be drained when required. Consideration should be given to installation of this feature should the proposed structure reach the final design stage.

A lift station would be required on the north berm of the floodway, approximately 16 m west of the siphon. This lift station would pump water into the siphon. The manhole would be concrete, 1.2 m in diameter and approximately 8.0 m deep. Hydro would have to be brought to this location as well. The pump in this lift station would raise the water approximately 3.0 m from the floodway low flow channel to the siphon outlet.

Diverting water from the Red River to the Seine River would relieve the strain being placed on the Seine by water withdrawals and alleviate the conflicts of use which have developed. Such a scheme may be quite appealing to the golf courses reliant on the Seine River, for they would accrue significant benefits from a reliable source of water at a reasonable cost. The Province of Manitoba and City of Winnipeg may also be interested as the diversion proposal would benefit aquatic life, wildlife and waterfowl as well as generally improve the appearance of the river corridor through the City.

The parties mentioned above should be approached with the diversion proposal to establish their degree of interest based on their projected benefits. It should be possible to establish a cost sharing arrangement based on the benefits to each party involved.

Regardless of the amount of water diverted, an environmental license would be required prior to the construction of the project, pursuant to Manitoba Regulation 164/88 of the Environment Act. The undertaking would be considered a Class 2 development because it is a Water Development and Control project which meets the criteria set out in the regulation. Further studies may be required at the time of licensing, particularly with regard to the water quality implications of the project. The diversion would also require licensing under the Manitoba Water Rights Act to acquire the water rights to withdraw water from the Red River.

## 8.2 INCREASING WATER LEVELS

The proposed weirs in the City of Winnipeg were designed to drown out at bankfull stage. Weir height was limited to 1 m because the design does not utilize a steel membrane. Higher crest heights would require a steel membrane to maintain structural integrity. This would add significant cost to each structure.

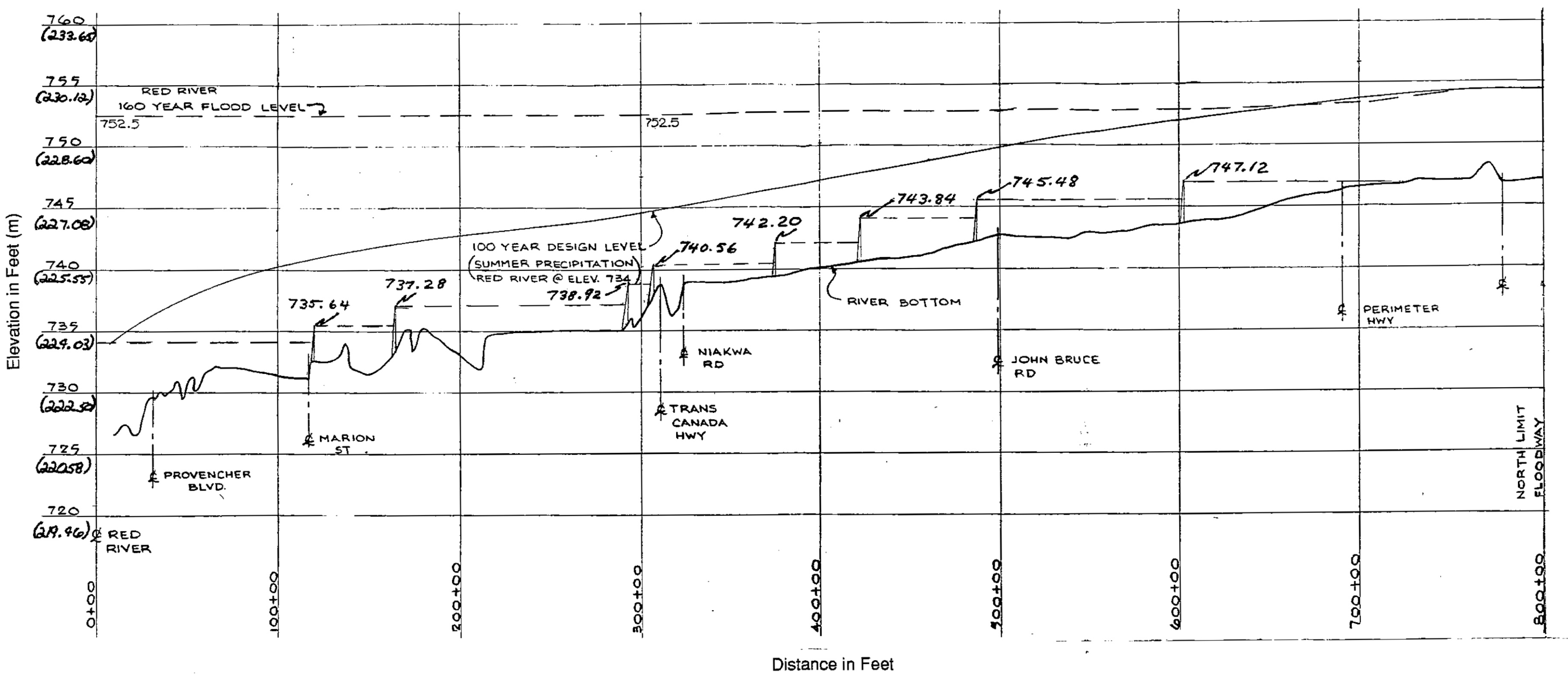
The design used for these weirs was adopted from the Manitoba Fisheries Branch. Each dam features an upstream slope of 4: 1, a V -shaped crest and a downstream chute with a slope of 20: 1. The weirs were designed to back water half way up the chute of the next upstream dam. These features are included in the design to provide for better fish passage, greater aeration, reduced velocities and hiding locations for fish among the rocks.

This type of weir has been utilized by the Fisheries Branch on a number of Manitoba waterways including the Mink and Icelandic rivers. Fisheries are very pleased with the design and have had no significant problems with icing or washouts to date. These are problems which might be expected when a steel membrane is not incorporated into the design.

Cross-sections of the Seine River were obtained from Acres Consulting Services Ltd. which had used the information for the Seine River Hydrology Study (Acres, 1978). During summer the Red River water level is controlled at a minimum elevation of 223.7m. This results in a backwater up the Seine River to approximately Marion Street. Consequently this site was chosen as the location of the first weir. The remaining weirs were located by drawing a horizontal line from the crest of the downstream weir until it intercepted a point 0.5 m. above the river bottom. Since all the weirs are to have a 1.0 m crest height, this corresponds to the elevation required to submerge approximately one half of the upstream dam's chute. A total of 8 weirs would be required to pool water from Marion Street to the Perimeter Highway. Figure 13 shows the location of the proposed weirs.

For cost estimating purposes, one weir was designed in detail; this being the furthest downstream weir with the largest cross-sectional channel area and therefore the highest structure cost. The cost of the first weir was multiplied by eight to give the total cost of the eight weirs.

The cost estimate for the most downstream weir was $6,000 based on Manitoba Water Resources 1991-92 table of unit prices and the Manitoba Fisheries Branch method of cost estimating such structures. Therefore, if there is a desire to pond water along the entire length of the Seine River through the City of Winnipeg, the total cost would be




SEINE RIVER PROFILE AND LOCATION OF PROPOSED WEIRS IN WINNIPEG

Figure 13

$48,000. It should be recognized that this project can be undertaken on a piecemeal basis; water does not necessarily have to be ponded all the way to the Perimeter Highway. Details regarding the preliminary designs and cost estimates for the weir proposal are located in Appendix D.

Ponding water during periods of low flow could encourage algae growth and stagnant water. Blooms of algae were experienced last year upstream of one of the weirs in Ste. Anne. In light of this, the weir option should only be employed if a diversion option is undertaken which would provide enough inflow to prevent stagnation.

## 8.3 PROPOSED STRATEGIES

1. The proposed Seine River Water Management Authority should approach various government jurisdictions and private enterprises regarding the possibility of funding the Red River to Seine River Diversion. The amount of water to be diverted would depend on the resources made available.

2. Weirs should be constructed if found to be desirable by the proposed Seine River Water Management Authority in consultation with the general public. Such structures are not recommended unless a constant inflow can be guaranteed. Manitoba Environment should be consulted to establish the potential impact that such a development may have on water quality.

# CHAPTER IX

# SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 9.0 SUMMARY

The Seine River has been subjected to many of the characteristics frequently associated with common property resources such as water. Included among these are over Included among these are over exploitation and inadequate resource management which have contributed to the low summer flow and water level problems being experienced in the lower Seine River. The purpose of this study was to develop water management strategies to alleviate these problems while minimizing the negative impact of manmade water control structures and water withdrawals. The overriding criteria governing formation of the strategies was that the river should be managed in a manner which meets human needs without jeopardizing the needs of the river environment. This factor is embodied in the conclusions and recommendations which follow.

## 9.1 CONCLUSIONS

Seine River summer flows (June - Sept.) were found be steadily declining since the Seine River Diversion came into operation in the early 1960's. This problem can be
partially attributed to agricultural drainage projects and recreational development which have resulted in a 23% loss in drainage area contributing to the Seine River for most of
the summer season.

The Seine River Diversion was also found to be a factor contributing to lower flows. The control structure has been operated in a manner which did not allow sufficient flow to pass through Ste. Anne prior to the commencement of Diversion flow. It was established that approximately three times as much flow (1.9 cm/s) could be allowed to pass through the control structure without aggravating flooding at or downstream of Ste. Anne.

Six small weirs were discovered in the river; none of which were contributing to the low flow conditions being experienced. Three of the weirs (dam #1, dam #2 and dam #6) were found to increase water levels during flows which exceeded the natural bankfull capacity and were therefore considered to be causing flooding which would not have occurred under natural conditions.

A leak test conducted on the Seine River Siphon revealed that it was leaking approximately 0.023 cm/s (23 lis) during low flows. Though this may be considered minor relative to the mean monthly flow of the river, it probably has significant implications during low flow periods given that this flow is 33% of the instream flow needs. Furthermore, the problem will probably get worse if left unattended, particularly if it is corrosion related.

Instream flow needs were determined to be 0.069 cm/s. For the month of June the water supply capabilities of the river were found to meet instream flow needs plus those for water withdrawal use. However, the river was unable to meet this demand on a reliable basis for the months of July through September.

When allocating water for withdrawal use, the Province does not place adequate priority on protecting instream flow needs. Nor is there an effective method in place to ensure that water users do not pump below the cut-off flow stipulated on their water rights licenses.

Under current conditions, where water users are unable or unwilling to adhere to their cut-off flows, water withdrawals could significantly reduce the river's flows during the summer months. This finding was based on a worst case scenario where all users were pumping at full capacity and all were pumping at the same time; an event which was considered unlikely. None the less, adherence to cut-off values would reduce the impact water withdrawals have on Seine River flows.

Though somewhat time consuming, involvement of the public in this matter was beneficial in all regards. It improved the quality of the study by providing information and insight which was critical to developing sound water management strategies. It also provided a mutually educational experience regarding river management and served to focus the study on concerns of the greatest priority. The experience of the author was that the government and public could work very effectively in an effort to co-manage the Seine River.

The proposed water management strategies considered technical, environmental and economic factors. At the same time they are practical, attempting to meet the needs of both nature and society. In this sense the strategies must be considered sound. Yet, it must be recognized that the Seine River environment can never be returned to its natural state. The water regime has been permanently altered by agricultural and urban development, water control structures, and the demand that humans place on the river's water for irrigation. It is not unreasonable, however, to expect measures to be undertaken to improve the condition of the river so that it more closely resembles its natural condition.

## 9.2 RECOMMENDATIONS

A Seine River Water Management Authority should be established with public representatives from various areas within the watershed as well as personnel from the City of Winnipeg, Manitoba Environment and Manitoba Water Resources. Representation must also be obtained from the private sector, including golf course owners, to ensure that their interests are considered. Though the Seine River Water Management Authority would have no legislated power at this time, its mandate would be to provide recommendations pertaining to water related issues within the watershed and to promote sustainable resource use. One of the first tasks of the newly formed group would be to work cooperatively with the appropriate government agencies to implement the following water management strategies:

1. Additional agricultural drainage works which would result in drainage area loss from the Seine River Watershed should be prohibited.

2. The Manitoba Water Resources Branch should undenake an assessment to ensure that the Lake Riviera reson operates its outlet structure in accordance with its licensed full supply level. The Water Resources Branch should also investigate the unauthorized groundwater withdrawals taking place at the reson.

3. The downstream dam in Lorette (dam #1) should be lowered 0.69 m and the upstream dam in Lorette (dam #2) should be removed completely.

4. All dams in the Seine River should be licensed under the Manitoba Water Rights Act and a hydraulic analysis should be undenaken before the license is issued. This would

allow the Water Resources Branch to maintain an inventory of the dams and determine their cumulative impact.

5. The Seine River Diversion Control Structure should be operated at gate settings of 50 cm during the summer months to allow flushing flows to pass downstream of Ste. Anne without significantly increasing flood levels.

6. The Seine River siphon should be inspected and repaired by the Manitoba Water Resources Branch. The structure should then be monitored for leaks at least once every three years. As well, a log boom should be stretched across the river approximately 50 m upstream of the siphon to collect debris and prevent the siphon inlet from plugging. The debris collected by the log boom should be removed approximately once every two weeks. At the same time, any debris lodged against the siphon inlet grate should be removed.

7. In keeping with the concept of sustainable resource use, management of the Seine River should be such that instream flow needs receive the highest allocation priority. Once river flows are below the instream flow need quantity, no water withdrawals should be permitted.

8. An irrigation schedule should be established for the Winnipeg golf courses which withdraw water from the Seine River so that only one golf course is pumping at a time.

9. A suitable mechanism should be employed to provide water users with an indication that they are pumping below the cut-off values stipulated on their Water Rights Licenses. A stake relating the cut-off flow to a water level may be an appropriate means of accomplishing this.

10. A water diversion from the Red River to the Seine River (via the Red River Floodway) could benefit a number of parties. These beneficiaries should be approached regarding a cost-sharing agreement based on desired quantities of water. This should be done in consultation with the public and the appropriate river management authorities.

11. If the diversion proposed in Recommendation 10 is constructed, ensuring a constant inflow of water, consideration should be given to increasing water levels in the Seine by constructing a series of small weirs in the Winnipeg reach of the river.

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# APPENDIX A

# ASSESSMENT OF DAM #1 IN LORETTE

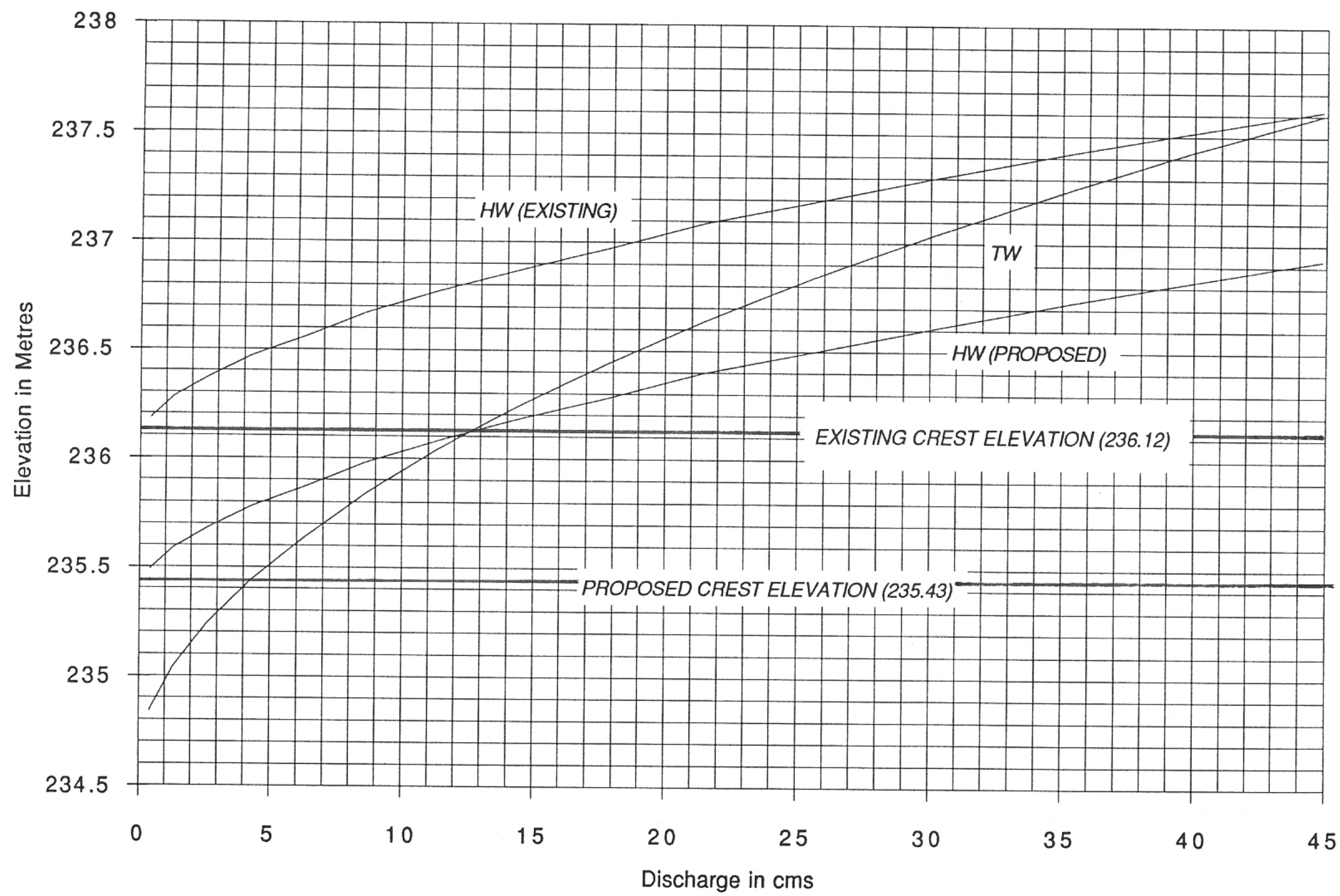
## ASSESSMENT OF DAM #1 IN LORETTE

To determine the effect of the furthest downstream dam in Lorette (dam #1) rating curves had to be developed for the channel downstream of the dam and for the dam itself. Information on the configuration of the channel near the dam site was obtained from field books EC 752 and EC 669. These surveys were conducted by the Manitoba Engineering and Construction Branch in 1982 for the purposes of flood risk mapping the community.

Utilizing the above survey information, a tailwater rating curve was established for the dam based on Mannings formula for determining discharge/depth relationships in an open channel. The roughness coefficient (n value) used in this calculation was 0.033 based on site inspection and reference to Ven Te Chow's "Open Channel Hydraulics"(1959). This text provides information regarding the n-values appropriate for various channel conditions. The channel in this instance was relatively clean, winding and had some pools. As well the top width of the channel was less than 30 m.

As mentioned a rating curve also had to be developed for flow over the darn. This curve was constructed utilizing a computer program at the Manitoba Water Resources Branch. The program is based on the broad crested weir formula presented by C. D. Smith (1978). The top of the darn was surveyed to determine its configuration. The crest elevation was determined in previous surveys of the structure which were obtained from the Municipality of Tache.

The rating curves for the existing dam and tail water condition are shown in Figure 1. The curve reveals that under existing conditions the dam does not completely drown out until a flow of 45 cms. This is the flow at which the tailwater rating curve (the water surface elevation determined by natural channel capacity) results in a higher depth of




**RATING CURVE FOR DAM #1 IN LORETTE** **FIGURE 1**

flow than the headwater rating curve (the water surface elevation determined by the dam for the same flow).

This fact alone is of little value without knowing whether the channel capacity is exceeded prior to drown out (45 cms). If the channel capacity is less than 45 cms the dam should be lowered in order to meet the criteria established for dam height (ie. drown out at bankfull stage).

The channel capacity through Lorette was determined by generating water surface profiles using the Hec-2 Water Surface Profile computer program developed by the U.S. Army Corps of Engineers. Using the tailwater rating curve at the dam site to determine starting elevations, water surface profiles were developed for various flows. The channel n-value chosen for the backwater calculations was 0.033. This value was selected based on site inspection and reference to Ven Te Chow's "Open Channel Hydraulics" (1959).

The water surface profiles generated from the backwater analysis were compared to the top of bank elevations of the river's cross sections to determine the existing capacity of the river. Though the capacity varied somewhat from section to section, the reaches of the river having the lowest capacity were able to pass a 13 cms flow. This flow was accepted as the existing capacity of the Seine River through Lorette.

The above analysis determined that dam must not cause an increase in upstream water surface elevation when flow equals 13 cms. By determining the headwater caused by varying dam heights (using the broad crested weir formula mentioned above) it was determined that this condition is satisfied when the dam is lowered approximately 0.69 m. to an elevation of 235.43 m.

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# APPENDIX B

# ASSESMENT OF DAM #6 IN STE. ANNE

## ASSESSMENT OF DAM #6 IN STE. ANNE

To develop a tailwater rating curve for the diversion control structure a backwater analysis was undertaken from the upstream dam in Ste. Anne (dam #6) to the outlet of the diversion control structure. Dam #6 in Ste. Anne is located 2.4 km downstream of the diversion control structure.

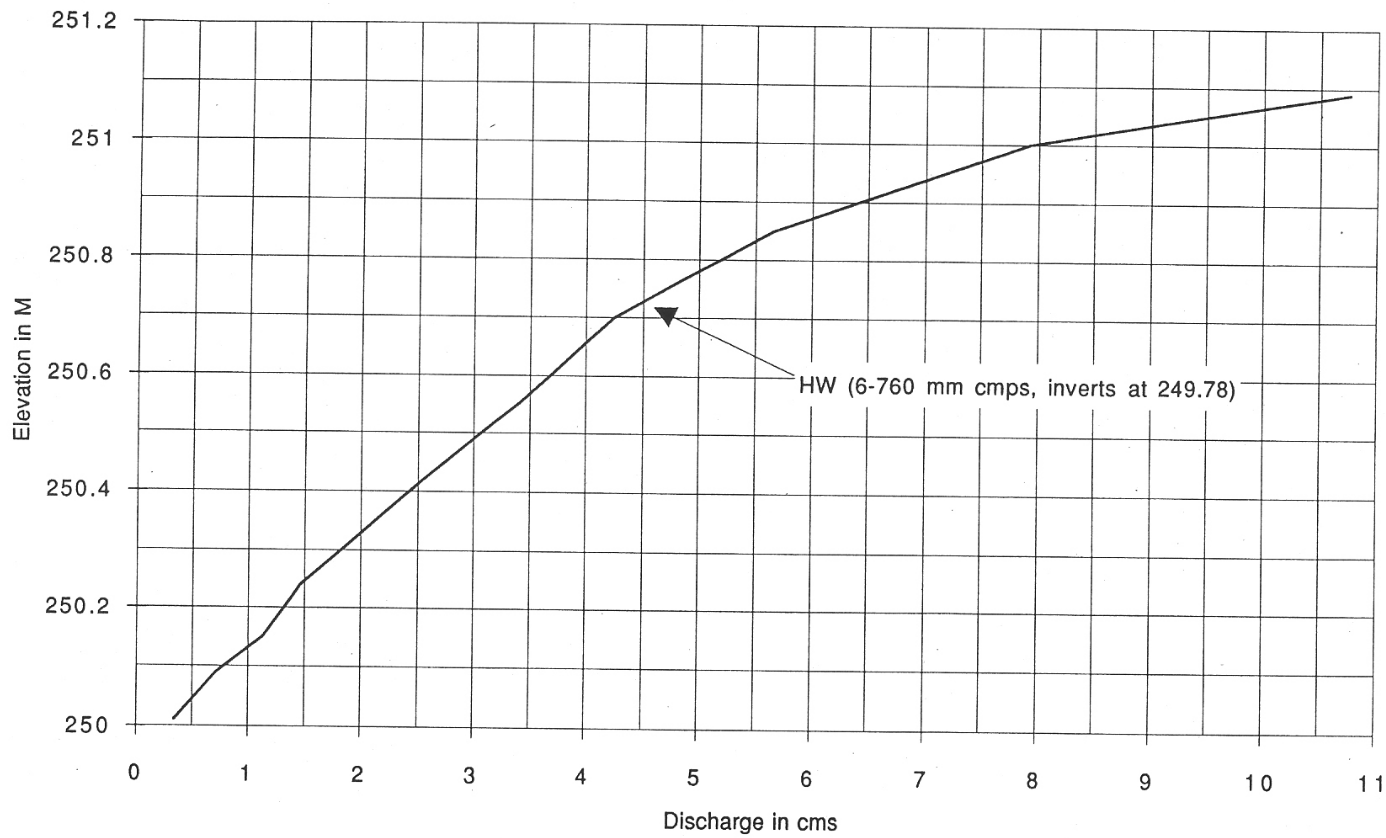
The survey information used in the backwater calculations was obtained from the Manitoba Water Resources Branch. The field book numbers are as follows: EC 563, EC 565 and EC 841. These surveys were completed in 1982. Design details of the Ste. Anne dam were obtained from the Village of Ste. Anne Operations Manager.

Starting elevations for the backwaters were determined by developing a headwater rating curve for the dam. The dam is an earth, rock and gravel structure with 6-760 mm diameter cmps with inverts placed at 249.78 m. The headwater rating curve shown in

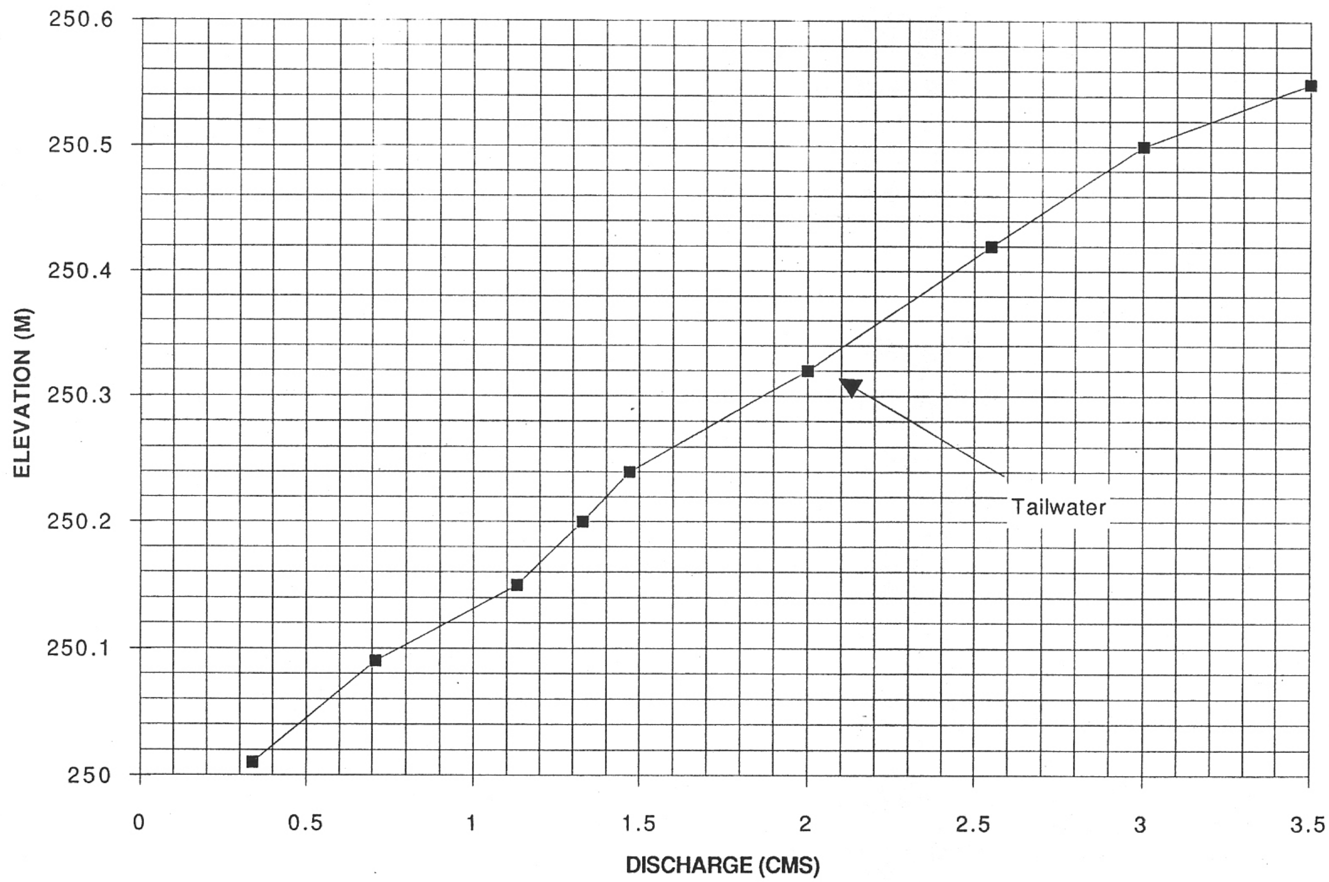
Figure 1 was constructed using a computer program for calculating head loss through cmps operating under inlet control.

The channel n-value chosen for the backwater calculations was 0.033. This value was selected based on site inspection and reference to Ven Te Chow's "Open Channel Hydraulics" (1959). This text provides information regarding the n-values appropriate for various channel conditions. The channel in this instance was relatively clean, winding and had some pools. As well the top width of the channel was less than 30 m.

The Hec II backwater computer program was used to generate the water surface profiles from upstream of the dam to downstream of the control structure. The resulting tailwater rating curve for the control structure is shown in Figure 2.




**RATING CURVE FOR DAM #6 IN STE. ANNE** **FIGURE 1**




TAILWATER RATING CURVE FOR SEINE R. DIVERSION CONTROL STRUCTRURE FIGURE 2



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# APPENDIX C

# PROPOSED RED RIVER TO SEINE RIVER DIVERSION

## APPENDIX C TABLE OF CONTENTS

Total Cost of Proposed Diversion

42.5 LIS Diversion

(Project Life = 50 years, Interest Rate = 6%)

| | | |
|---|---|---|
| Capital Cost | - Diversion Inlet $53,400 | |
| | - Diversion Outlet $88,900 | |
| | Total Capital Cost | $142,300 |
| Operational Cost | - Hydro for Inlet Pump $6831 yr | |
| | - Hydro for Outlet Pump $477 Iyr | |
| | Total Operational Cost $1160/yr | |
| | Present Value of Cost Stream 1160*15.762 | $18,300 |
| Maintenance Cost | - Maintenance Contract for 2 stations $42S I yr | |
| | Present Value of Cost Stream 425*15.762 | $6,700 |
| | - Overhaul Pumps every 5 years @ $15OO/pump | |
| | Present Value | $4,200 |
| | - Replace Pumps every 20 years @ $SOOO/pump | |
| | Present Value | $4,100 |
| Total Present Value of Proposed Diversion | | $ 175,600 |

Cost Estimate of Diversion Inlet

42.5 L/S Diversion

| | |
|---|---|
| Pump - 1 Flygt model CP3127LT w / imp 412 | |
| (includes control pane) | $5,000 |
| Manhole - 1 - 1.22 m dia X 6.7 m long | |
| (Top Elv. = 752 ft)(Bottom Elv. = 730 ft) | $5,000 |
| Pipe - 73 m long X .61 m dia sclairpipe | |
| ($160/m installed) | $11,600 |
| Pipe - 310 m long X .20 m dia sclairpipe | |
| ($23 / m installed) | $7,100 |
| Hydro - Cost to bring electricity to manhole | $10,000 |
| Cost of equipment and installation | |
| Contingencies (20%) | $ 38,700 |
| | $7,700 |
| Sub-Total | $46,400 |
| Engineering (15%) | $ 7,000 |
| Total Estimated Cost of Proposed Diversion Inlet | $ 53,400 |

Cost Estimate of Diversion Outlet

42.5 LIS Diversion

| | |
|---|---|
| Pump - 1 Flygt model CP3127MT wi imp 436 | |
| (includes control panel) | $5,000 |
| Manhole - 1 - 1.22 m dia X 7.9 m long | |
| (Top Elv. = 764 ft)(Bottom Elv. = 738.5 ft) | $6,000 |
| Pipe - 137 m long X .61 m dia sclairpipe | |
| ($160/m installed) | $21,900 |
| Pipe - 20 m long X .20 m dia sclairpipe | |
| ($23 I m installed) | $500 |
| Hydro - Cost to bring electricity to manhole | $15,000 |
| Weir - Steel membrane - rock structure | $16,000 |
| Cost of equipment and installation | $ 64,400 |
| Contingencies (20%) | $12,900 |
| Sub-Total | $77,300 |
| Engineering (15%) | $ 11,600 |
| Total Estimated Cost of Proposed Diversion Outlet | $ 88,900 |

Total Cost of 142 LIS Diversion

(Project Life = 50 years, Interest Rate = 6%)

| | | |
|---|---|---|
| Capital Cost | - Diversion Inlet $96,600 | |
| | - Diversion Outlet $134,800 | |
| | Total Capital Cost | $231,500 |
| | | |
| Operational Cost | - Hydro for Inlet Pump $184O/yr | |
| | - Hydro for Outlet Pump $1200/yr | |
| | Total Operational Cost $304O/yr | |
| | Present Value of Cost Stream 3040*15.762 | $48,000 |
| | | |
| Maintenance Cost | - Maintenance Contract for 2 stations $425/yr | |
| | Present Value of Cost Stream 425*15.762 | $6,800 |
| | - Overhaul Pumps every 5 years @ $1500/pump | |
| | Present Value | $4,200 |
| | - Replace Pumps every 20 years @ $23,000/2 pumps | |
| | Present Value | $9,500 |
| | | |
| Total Present Value of 142 LIS Diversion | | $ 300,000 |

Cost Estimate of Diversion Inlet

142 LIS Diversion

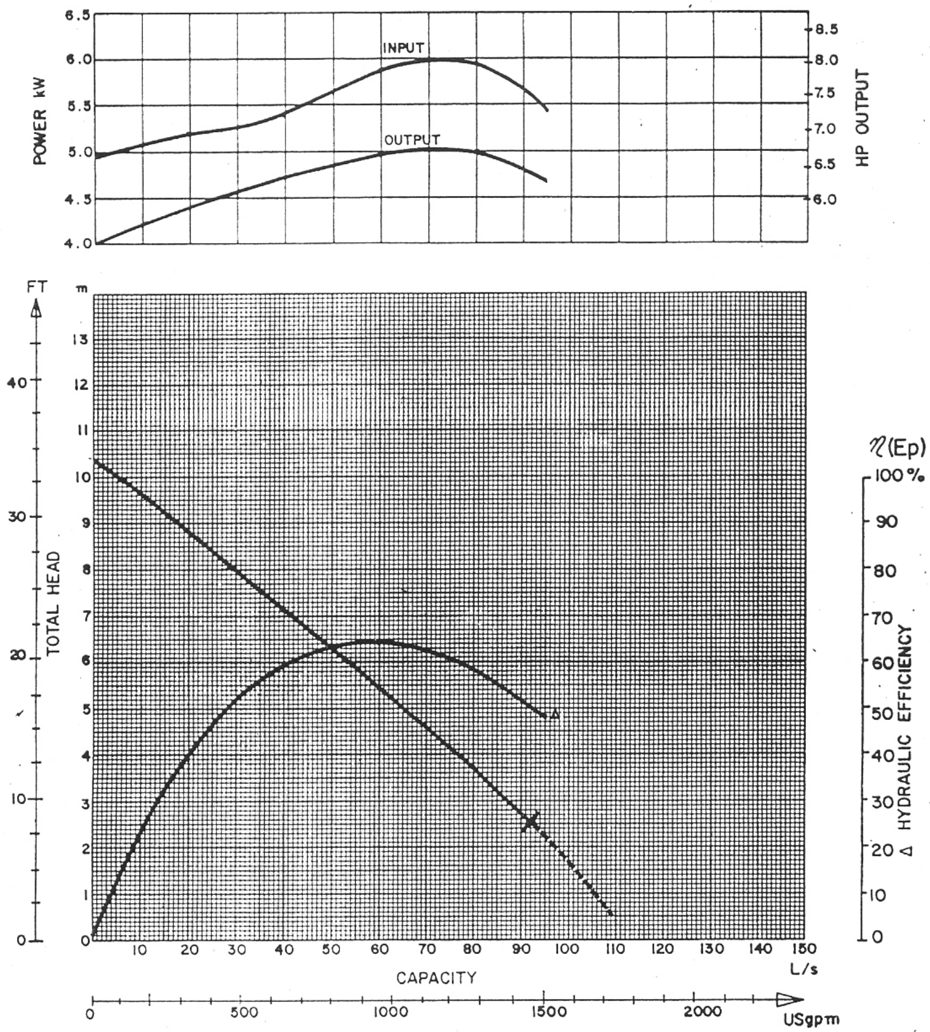
| | |
|---|---|
| Pump - 1 Flygt model CP3201MT wi imp 825 | |
| (includes control panel) | $14,000 |
| | |
| Manhole - 1 - 1.22 m dia X 6.7 m long | |
| (Top Elv. = 752 ft)(Bottom Elv. = 730 ft) | $5,000 |
| | |
| Pipe - 73 m long X .914 m dia sclairpipe | |
| ($370 I m installed) | $27,000 |
| | |
| Pipe - 310 m long X .305 m dia sc1airpipe | |
| ($45 I m installed) | $14,000 |
| | |
| Hydro - Cost to bring electricity to manhole | $10,000 |
| | |
| Cost of equipment and installation | $ 70,000 |
| Contingencies (20%) | $14,000 |
| Sub-Total | $84,000 |
| Engineering (15%) | $ 12,600 |
| | |
| Total Estimated Cost of 142 LIS Diversion Inlet | $ 96,600 |

Cost Estimate of Diversion Outlet

142 LIS Diversion

| | |
|---|---|
| Pump - 1 Flygt model CP3152LT wi imp 624 | |
| (includes control panel) | $9,000 |
| Manhole - 1 - 1.22 m dia X 7.9 m long | |
| (Top Elv. = 764 ft)(Bottom Elv. = 738.5 ft) | $6,000 |
| Pipe - 137 m long X .914 m dia sc1airpipe | |
| ($370/m installed) | $50,700 |
| Pipe - 20 m long X .305 m dia sc1airpipe | |
| ($45 I m installed) | $1,000 |
| Hydro - Cost to bring electricity to manhole | $15,000 |
| Weir - Steel membrane - rock structure | $16,000 |
| Cost of equipment and installation | $ 97,700 |
| Contingencies (20%) | $19,500 |
| Sub-Total | $117,200 |
| Engineering (15%) | $ 17,600 |
| Total Estimated Cost of 142 LIS Diversion Outlet | $ 134,800 |

PUMP CURVE @ DIVERSION INLET




CURVES SHOW PERFORMANCE WITH CLEAR WATER AT 20°C

| IMPELLER | | | | | | MOTOR OUTPUT | | MOTOR RATING kW (HP) | | RPM | PHASE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CODE | PART NO. | VANE | DIA. | Kgm² | SPHERE SIZE | kW | HP | CP/CS | CT | | |
| 412 | 441 30 02 | 2 | 150 | | 76mm (3") | 5 | 6.7 | 5.5 (7.4) | ——— | 1750 | 3 |

| | | | |
|---|---|---|---|
| FLYGT CANADA | C 3127 LT<br>IMPELLER 412 | SECTION C 3127 | |
| | | PAGE 6C | ISSUE 3 |



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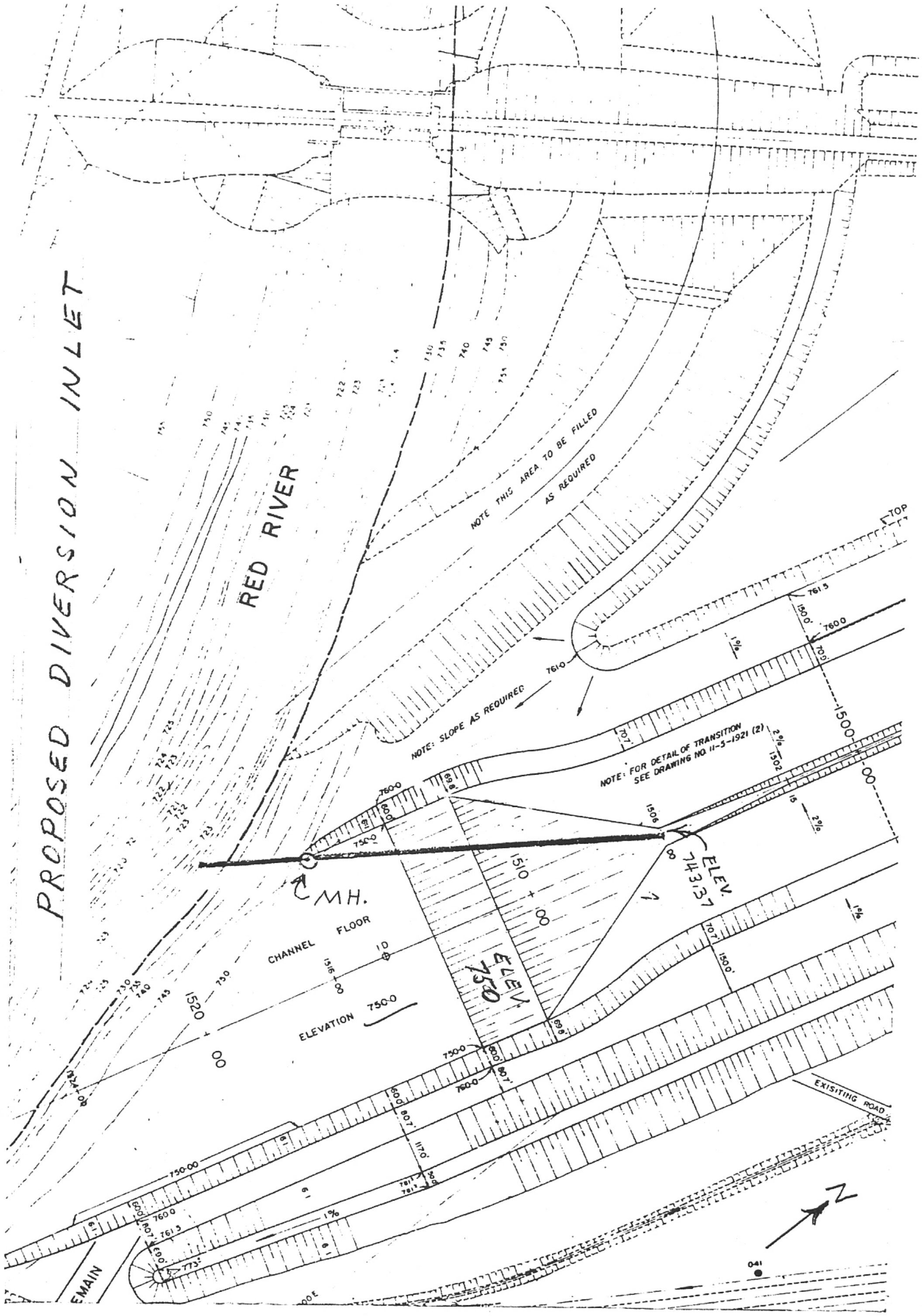
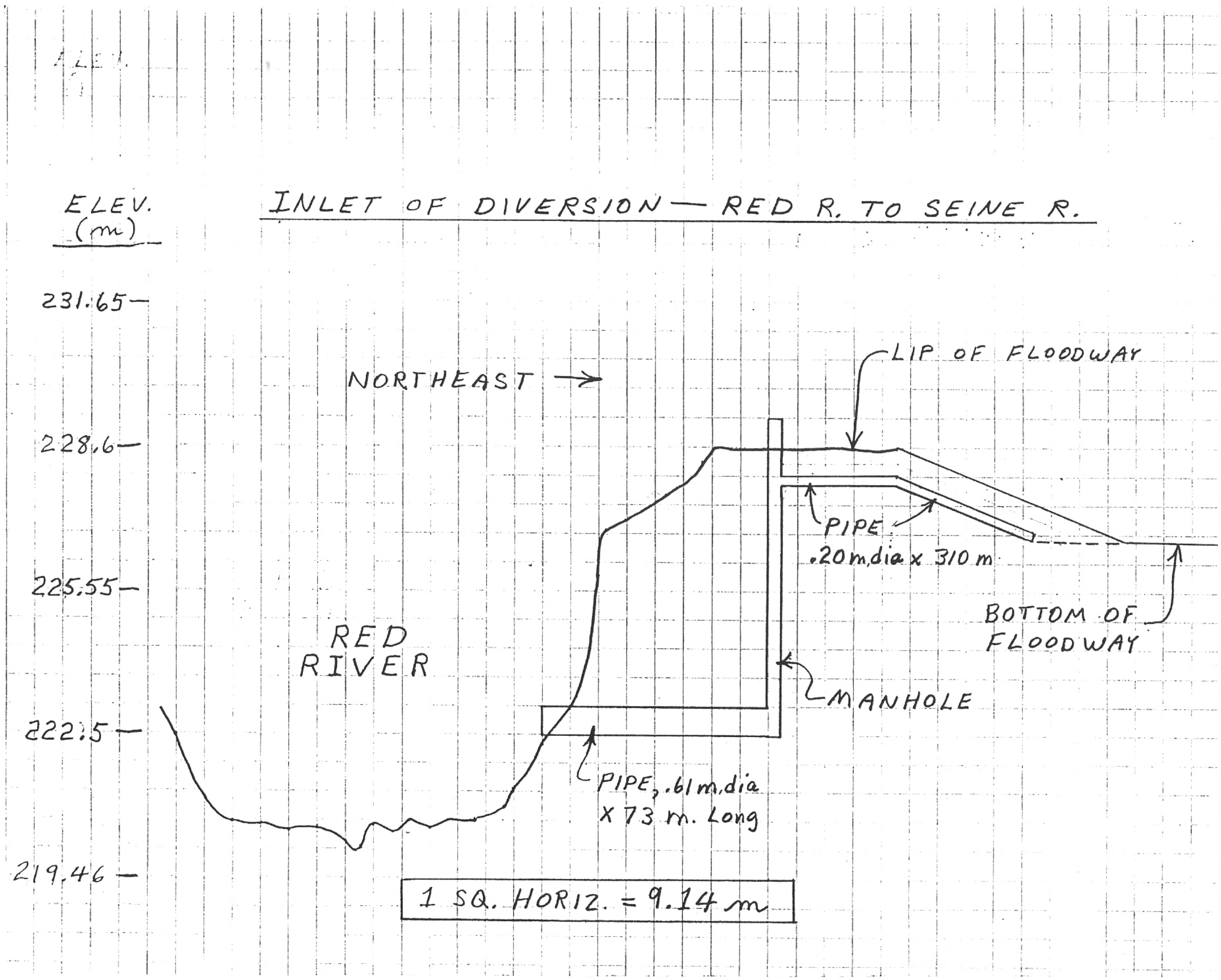
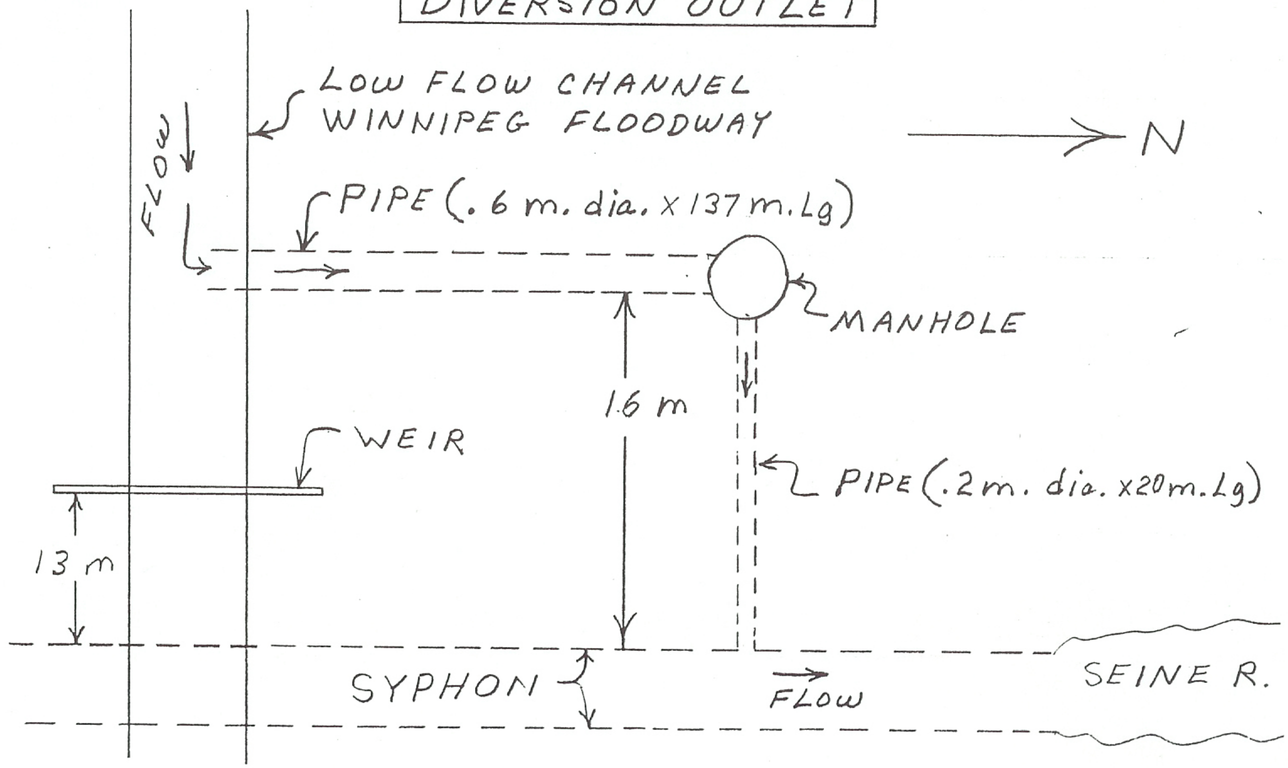
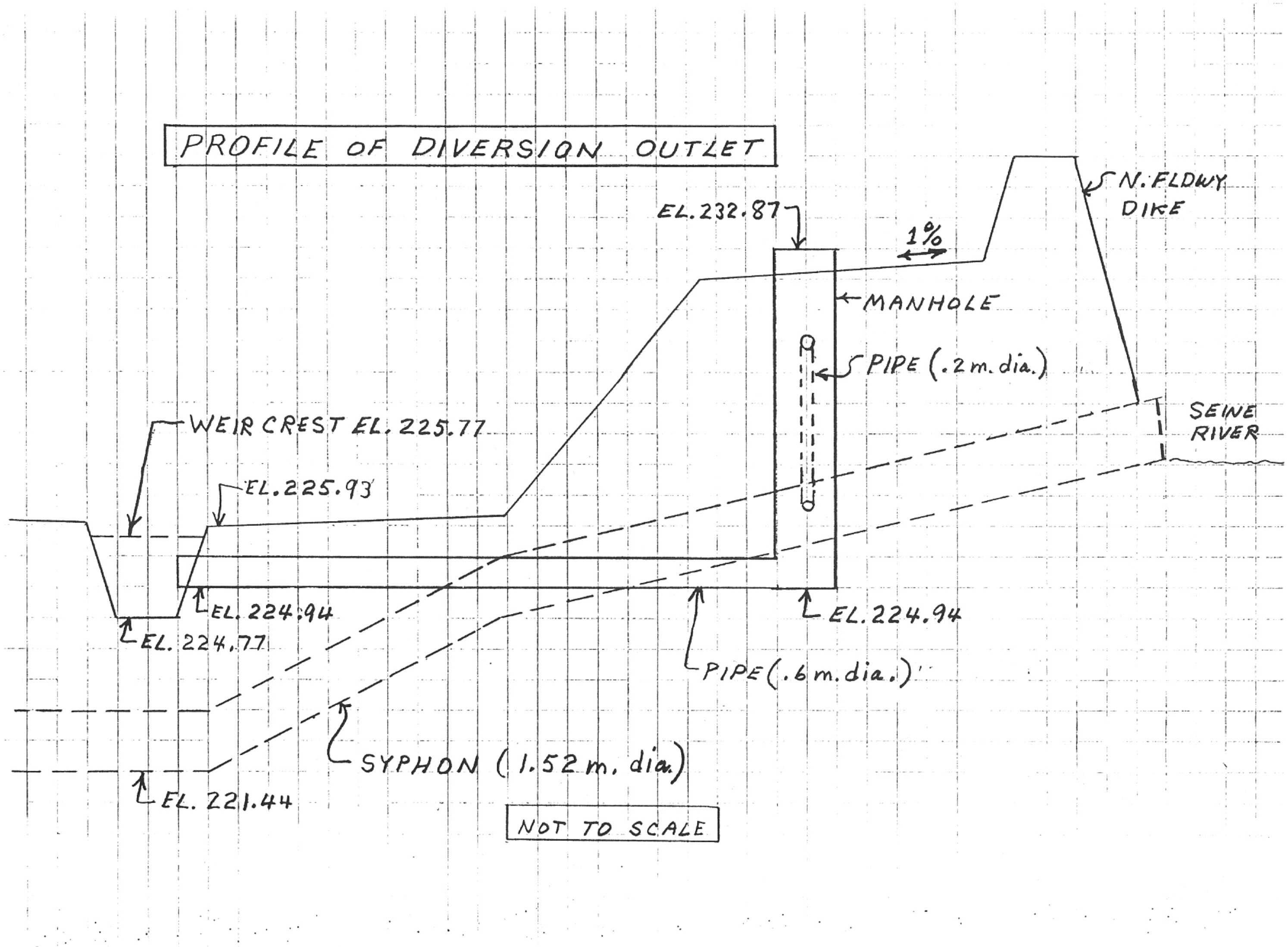

PROPOSED DIVERSION INLET
RED RIVER
NOTE: THIS AREA TO BE FILLED AS REQUIRED
NOTE: SLOPE AS REQUIRED
NOTE: FOR DETAIL OF TRANSITION SEE DRAWING NO. 11-5-1921 (2)
MH.
ELEV. 743.37
ELEV 750
CHANNEL FLOOR
ELEVATION 750.0
1510 + 00
1520 + 00
1500 + 00
EXISITING ROAD
N


ELEV. (m)
INLET OF DIVERSION — RED R. TO SEINE R.
231.65
228.6
225.55
222.5
219.46
NORTHEAST
LIP OF FLOODWAY
PIPE .20m.dia x 310 m
BOTTOM OF FLOODWAY
RED RIVER
MANHOLE
PIPE, .61m.dia X 73 m. Long
1 SQ. HORIZ. = 9.14 m

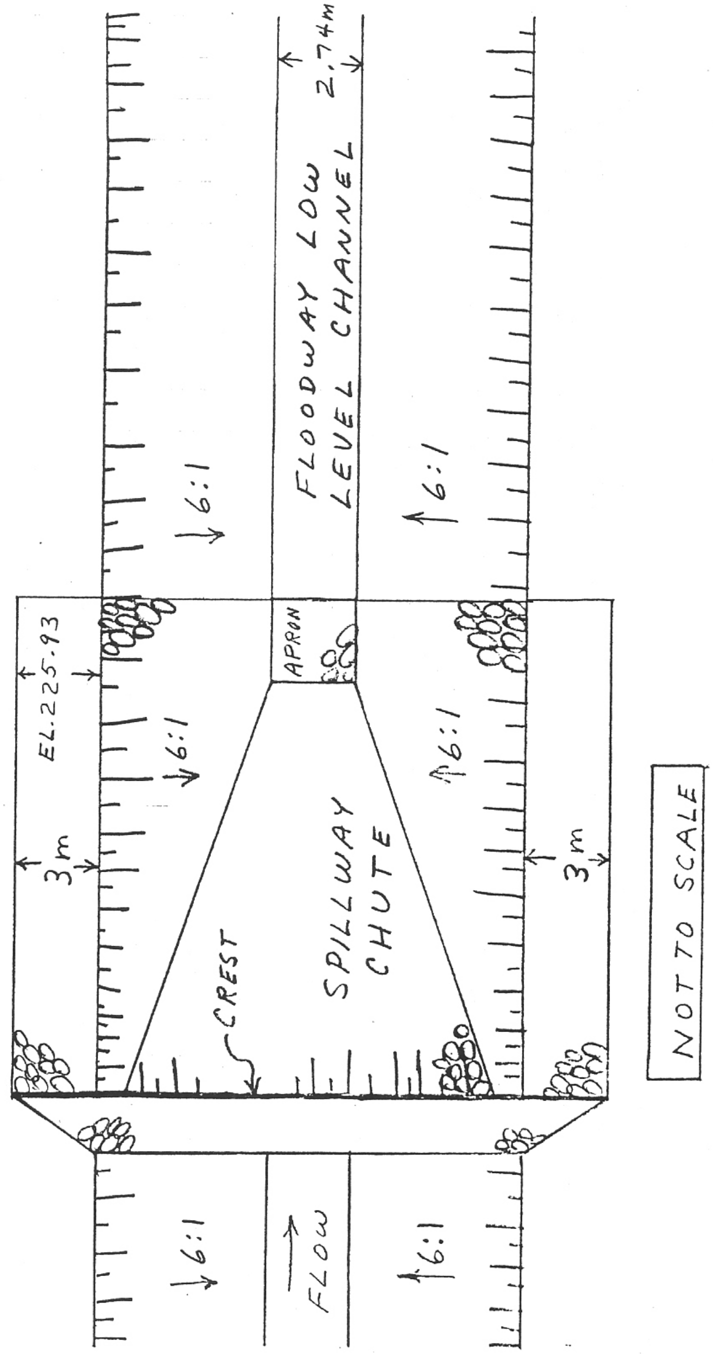
PLAN VIEW
of
DIVERSION OUTLET




NOT TO SCALE


PROFILE OF DIVERSION OUTLET
N. FLDWY DIKE
EL. 232.87
1%
MANHOLE
PIPE (.2 m. dia.)
SEINE RIVER
WEIR CREST EL. 225.77
EL. 225.93
EL. 224.94
EL. 224.77
EL. 224.94
PIPE (.6 m. dia.)
SYPHON (1.52 m. dia)
EL. 221.44
NOT TO SCALE

PLAN OF WEIR AT DIVERSION OUTLET



DESIGN DETAILS FOR EROSION CONTROL STRUCTURE E2 PROGRAM WRITTEN BY D.M.LUDWIG

LOCATION -- WEIR AT DIVERSION OUTLET

DISCHARGE DATA -- DESIGN DISCHARGE = 1.63 cu. m./s
-- 2% DISCHARGE = 1.63 cu. m/s

CHANNEL DATA -- UPSTREAM -- DEPTH OF FLOW AT DESIGN DISCHARGE = 1 m
-- PROPOSED BASE ELEVATION = 224.77 m
-- DOWNSTREAM -- BASE WIDTH = 2.74 m
-- BASE ELEVATION = 224.77 m
-- BASE GRADIENT =.009 %
-- ROUGHNESS COEFFICIENT (N)= .035
-- SIDE SLOPES = 6 :1

STRUCTURE DATA -- CREST WIDTH = 15 m
-- CREST ELEVATION = 225.77 m
-- SIDE SLOPES = 6 TO 1
-- MAX. ELEV. OF STEEL MEMBRANE = 225.93 m
-- CHUTE GRADIENT = 16 %
-- HORIZONTAL LENGTH OF CHUTE D.S. OF MEMBRANE = 6.25 m
-- LENGTH OF APRON = 5.95 m
-- MAX. RIP-RAP ELEV. AT D/S END OF CHUTE AND APRON = 226.06 m

RIP-RAP DATA -- ZONE A -- SELECT GRANULAR FILL BENEATH RIP-RAP
-- 100% PASSING 75 mm SIEVE
-- 30-70% PASSING 4.75 mm SIEVE
-- 0-5% PASSING 75 um SIEVE
-- VOLUME = 87 cu. m
-- COST AT $15.60 PER cu. m. INSTALLED = $1351

-- ZONE B -- RIP-RAP DOWNSTREAM OF MEMBRANE
-- 15% BETWEEN 450 mm + 300 mm
-- 85% BETWEEN 300 mm + 100 mm
-- VOLUME = 109 cu. m
-- COST AT $25.20 PER cu. m INSTALLED = $2751

-- ZONE C -- RIP-RAP UPSTREAM OF MEMBRANE
-- 15% BETWEEN 450 mm + 300 mm
-- 85% BETWEEN 300 mm + 100 mm
-- VOLUME = 51 cu. m
-- COST AT $25.20 PER cu. m INSTALLED = $1292

STEEL SHEET PILING -- MEDIUM WEIGHT (LARSSEN 20 TYPE)
-- ESTIMATED AREA = 79 sq. m
-- COST AT $125.80 PER sq. m INSTALLED = $9982

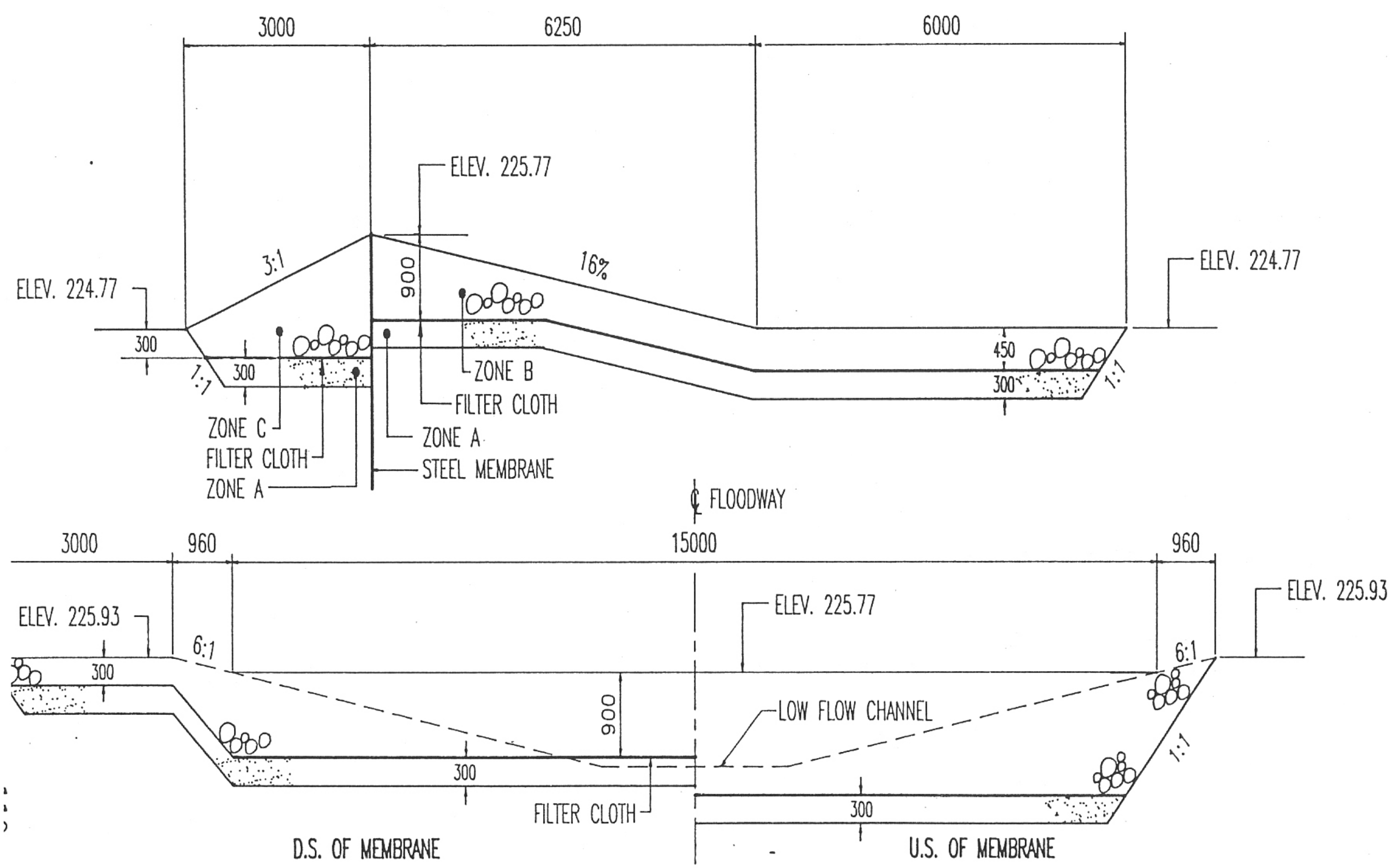
FILTER-CLOTH -- MIRAFI 600X OR APPROVED EQUAL
-- AREA = 332 sq. m
-- COST AT $2.32 PER sq. m INSTALLED = $772

TOTAL ESTIMATED STRUCTURE COST = $16,147

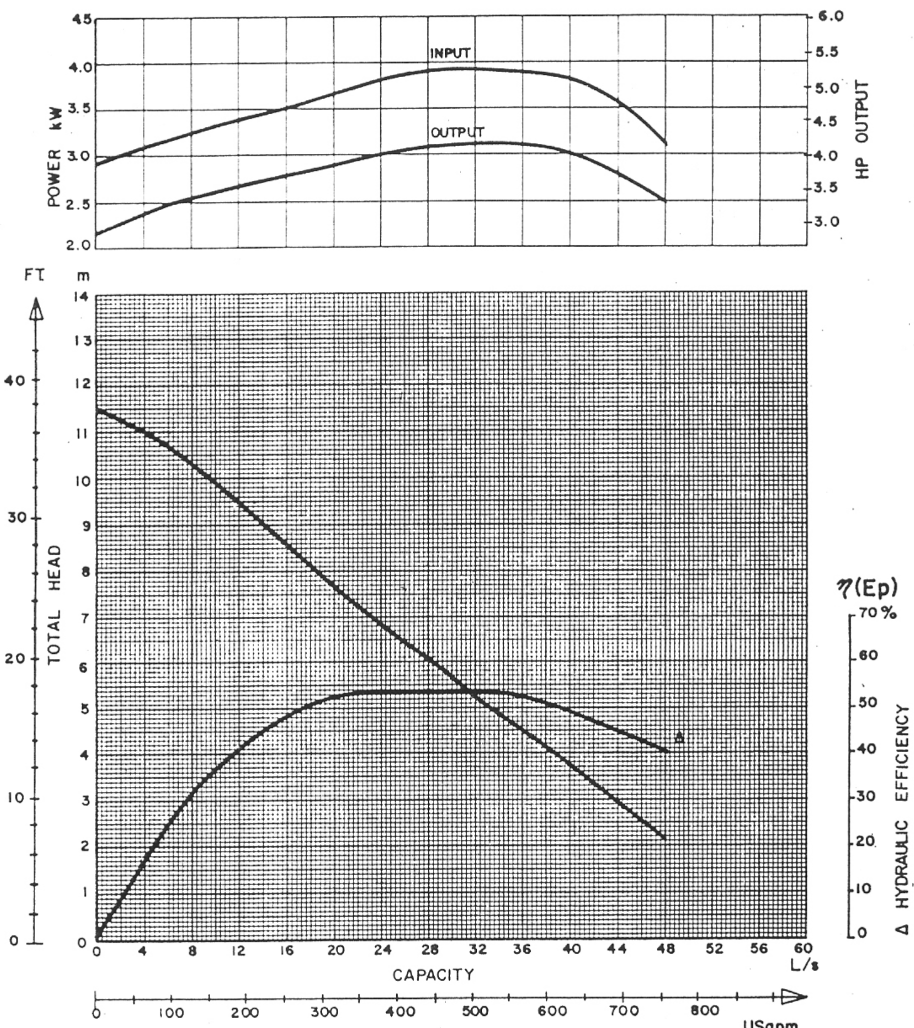
RATING CURVE

| HEADWATER ELEV.(m) | DISCHARGE (cu.m/s) | TAILWATER ELEV.(m) |
|---|---|---|
| 225.79 | 0.08 | 225 |
| 225.83 | 0.42 | 225.3 |
| 225.89 | 1.09 | 225.6 |
| 225.96 | 2.19 | 225.9 |

# PROPOSED STEEL MEMBRANE-ROCK STRUCTURE ON RED RIVER FLOODWAY



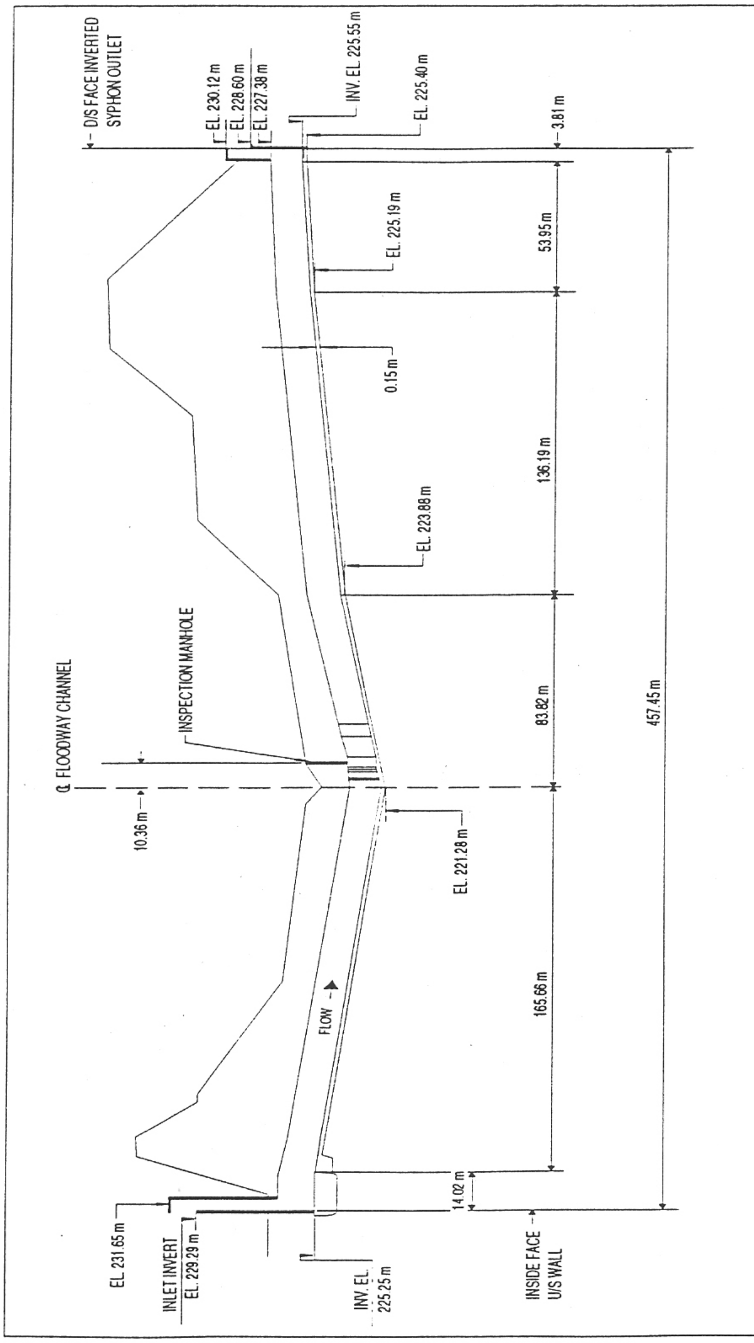
PUMP CURVE @ DIVERSION OUTLET




CURVES SHOW PERFORMANCE WITH CLEAR WATER AT 20°C

| IMPELLER | | | | | | MOTOR OUTPUT | | MOTOR RATING kW (HP) | | RPM | PHASE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CODE | PART NO. | VANE | DIA | $Kgm^2$ | THROUGHLET | kW | HP | CP/CS | CT | | |
| 436 | 457 53 00 | 1 | 195.5 | | 100mm (3.9") | 3.0 | 4.0 | 5.5 (7.4) | 4.8 (6.4) | 1750 | 1 |

| | | | |
|---|---|---|---|
| | C 3127 MT<br>IMPELLER 436 | SECTION C 3127<br>PAGE 8C | ISSUE 2 |

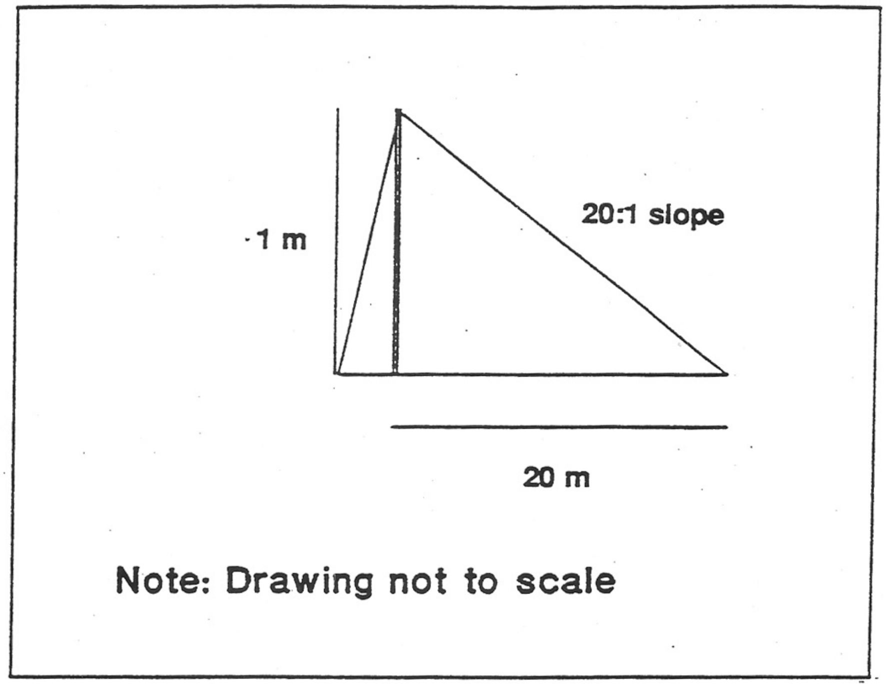



PROFILE OF SEINE RIVER SYPHON

# APPENDIX D

# DESIGN AND COST ESTIMATES FOR SEINE RIVER WEIRS

## SEINE RIVER WEIR DESIGN AT STATION 118+60




Volume = L X W X H

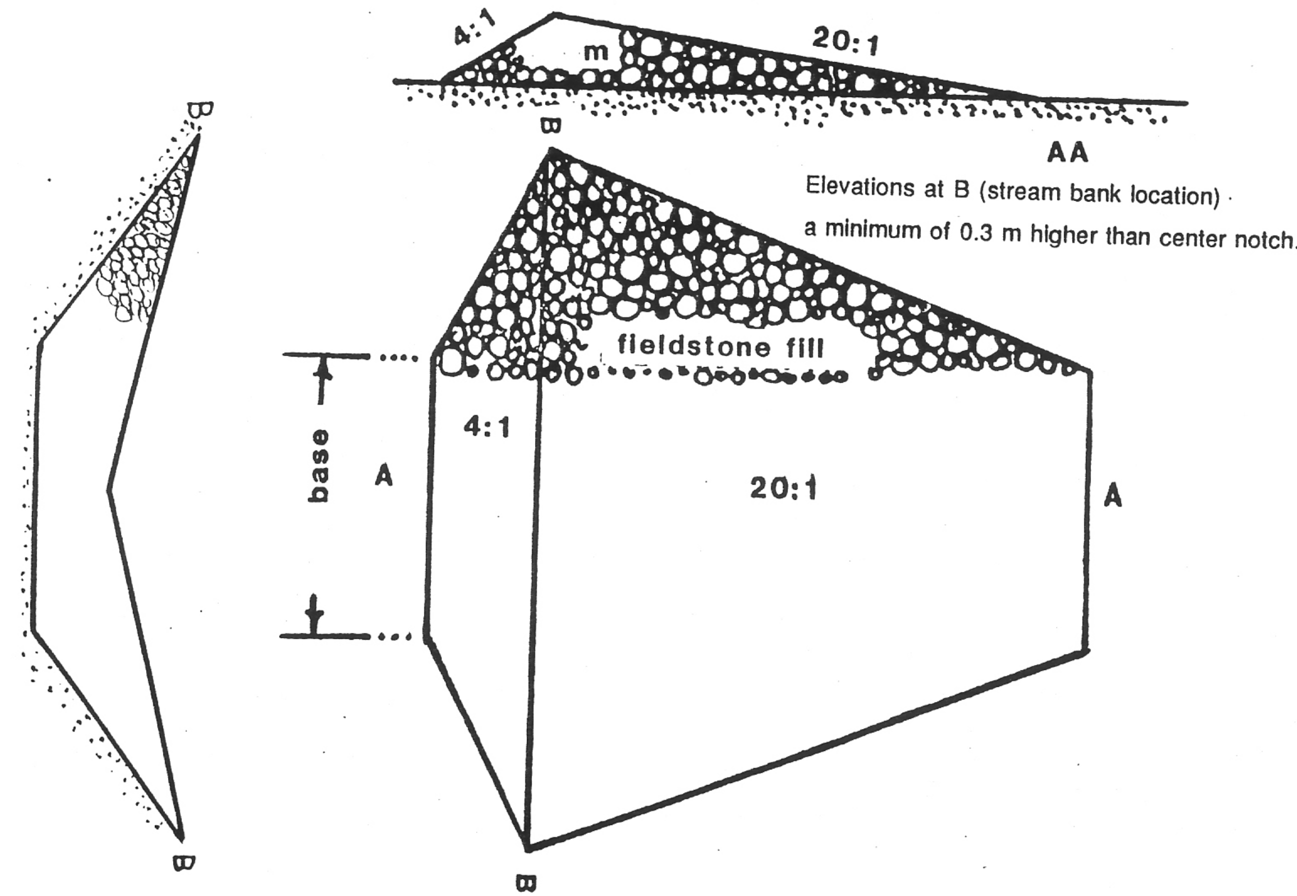
= 20m X 12 m X 1m

= 240 cu. m

= $ 6,000 (@ $25/ cu m placed

Total cost: 8 weirs @ $ 6,000/weir = $ 48,000

## TYPICAL WEIR DESIGN




(Source: Manitoba Fisheries Branch memo. Gaboury to Stefanson Aug. 2/91. Re. Dominion City Dam)