Floodplain management in Quebec: A case study of the Mille Iles River floodplains.

by

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Abstract

Until 1976, no specific policy coordinated the actions of the agencies involved in the management of Quebec's floodplains. Consequently, during the 1950's and 1960's riparian land uses along the Mille Iles River expanded from the dry terrace sites to the lower floodplains while changing in character from largely rural to urban, producing a landscape increasingly vulnerable to seasonal flood events.

To determine the nature of the encroachment process a land use classification system was applied to sequential aerial photographs (1958 to 1980). The extent of floodplain encroachment and the nature of land use changes and riparian habitat loss were identified. Four major land use trends (the polarization of land uses towards residential and wooded wetland occupations, the encroachment of suburban land use along the lower floodplains, the intensification of residential developments along the upper floodplains, and unequal floodplain development) were found to have produced the present flood-vulnerable landscape.

On October 4, 1976, in the hope of reducing flood damages and establishing a comprehensive floodplain management policy, Quebec signed two agreements with the federal government to reduce flood hazards along the Mille Iles River and across the province. The long- and short-term objectives of the structural and non-structural measures are described and the consequences of their implementation is discussed. Given the past land use trends and the objectives of the present flood damage reduction program, the effectiveness of the new measures for ensuring the reduction of flood damages and the rational use of floodplains is assessed.

The management of the Mille Iles River floodplains illustrates problems and issues related to the human use of riparian environments throughout Canada. Federal and provincial trends in floodplain management are identified and the implications for the rational use of floodplain environments are discussed.

Résumé

Jusqu'à 1976, il n'existait aucune politique spécifique coordonnant les actions des agences impliquées dans la gestion des zones inondables au Québec. Ainsi, au cours des années cinquante et soixante, l'utilisation du sol en bordure de la rivière des Mille Iles s'étendit des terrasses sèches jusque dans les zones inondables, perdant en même temps son caractère largement rural pour devenir davantage une zone urbaine. Ces changements produisirent un paysage de plus en plus vulnérable aux inondations saisonnières.

Un système de classification de l'utilisation du territoire fut appliqué à une série de photographies aériennes prises entre 1958 et 1980, afin de déterminer la nature du processus d'empiétement. L'étendue de l'empiétement sur la zone inondable, ainsi que le genre de changements survenus dans l'utilisation du sol et dans la perte d'habitat riverain on été noté. Quatre tendances principales produisant le paysage contemporain vulnérable aux inondations ont été identifiées: la polarisation du territoire d'une part vers l'usage résisdentiel et d'autre part vers le dévelopement des boisés, l'empiétement des banlieues le long des zones inondables à risque élevées, l'intensification du développement résidentiel le long des zones inondable à risque moins élevées et le développement inégal des zones inondables.

Le 4 octobre 1976, les gouvernements provincial et fédéral signaient deux accords visant à réduire le danger d'inondations le long de la rivière des Mille Iles et partout ailleurs dans la province, dans l'espoir de réduire les dommages et d'établir une politique complète de gestoin des zones inondables. Les objectifs à court et long terme des mesures structurales et non-structurales sont décrits et les conséquences de la mise en oeuvre de ces mesures sont discutées. Etant donné les tendances d'utilisation du territoire dans le passé ainsi que les objectifs du programme existant de réduction des dommages, l'efficacité des nouvelles mesures assurant une réduction des dommages et l'utilisation rationnelle des zones inondables sont évaluées.

La gestion de la zone inondable de la rivière des Mille Iles illustre bien les problèmes et les questions reliés à l'utilisation du milieu riverain à travers le Canada. Les tendances adoptées dans la gestion des zones inondables sont identifiées au niveau provincial et au niveau fédéral, et la signification dans l'utilisation rationelles des zones inondables est discutée.

Prologue

Land of Canaan, c. 2957 B.C.. Vast flood, probably centered around Ur on the Euphrates, subsides. Noah and family are reported safe. Word has just been received that the deluge resulting from forty days and forty nights of continuous rainfall has abated. Flood waters are reported to have greatly exceeded 15 cubits. Lands have been inundated for 150 days. All living creatures have been drowned, except for Noah, his immediate family, and the animals "two by two", who rode to safety in a homemade ark and finally have come to rest on Mt. Ararat.

(Hoyt and Langbein, 1955)

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Introduction - The research problem

Urban expansion, with suburban and new town development, has increased pressure on undeveloped lands around cities. Historically, some areas have resisted extensive development because of inherent qualities; in the case of floodplains, their propensity for flooding. Recently, however, riparian zones in or adjacent to urbanizing communities have been under increasing pressure to accomodate intensive development, resulting in extensive floodplain degradation and drastic increases in flood damages.

As a consequence of uncontrolled encroachment, annual flood damages across Quebec have greatly increased: damages have risen from $1.3 million in 1966, to over $60 million for each of the 1974 and 1976 spring floods (Perrier 1978). Though these increases in flood damages can be partially attributed to inflation and to changes in the hydrological regime of Quebec's streams, the primary cause of increasing flood damages is continued encroachment upon riparian zones. Today, it is estimated that 280 of Quebec's 1600 municipalities are seasonally affected by flooding. The Montreal region, the most populated and urbanized, is particularly vulnerable (Hydro-Quebec 1982).

Floodplain development in the Montreal archipeligo reflects an insensitivity to the social and biological values of riparian ecosystems. Uncontrolled residential and industrial developments, the building of roads, marinas and harbours, the modification of shore-front properties and drainage of foreshore space for agriculture have greatly reduced the extent of natural

riparian habitat and resulted in escalating flood damage potential.

The Mille Iles River floodplains, northwest of Montreal, have not escaped these development pressures. The area has many attractive properties in terms of residential development. It is close to the urban area, but still possesses rural qualities. It has the attraction of the water-front and a lower tax base because of its distance from the urban centre. Since the 1950's residential, industrial and commercial developments have expanded from the dry terrace sites to the lower floodplains. Encroachment has resulted in the destruction of valuable riparian habitats and engendered some of the most significant flood damages in the Montreal region. The Mille Iles River floodplains are a good example of the encroachment processes which have characterized Quebec's urbanizing floodplains.

Historically, economic conditions have been the major factors controlling the residential, industrial and agricultural development of Quebec's riverine lands. The adoption of ad hoc structural flood control measures, such as diking and damming, have been the most common reactions to the subsequent flood hazards.

In 1976, escalating flood damages across the province promoted the formulation of a federal-provincial flood damage reduction program. Portions of the joint agreements specifically aim to reduce flood damages along the Mille Iles River's floodplains. The program is presented as a comprehensive floodplain management scheme because it encourages a combination of structural and institutional measures to cope with the flood problem.

The purpose of this study is to describe and evaluate the effectiveness of the 1976 flood damage reduction program for coping with the suburban flood hazard along the Mille Iles River floodplains. The goals of the research are to :

1) document the resources of the floodplain and the nature of the flood hazard,

2) describe the past floodplain management policies,

3) analyse the nature of land use change along the Mille Iles River prior to the 1976 federal-provincial flood damage reduction program (1958 - 1980),

4) describe and evaluate the effectiveness of the 1976 federal-provincial flood damage reduction program for ensuring the reduction of flood damages and the comprehensive use of floodplain resources,

5) discuss the major trends in coping with the flood hazard along the Mille Iles River and their implications for comprehensive floodplain management across Quebec.

The flood hazard and the measures adopted to cope with the hazard in the Mille Iles River area is a matter of local, regional and provincial importance. Recognition of its scale of importance is found not only in the institutional arrangements to the hazard but in the physical adjustments agreed upon in 1976. The management of the Mille Iles River floodplains illustrates problems and issues related to the human use of riparian environments throughout Quebec and Canada. By examining floodplain management policies along the river, the problems of comprehensive floodplain management in Quebec are addressed.

Chapter 1: The principles of floodplain management

1.1 The floodplain environment

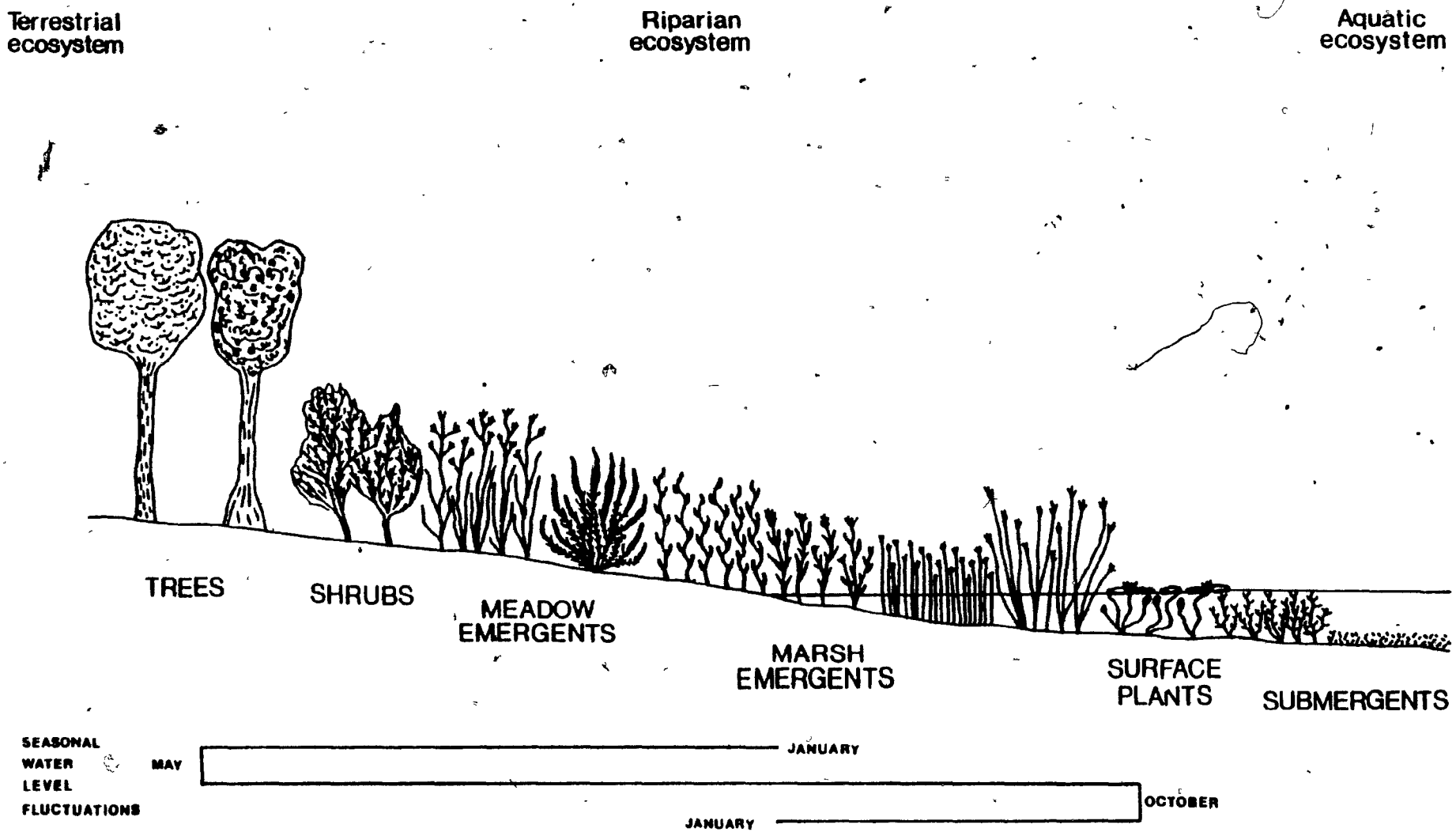
Floodplains are the result of fluvial processes acting upon the earth's surface. They are amongst the most dynamic features of a landscape: a floodplain is both a product and a functional part of the stream environment. Floodplains play a necessary role in maintaining the overall adjustments that a stream makes to the variable quantities of water, solubles and sediments derived from its drainage basin (Fairbridge 1968).

Floodplains, or riparian habitats, are ecotones between aquatic and upland ecosystems. Continuous interaction occurs between riparian, aquatic and upland ecosystems, through exchanges of energy, nutrients and species. The ecosystem is often characterized by the combination of high species diversity, high species density and high productivity. Because different portions of the riparian zone are subject to different degrees of seasonal or periodic flooding, floodplains support a range of distinct vegetation, soil and hydrologic properties, and a variety of wildlife species (Fig. 1.1). (Unesco 1974; Brown et al. 1978; Jahn 1978; Odum 1978). The hydrological regime of the floodplain is the key external factor which controls the productivity of a riparian ecosystem (Fig. 1.2).

Riverine locations have historically provided well known locational advantages for human settlements. Flat land, tillable and fertile soils, water supply, water power and water transportation have attracted agricultural, industrial and

Figure 1.1

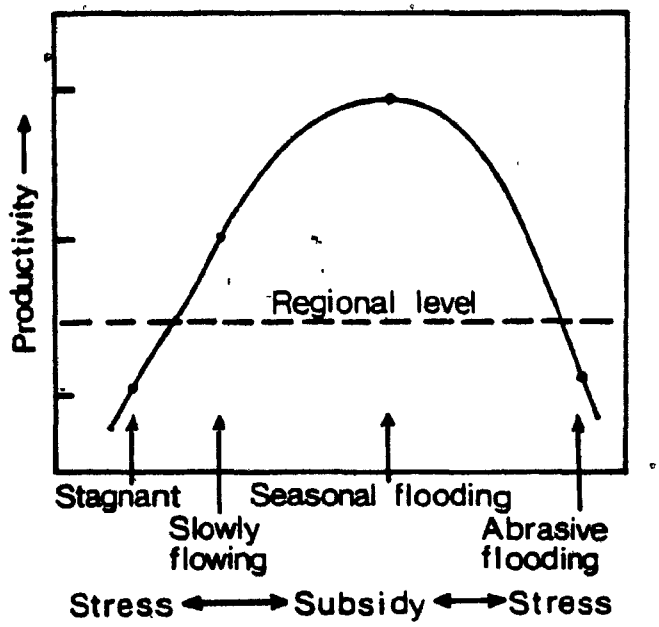
THE RIPARIAN ECOTONE



(Based on Dansereau 1957, in Baribeau, Lanouette et Tessier 1981)

Figure 1.2

THE EFFECT OF FLOODING ON PRODUCTIVITY



The effect of a gradient of flooding on productivity as compared with a regional level that might be expected in the absence of standing or flooding water.

(Source: Odum 1978)

commercial activities. The aesthetic and recreational aspects of riparian settings have also attracted residential and recreational land uses.

The unsuitable development of a floodplain results in the loss of natural resources whose functions are beneficial to man. Floodplains play important roles in ground water storage and replenishment (O'Brien and Motts 1980; Mass. Water Res. com. 1971; Lewin et al. 1979), surface water hydrology (Hoyt and Langbein 1955; Leopold, Wolman and Miller 1964; Leopold 1968; Hollis 1973; Packman 1979; Walling 1979) and in the filtration of pollutants and sediments (Lugo and Shekader 1974; Meehan et al. 1977; Brown et al. 1978; Jahn 1978). The absorption and filtration capacities of these natural buffer zones are especially important in urbanizing areas where impermeable surfaces cause rapid runoff and where polluting activities lower water quality.

Inappropriate developments in drainage basins interrupt bio-physical processes, reduce the natural flood water storage capacities of floodplains and alter the flood characteristics of rivers. The loss of floodplain resources has been translated into financial losses. For example, a study by the United State Corps of Engineers (1972) along the Charles River floodplains (Mass.) quantified the annual flood losses as a function of floodplain wetland encroachment (Table 1.1)

As a result of the attractive properties of floodplains, riverine lands in or adjacent to urbanizing communities have been under increasing pressures to accommodate intensive development, resulting in floodplain encroachment and increased flood hazard.

Flood hazard results from a combination of natural and human

Table 1.1

ANNUAL FLOOD LOSSES AS A FUNCTION OF FLOODPLAIN WETLAND LOSS

Condition	Annual losses
Current - 1971	$158 000
With 10% loss of storage	229 000
With 20% loss of storage	414 000
With 30% loss of storage	641 000
With 40% loss of storage	957 000

(Source: U.S. Corps of Engineers 1972)

circumstances.

> Flood hazard is a relative term and concept. It does not exist apart from people, though flooding as a process does .... Flood hazard consists of the interaction and conflict between the occasional flooding and inundation of riverine areas and the extensive and intensive use of these areas by people (Mitchell et al. 1978:1).

Attempts to reduce flood hazard and the costs of flooding, while retaining the locational advantages of riparian sites, have largely taken the form of structural measures (dams, dikes, channel alterations, land filling). Structural flood control measures are designed to interrupt the natural bio-physical processes of the stream system. This has important repurcussions on wildlife, recreation and the aesthetic appreciation of the environment. Floodplain development and flood control measures therefore pose a basic conservation problem with respect to natural riparian ecosystems and the river's environmental quality.

A major weakness of past management policies has been the failure to give consideration to the inherent values of floodplain environments. Floodplain management has traditionally reflected crisis oriented responses such as diking and damming. This illustrates the tendency to view natural floodplain processes as impediments to development and land use, rather than as continued bio-physical processes which enhance the human environment.

Rational floodplain management and development must be closely connected with conservation and focus on the means of reducing conflicts between man and the environment. The primary goal of a comprehensive management policy is not to prevent the

use of fore-shore space, but to plan for appropriate uses. Floodplain management should be based upon a combination of delineating those uses which are compatible with the floodplain and an evaluation of the physical environments to determine the uses which they are best able to accomodate. As our society continues to demand more space and resources, the need for planned use of land grows urgent.

The general concerns of comprehensive flood hazard reduction and floodplain management are how to best take advantage of the benefits of riverine lands and locations, while minimizing the costs induced by flooding. The purpose of this chapter, is to describe the range of floodplain management tools and discuss the theoretical mix and interactions of the physical and institutional adjustments necessary for comprehensive floodplain management.

1.2 The tools of floodplain management

Research into flood hazards has led to a classification of the theoretical range of measures, or adjustments, available for floodplain management (Burton, Kates and White, 1968; Saarinen 1974; White and Haas, 1975; White et al. 1975; Mitchell et al. 1978). Adjustments, as defined by White and Haas (1975:57), are all "those intentional actions which are taken to cope with the risk and uncertainty of natural events". These measures include a range of activities which require the expenditure of different temporal and pecuniary resources. Some are practiced by individuals, others can only be enforced on a community or basin

Table 1.2

SIX MAJOR ADJUSTMENTS TO FLOOD HAZARD

1. Flood control and protection works
   a. dams and reservoirs
   b. levees and dykes
   c. channel alterations (widening and dredging)
   d. landfilling and landscaping
   e. emergency flood control

2. Flood forecasting and warning
   a. forecast systems
   b. emergency preparedness plans

3. Flood-proofing
   a. permanent
   b. temporary

4. Land use management
   a. floodplain development policies and plans
   b. redevelopment and renewal policies and plans
   c. subsidized relocation
   d. land acquisition
   e. zoning and land use ordinances
   f. subdivision regulations
   g. building codes
   h. sanitary and well codes
   i. public information

5. Flood insurance
   a. subsidized insurance

6. Flood relief
   a. grants
   b. tax deductions
   c. loans
   d. feeding and sheltering of victims
   e. reconstruction

(Source: adapted from White 1975, and Mitchell et al. 1978)

wide level. The measures should be combined to achieve optimum success.

Six major adjustments have been the focus of research: 1) flood control and protection works; 2) flood forecasting and warning; 3) flood proofing; 4) land use management; 5) flood insurance; and 6) relief and rehabilitation (Table 1.2).

1.2.1 Flood control and protection works -

Flood control and protection works include structural works such as temporary or permanent dams, reservoirs, dikes, canals, levees, channel enlargement, dredging, floodways and other structural measures for the control of flood waters. The purpose of such measures is to decrease flood hazard in a given area by modifying or controlling the natural bio-physical processes.

Such engineering approaches have received a great deal of attention in the past. In many cases, they have been the most important, if not the only, component of floodplain management policies. Dams and levees are often regarded as the only effective solution to flood problems because, in the short-run, among all the available alternatives flood control works can be undertaken with the greatest confidence of success. Structural works are highly effective in preventing flood losses to existing property up to their design levels.

Though structural measures are effective solutions for modifying and reducing flood hazards they present a number of problems. A principal limitations to the adoption of structural works, such as dikes and dams, is the availability of sites with acceptable construction costs. Traditionally, budgetary limits have been an important restraint to the adoption of structural

works. Budgetary constraints have often limited the adoption of such measures to the federal and provincial levels of government.

Structural solutions are also limiting because they necessitate continued energy and money inputs. Once a flood control structure is erected it requires a permanent commitment to maintenance and periodic reconstruction.

In addition, structural solutions are designed only to control certain levels of flooding and to function for a limited number of years. In the United States, it has been estimated that between 1903 and 1958, flood damages from overtopping or failure of works accounted for 33% of the total flood losses and occured in one third of the 56 years studied (Holmes 1961, in White et al. 1975). White (1958:215) has stated, following a study of 17 urban areas in the United States, that

> ... It is important to explain that in a strict sense no flood-protection works in operation in the United States offer complete protection against all possible floods. Engineering works are designed to protect against floods of specified magnitudes, the "standard project flood", or the "design flood". Depending upon the land uses, expected benefits, and the hydrologic means of selecting the project flood, it may have an estimated frequency of occurrence of as much as one in 25 years (the rule in a few agricultural areas) and as little as once in 300 or 500 years .... Yet even with conservative design criteria, the greater number of all protection projects may be expected with a frequency of perhaps once in 100 or 1 000 years to be confronted with river flows beyond the designed capacity.

An indirect result of structural solutions has been shown to be additional floodplain encroachment by flood-vulnerable land uses such as residential, industrial and commercial developments. Burton (1965 in Mitchell et al. 1978:112) has stated, concerning flood damage potential in Canada, that

> Engineering works such as dams, dykes, and channel

> improvements, reduce or control flood flows in part, but do not prevent, and may even encourage the creation of new damage potential, without providing all the security that is sometimes attributed to them.

Similarly, Kollmorgen (1953 in Mitchell et al. 1978:113) stated,

> Paradoxical as it may appear, present flood-control engineering works not only enhance the danger of floods, but actually contribute to the high flood losses which in turn are used to justify more extensive and complicated control structures.

Structural measures can, therefore, engender a false sense of security and encourage continued and intensified hazard land occupation, thereby increasing flood hazard in the long-run. The purpose of many flood control projects is to reduce flood risks so as to permit the construction and renovation of buildings in the flood risk zones. Thus, while flood protection works decrease the potential for fatalities, they tend to increase catastrophe potential for property loss.

Finally, it must be emphasized that the purpose of a structural work is to modify the natural processes of a stream environment. Because of this, objections to structural approaches have grown in recent years on the grounds of environmental degradation.

1.2.2 Flood forecasting and warning -

Flood forecasting and warning systems are another form of adjustment to flood hazard which consist of the dissemination of information to the inhabitants of a floodplain in order to warn them of an impending flood. While flood forecasting does not eliminate flood damages, it can effectively reduce them. Through the adoption of such measures, the vulnerability of a population to a flood event is decreased.

A number of different systems can be used to predict and warn of flood events. These range from national computerized flood forecasting programs to local organisations which collect streamflow and percipitation data.

Serious shortcomings of flood warning systems include the technical problems associated with accurate predictions of flood events, factors influencing the behavior of the public when faced with the flood warning, and factors influencing public officials who prepare plans and who organize the dissemination of warning and evaluation plans (White and Haas, 1975).

1.2.3 Flood-proofing -

Flood-proofing adjustments consist of alterations in design and construction such that structures are less susceptible to damage from flooding. Some common flood-proofing measures are 1) the installation of water-tight windows and door closures, 2) plans for the removal of damageable goods, 3) provision for emergency operation of electricity, water and sanitary services, 4) the sealing of foundations against seepage, 5) the strengthening of walls to resist hydro-static pressure, 6) the installation of drains and pumps, and 7) the elevation of structures above certain flood heights (White et al. 1975). Such measures can be incorporated in the original building design.

There are four major constraints to the use of flood-proofing adjustments: 1) a lack of technical advice and supporting research focusing on methods of flood-proofing different structures at various levels of flood hazard, 2) the economic costs of flood-proofing existing structures are often high, 3) flood-proofing has traditionally been a responsibility

of property owners and there has been little public encouragement of flood-proofing through incentives such as tax deductions or subsidized loans, and 4) property owners may be reluctant to make visible changes to their properties if the flood hazard is infrequent. Finally, while flood-proofing measures are successful in reducing flood damage potential, they may promote a false sense of security and encourage owners to expose themselves to events exceeding the resistance of the structure.

1.2.4 Land use management -

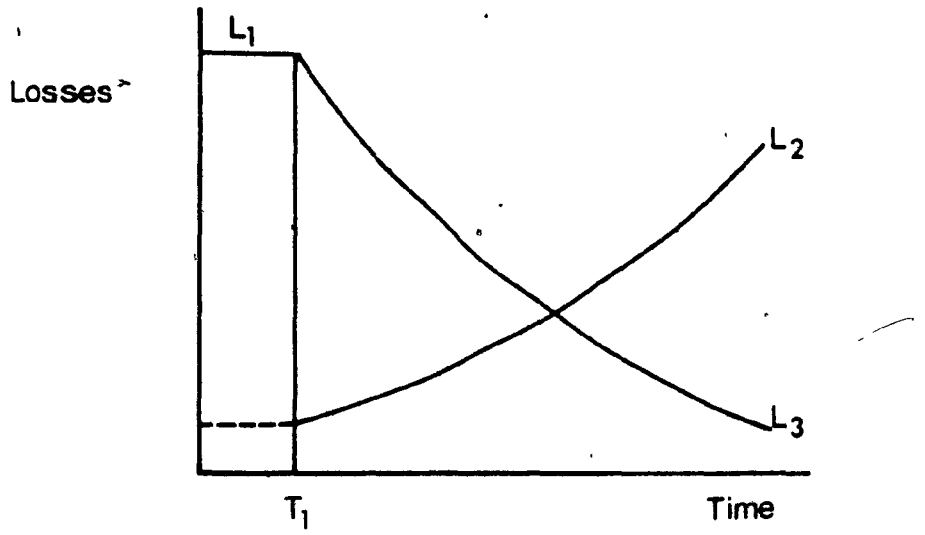
Land use management refers to the systematic adoption of local, provincial and federal regulations concerning the acquisition, use and management of flood prone lands. By encouraging appropriate types and amounts of economic and social development in the floodplain, land use management can effectively reduce flood losses and increase the net benefits of floodplain uses.

The range of land use management measures includes zoning, lot size requirements, land filling regulations, wetland protection laws, septic tank and well permits, incentives and deterents such as preferential taxation for suitable land uses, relocation of settlements and public facilities and land acquisition for parks, refuges and open spaces.

Land use management policies modify loss potential and permit long-term uses of hazard lands. Alone, floodplain land use management may be the single most important adjustment to reduce flood losses although, on a short-term basis, it is not certain that it yields the largest net benefits as damages from the previous developments persist. Because land use management

Figure 1.3

TIME PROFILE OF LOSS REDUCTION BY ADJUSTMENT



L_1 – average losses before adoption

L_2 – losses after adoption of dam and channel construction

L_3 – losses after adoption of land use management

T_1 – adoption of adjustment since inception

(Source: White 1975)

is better at keeping new developments out of the floodplains than in encouraging the transformation of uneconomic ones, it may not be the most appropriate method for coping with the problems caused by existing inappropriate land uses.

Thus, a limitation of land use management measures is that they require a long period of time for their effect to be fully realized. However, once the measures are operative, the potential flood loss is drastically decreased. Long-term benefits include the stabilization and reduction in the population and economic investments at risk, the reduction in the cost of evacuation, relief and rehabilitation measures, and importantly, decreased dependence upon flood control and protection works. Though the social costs and benefits which accrue from land use management are difficult to calculate, because they require an estimation of the values of replaced uses and the benefits of alternative uses, they are usually more economical than structural approaches.

In comparison to flood control and protection works, land use management approaches are designed to alter human behavior rather than the natural bio-physical processes of the stream environment. Land use management is, therefore in principle, a more environmentally sound method of maintaining a balance between river and development. Through the adoption of land use measures conflicts between man and the environment are reduced rather than intensified, as is the case with structural adjustments. In the long-run, land use measures discourage flood vulnerable developments from encroaching upon hazard zones and reduce flood damages, doing what the flood control measures cannot do (Fig. 1.3). Thus, land use management measures permit

long-term uses of lands, accommodate the natural energy cycles of water and do not require great commitments to maintenance, which often translate into social, biological and economic savings.

Though land use management is the adjustment most likely to reduce flood hazards and ensure the rational use of floodplain lands, it has rarely been adopted by communities because of the long period of time which is required for the effects to be realized. An incentive to the adoption of land use management programs has been found to be the development of subsidized flood insurance programs.

1.2.5 Flood insurance -

Flood insurance programs are insurance schemes which are subsidized by senior levels of government (federal or provincial), so as to make previously unavailable flood insurance available to floodplain inhabitants. In return for providing subsidized insurance to existing property owners, senior governments demand that local governments (regional or municipal) adopt and enforce land use measures that curb land development in the hazard zones. Private firms are responsible for marketing the insurance while the senior government is responsible for delineating flood hazard zones and estimating the actuarial and subsidized premiums. Private companies are protected from catastrophic losses by government re-insurance (White et al. 1975).

Insurance coverage itself does nothing to change the amount of actual physical flood damage, although the land use planning measures are designed to do so.

The effectiveness of federally subsidized insurance to

reduce losses over time is largely unexplored. The preventive aspect of subsidized insurance depends upon its being tied to a systematic floodplain management program which requires the adoption of a range of measures to progressively modify flood losses. If these are not prerequisites, the insurance encourages continued occupance and development of floodplains, rewarding residents with public grants in the event of a damaging flood (White et al. 1975).

Through the adoption of flood insurance programs, the significance of flood hazards can be incorporated into the local land use decision making processes. Simultaneously, subsidized insurance programs shift the costs of flood damage from the general tax payer, those whose taxes provide flood damage relief funds, back to those who directly benefit from floodplain locations.

1.2.6 Flood relief -

Generally, flood victims have to bear the costs of flood damages to personal property. However, in the event of severe flooding, as was the case in Quebec in 1974 and 1976, governments have organised public relief funds to aid flood victims following the disasters.

Flood relief is an adjustment composed of a series of linked activities. The first period consists of the moments during the initial disruption when efforts are made to provide care for the victims. This is followed by a period, which can extend over a few weeks or months, during which actions are taken to re-establish temporary functions. The last phase is comprised of efforts to put things back together and possibly improve on past

conditions.

White and Haas (1975) have noted three general trends with respect to flood disaster relief in the United States: 1) an increasing number of flood disasters to which the federal government will respond, 2) increasing kinds of aid which the federal government will make available, and 3) increasing federal expenditures for involvement. Thus, federal involvement in relief continues to increase while flood damages continue to escalate.

There is no doubt that flood victims need some aid after a severe flood. However, a major concern arises as to whether tax payers, the general public which does not benefit from floodplain locations, should subsidize those citizens who live in the hazard areas by providing funds to re-establish themselves in the same location. This has stimulated interest in, first, insuring that aid is provided on the basis that the victims modify their vulnerability to future flood events, and second, on putting the cost of flood damages back on those who benefit from floodplain locations through measures such as subsidized flood insurance.

1.3 The combination and interaction of adjustments

Given the variety of adjustments to flood hazard which exist, questions have been raised about the interactions of adjustments and the mix of measures which produce the most efficient and effective management policies.

Studies indicate that there are no set rules or regulations which yield an optimun mix of measures (White (ed.) 1974, in

Mitchell et al. 1978). The choice of mix of adjustments by a community, a region or a nation is influenced by the flood hazard (the frequency of flooding, the nature and extent of development), by the past attitudes towards certain adjustments and by the availability of the adjustments. The availability , or feasibility, of adjustments is usually a function of the past losses, the potential benefits and the costs of the proposed measures. Losses caused by the occurrence of a flood are calculated (be they property losses, injuries to physical or mental health, death and social disruption) on the basis of estimates and can only be obtained in a crude fashion. Benefits are also difficult to calculate because they require the estimation of the values replaced and the social, economic and political benefits gained. The calculation of the costs of adjustments include the initial implementation costs of the undertaking, maintenance, reconstruction and inflation. The choice and mix of adjustments is, therefore, complicated by a lack of reliable information, changes in technology and by the past and present prejudices towards specific adjustments.

Through time, the literature points to a changing emphasis of adjustments, from ad hoc measures which modify the flood hazard and distribute the flood losses (structural solutions and flood relief) to measures which modify a population's vulnerability to the hazard (land use regulations).

For example, between the 1930's and 1970's, flood adjustments in North America emphasized measures which modified the hazard, such as dams, levees and reservoirs. Flood damages, however, continued to increase in the face of increased expenditures on these types of adjustments, suggesting that their

Figure 1.4

MATRIX OF INTERACTION OF ADJUSTMENTS TO FLOODS

INITIAL ADJUSTMENT	OTHER ADJUSTMENT AFFECTED: CONTROL AND PROTECTION	FLOOD-PROOFING	LAND USE PLANNING	WARNINGS	INSURANCE	RELIEF
CONTROL AND PROTECTION		○	○	○	○	○
FLOOD-PROOFING	○		○	●	?	○
LAND USE PLANNING	○	?		●	●	○
WARNINGS	○	●	●		?	○
INSURANCE	○	?	?	●		○
RELIEF	●	○	○	○	○	

STIMULATED BY INITIAL ADJUSTMENT:

● – High

○ – Little or none

? – Doubtful

(Source: White and Haas 1975)

effectiveness was not as great as originally thought:

> Although both the federal and provincial governments have expended millions of dollars in construction and relief measures, annual losses continue and the potential for new disasters mounts with increasing housing and industrial development within flood-prone areas. Despite a federal expenditure of some $40 million in disaster assistance and $70 million on works constructed between 1948 and 1970, losses due to severe flooding across Canada exceeded $70 million in 1974 alone .... Recognizing the shortcomings of structural measures for flood control, the federal government is now carrying out a much wider range of possible adjustments to the flood problem (Fish. & Env. Can. 1975:90).

Recognition of a wider range and mix of possible measures in North America has resulted in an increasing emphasis on adjustments which modify the vulnerability or loss potential to flood hazard. Choosing the optimum mix of measures for ensuring rational floodplain management has become a major focus of research (Mitchell et al. 1978; White and Haas 1975; White et al. 1975).

Because of the short- and long-term costs and benefits of individual adjustments, adjustments are linked to one another in a variety of ways. Short term benefits have a tendency to render floodplain inhabitants complacent and discourage the adoption of adjustments with long-term objectives. Some adjustments strongly encourage one another, some inhibit one another, while others have no apparent relationship (Fig. 1.4). For example, it is known that the enforcement of land use regulations is aided by the adoption of a subsidized flood insurance program. Insurance may also be expected to stimulate interest in flood forecasting and warning if there are substantial deductible items (White et al. 1975). Flood relief policies can encourage the adoption of flood-proofing measures. There is no definite link between the

extent to which land use regulations inhibit or encourage flood proofing by owners of exposed buildings. It has been observed that if a community benefits from a flood control dam, it is less likely to support land use regulations in the remaining unprotected zones. Conversely, if a community adopts land use regulations it is less likely to support the adoption of structural flood control works.

To date, White et al. (1975) suggest that three main combinations of adjustments are widely encountered in urban floodplains. First, floodplain residents expect to suffer personal losses and to receive some assistance in the form of public flood relief and rehabilitation, accompanied by some attempt to protect themselves against future losses, possibly through flood-proofing. A second common mix is a community flood warning system combined with flood-proofing measures. The third combination is the reliance upon structural works, followed by the dependence upon flood relief for those not covered by the works or the disruptions created by the overtopping of the structure. None of these approaches to floodplain management ensure the reduction of flood damage potential and the rational use of floodplain lands.

As technology and needs change, the costs and benefits of the individual adjustments vary over time. As they do, the attractiveness and effectiveness of particular mixes of adjustments are apt to change over time as well. For example, as an area changes in nature from a rural to a suburban landscape the floodplain management needs changes, as do the costs and benefits of the adjustments.

The common tendency in the formulation of floodplain

management schemes is to adopt expedient short-term solutions and assume that the present costs and benefits of adjustments will remain the same. A result of this static pre-disposition is that little incentive exists to find out what the most suitable adjustment over time may be as the landscape changes in character: If there was a better understanding of the factors which affect choices, it would be easier to identify actions which effect the future suitability, benefits and costs of adjustments.

1.4 The principles of comprehensive floodplain management

A comprehensive floodplain management policy refers to a coordinated policy of combined long-term land use and short-term structural flood control measures designed to

1) reduce the traumas and costs resulting from presently constructed ill-suited land uses,
2) plan for appropriate land uses and maximize the benefits which accrue from them,
3) prevent the expansion of ill-suited land uses,
4) protect valuable riparian habitats from encroachment.

Both structural measures which modify the hazard and protect the already developed zones and non-structural measures which prevent further encroachment and modify the loss potential of the floodplain zone, must be combined in a coordinated manner. Structural adjustments which modify the hazard, such as dams and dykes, are temporary tools to help in the transition from unsuitable to suitable hazard zone land uses. Temporary

structures permit the protection of buildings until their economic lives expire and are gradually replaced by appropriate land uses. Once the unsuitable land uses are replaced the temporary flood control structures can be removed and the natural bio-physical processes permitted to resume. Simultaneously, the non-structural land use approaches offer long-term uses of lands and eventually save structural flood control costs. The choice and mix of measures will vary from community to community depending on the nature and extent of the encroachment, on the priorities of the governments and on the objectives and resources of the local managers.

When coordinated, structural adjustments and land use policies stabilize and eventually reduce the populations at risk, provide support to improved economic uses and reinforce the biological strengths of the floodplain. Conversely, the adoption of partial measures may encourage unwise developments and undermine the biological attributes of the floodplains.

The primary goal of a comprehensive management policy is not to prevent the use of foreshore space, but rather, to plan for all "reasonable and appropriate uses" (Barker and Morgan 1981). Floodplain management should be based upon a combination of delineating those uses which are considered appropriate along the floodplain and on an evaluation of the physical environments to determine the uses which they are best able to accomodate. The screening criteria used to determine appropriate land uses could combine the floodplain dependency of the activity, the impact of the land use on the environment and the direct and indirect impacts of flooding to the activity.

Critics of traditional structural floodplain management

approaches believe that a comprehensive floodplain management policy should be designed to minimize impacts on the bio-physical, aesthetic and recreational aspects of the floodplain environment. To achieve these objectives, programs should be required to conform to an environmental impact assessment process and to adhere to specific environmental guidelines. Policies should not be ad hoc responses to crises. Jurisdictional and administrative complications should be minimized for policy application. The policies should be based upon reliable information, techniques and guidelines to ensure technical effectiveness. Policies should be sensitive to the needs and concerns of affected individuals and provide for public participation. Finally, there should be provisions in the floodplain management program for hindsight evaluation and monitoring of policy results (Kreutzwiser 1982).

1.5 Conclusions

To be comprehensive, a floodplain management policy must be based upon a broad understanding of the floodplain environment. A management program must rest upon an understanding of the bio-physical elements and processes, such as the nature of flooding and seasonal water level fluctuations, floodplain material composition, the nature and extent of wetland areas, floral composition, wildlife potential, erosion and sedimentation, and on an understanding of the human elements and processes, such as the flood vulnerability of different land uses, the nature, rate and extent of human encroachment and on

the past management attitudes.

Upon such a basis, a policy can encompass a range of objectives which can include the reduction of private property damage, increases in the economic benefits of floodplain land uses, the protection of a population's health, the protection and conservation of valuable riparian habitats, the improvement of water quality and the reduction of sedimentation and erosion.

Comprehensive floodplain management can be accomplished within the borders of a single community, a region, a watershed or a larger planning department. However, while the tools for floodplain management exist and are judged adequate to insure comprehensive management, a problem which persists is the rational adoption and enforcement of the measures.

The following chapters examine the floodplain management trends along the Mille Iles River floodplains. The purpose of the study is to describe the apparent priorities in type of flood hazard adjustments, the changing mix and emphasis of adjustments through time and to assess the effectiveness of the recently adopted measures for ensuring the rational use of floodplains. By examining the problems of floodplain management along the Mille Iles River, light is shed upon the flaws and advances in the provincial floodplain management policies.

CHAPTER 2 - The setting: The Mille Iles River floodplains.

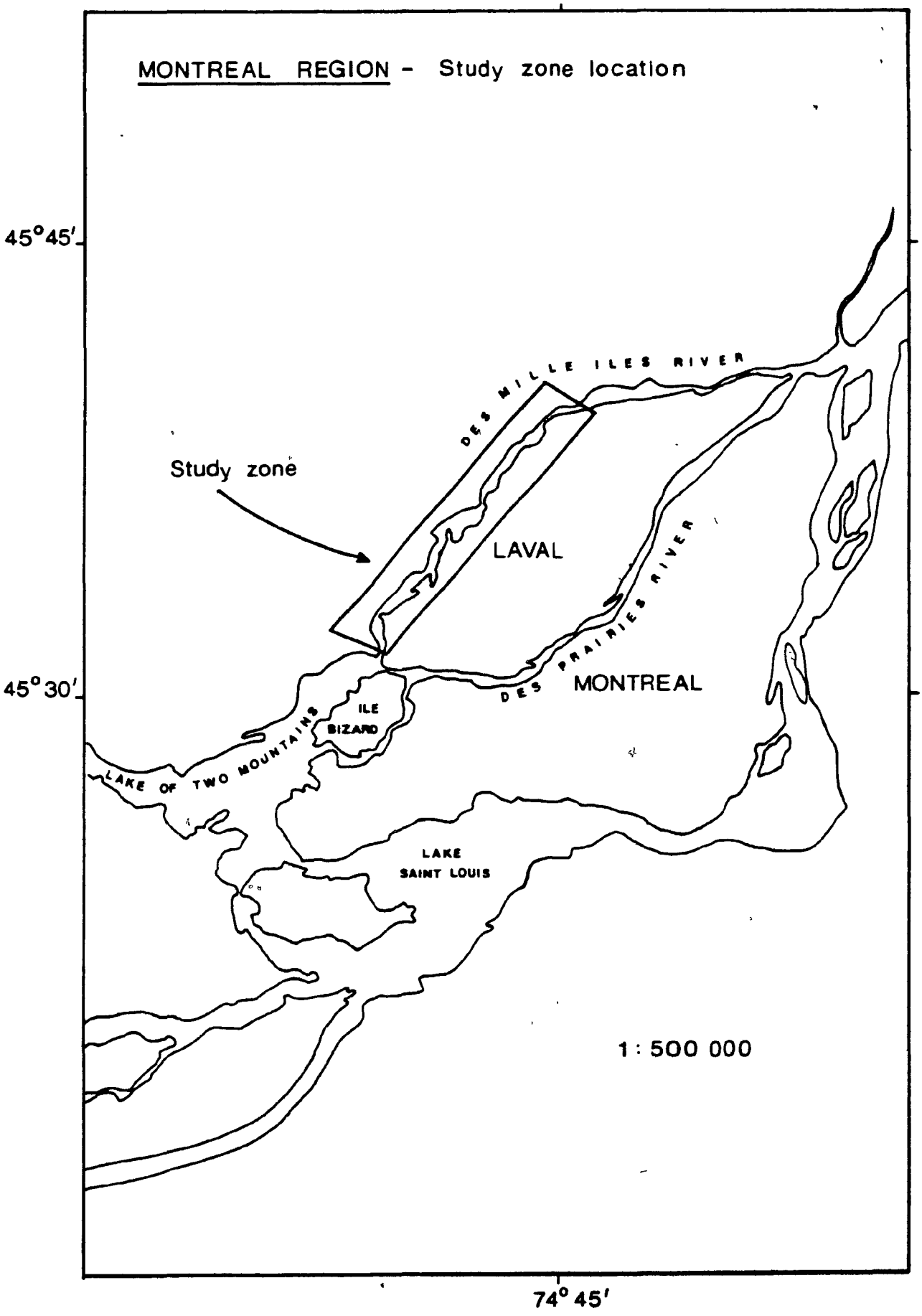
A necessary prerequisite to any comprehensive floodplain management scheme is an understanding of the bio-physical elements of the study zone. The following chapter, documents the floodplain's resources and nature of the flood hazard.

2.1 Location

The riparian zone under study in this thesis is located along the first 20 km of the Mille Iles river, northwest of Montreal (Map 2.1). The Mille Iles River region was selected as the study zone for this research on floodplain management because of its extensive floodplains which have recently been subject to suburbanization pressures. The first 20 km of the river's floodplains, between the municipalities of Two Mountains and Bois des Filion, were studied in detail because the hydrological properties of the area, the soils, water quality and vegetative associations favour the development of valuable floodplain ecosystems. Given the suburbanization pressures and the threat which they pose to the remaining valuable floodplain habitats, the management of the area is in urgent need of study.

The study zone extends over an area of approximately 998 ha. which includes the northern and southern floodplains of the river between the 100 year flood recurrence line and the normal low water mark, from the Canadian National railway (CN) bridge at the entrance of Lake of Two Mountains to the David bridge at the

Map 2.1


MONTREAL REGION - Study zone location
45°45'
45°30'
74°45'
DES MILLE ILES RIVER
Study zone
LAVAL
DES PRAIRIES RIVER
MONTREAL
ILE BIZARD
LAKE OF TWO MOUNTAINS
LAKE SAINT LOUIS
1 : 500 000

municipality of Bois des Filion (Appendix I).

The upper limit of the floodplains correspond to the height of the 100 year flood (1 580 m^3/s), which is internationally considered to represent a reasonable highest flood recurrence interval for planning purposes (UNESCO 1974). The lower limit of the floodplains correspond to the 1969 (500 m^3/s) water level as delineated by the federal ministry of energy, mines and resources, on the 1977 flood risk maps.

The 1977 flood risk maps further subdivide the floodplains into two zones. The lower floodplain, or strong current zone, extends from the shoreline to the 20 year flood recurrence height. The 20 year flood recurrence height corresponds to the 1974 flood height which equals a 1 310 m^3/s discharge rate. Buildings located in this zone are exposed to strong currents and ice. The damage in this zone is frequent and extensive. The upper floodplain, or weak current zone, starts where the first ends and extends to the limit of the 100 year flood. Structures in this area are less frequently affected by flooding.

Expressed in terms of probability, the 100 year flood recurrence height has a 1% chance of being equalled or exceeded in any given year and the 20 year flood has a 5% chance. It should be emphasized that the recurrence interval of a specific flood is an average based on historic data. In addition, the fact that a flood height is reached one year does not prevent that level from being equalled or exceeded in the following years. While the historical average may change over time, the flood recurrence intervals presently provide information for the management of floodplain lands because they define the flood risk or hazard at a particular location.

2.2 Geology and Soils.

The Mille Iles River flows through a plain of alluvial deposits which lies about 50 m above sea level. The bedrock in the area is of sedimentary origin, from the Ordivicien age, which belongs to the Beekmantown group. It is primarily comprised of finely crystalized dark grey dolomite which is inter-stratified with occasional layers of thin schist. Occasional outcrops of bedrock, often covered by a thin layer of moraine, also characterize the area. The most important bedrock outcrop in the study zone is manifest by the Grand Moulin rapids at the entrance of the river (Shawinigan 1981).

Four major soil types are common throughout the floodplain: moraine or glacial till, clay soils, thin moraine on bedrock and alluvial soils (Shawinigan 1981).

Thick moraine, or glacial till deposits, is the most common soil type. It covers over 50% of the Mille Iles River's banks. Moraine is found continuously on the south shore between Ile Taillefer and Ile des Gardes. In this area, the shoreline has a gentle slope (0 to 5 degrees) at least 50% of the time. This permits the penetration of water inland during high water levels. The floodplain zones which are made up of thick moraine are often poorly drained because of the gently undulating relief which prevents water from draining into the river. Such conditions are found along the south shore continuously from Ile Taillefer to the Canadian Pacific railway (CP) bridge in Ste. Rose. Along the north shore from Ile Malquin to Ile Ducharme and in front of Ile Garth to the David bridge.

Clay soils comprise about 24% of the river's floodplain.

Clay soils are present almost continuously along the north shore from the CN bridge at the entrance of the river to Ile Malquin. In general, the soils are impermeable, but well drained because of their slopes (0 to 15 degrees).

Alluvial soils are spread throughout the study zone and are normally located in areas adjacent to calm waters or behind obstacles. The two most notable cases are behind the thick moraine outcrops at the tip of the Arthur Sauvé bridge on the south shore and in front of Ile Belair on the north shore. These alluvials are for the most part quite permeable but badly drained because the terrain is usually flat. Well to very well drained alluvial soils are located along the north shore in front of Ile Bourdon and Ile Ducharme and 650 m downstream of the Grand Moulin rapids for a distance of 375 m . Along the south shore well drained alluvial soils are found on either side of the Arthur Sauvé bridge and downstream from the CP bridge in Ste. Rose to the floodplain zone in front of the western tip of Ile Garth.

Thin moraine soils overlaying bedrock occupy a very small portion of the study zone. A small amount is found near the CN bridge on the north shore. A larger amount is found on the south shore for 600 m downstream of the CN bridge. Another zone of thin moraine soil is located on the south shore between the western tip of Ile Garth and the David bridge. This type of soil is quite permeable and normally well drained, especially near the banks.

2.3 Hydrodynamic zones

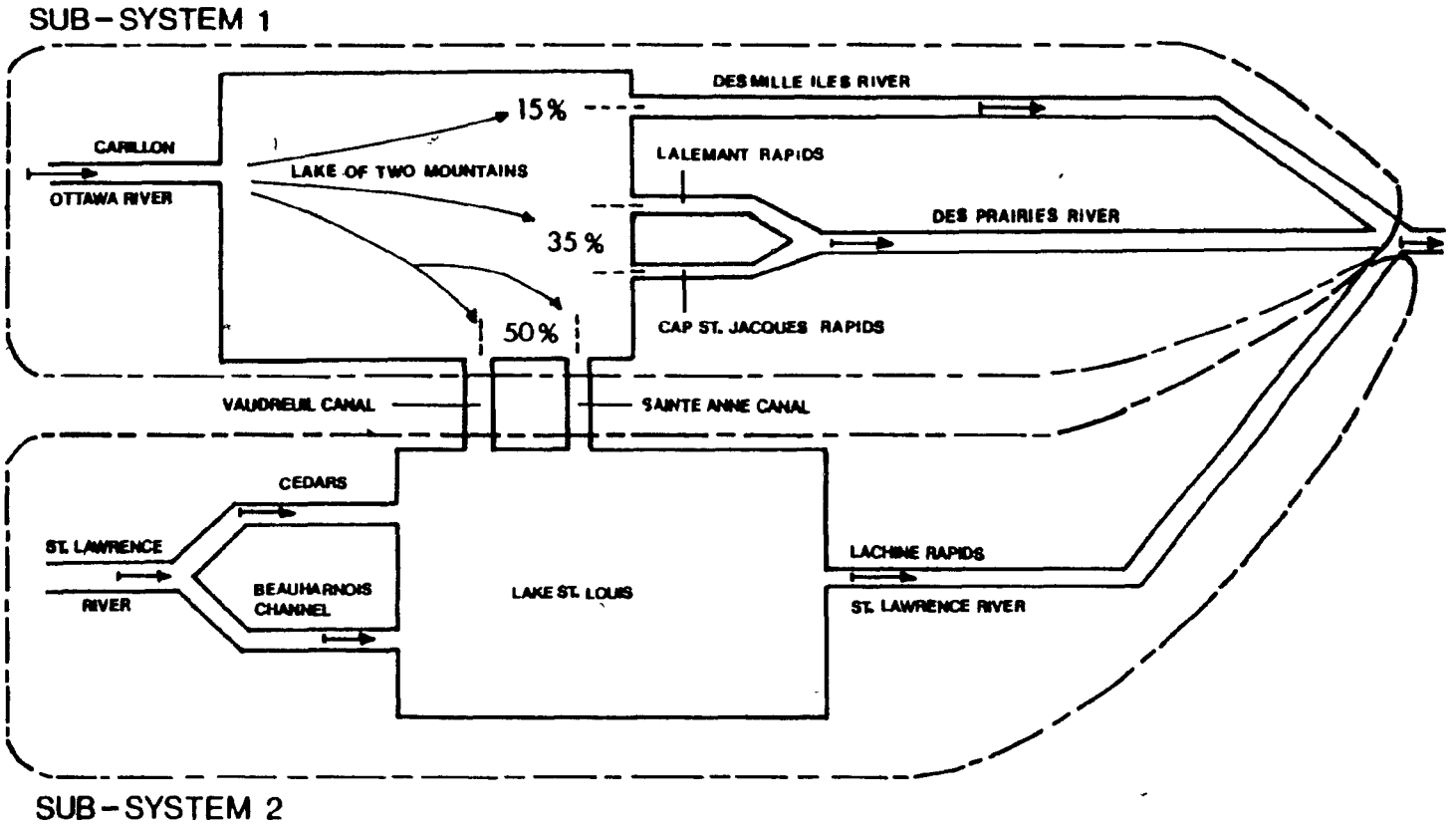
The morphology of the river basin gives rise to two distinct hydrodynamic zones along the reach of the river under study. These differences in hydrodynamic behavior are largely attributable to differences in stream bed profile and channel width (Appendix II). The first zone, which extends for approximately 0.5 km at the entrance of the river, is marked by the presence of the Grand Moulin rapids (also known as the Laval-sur-le-Lac rapids). The rapids flow through a shallow and narrow stream channel and around islands which mark a fracture zone of exposed resistant bedrock. Flow speeds over the rapids can reach 3 m/s, for which discharge rates can vary from 226 m^3/s to 1 416 m^3/s (Shawinigan 1981). Immediately after the rapids, the channel abruptly widens and deepens to form a trough, which marks the end of the first hydrodynamic zone.

The second hydrodynamic zone extends over the remaining 20 km of the river, from the trough succeeding the rapids to the David bridge in Bois des Filion where the river channel once again narrows. Within this zone, water depths vary form 4 to 30 meters. Channel width also varies considerably as the river flows through a channel which is interspersed with over 64 large and small islands. Flow speeds are generally less than 1 m/s even during floods (Shawinigan 1981).

The Mille Iles River is considered to be a "non navigable" river by the provincial government because the Grand Moulin and Terrebonne rapids (located further downstream outside the study area) are considered major hinderences to navigation and prevent profitable commercial navigation along the river's length.

Figure 2.1

Shematic diagram of hydrologic network – Montreal region



(Source: Fisheries and Environment Canada and Québec Ministère des Richesses Naturelles 1978)

2.4 Hydrological regime.

The hydrologic network of the Montreal archipelago can be divided into two interacting subsystems (Fig. 2.1). The first, consists of the Ottawa River and Lake of Two Mountains, and the second, of the St. Lawrence River and Lake St. Louis. The Mille Iles River area belongs to the first subsystem. The river is one of five outlets of Lake of Two Mountains. Through Lake of Two Mountains the Mille ILes River conducts between 8% and 15% of the Ottawa River's outflow depending on the water level in the lake.

The Ottawa River subsystem drains a basin of 142 000 km². Annually, following the spring snow melt, the hydrological regime of the Ottawa River is characterized by a peak flood lasting from ten to twenty days. During an extreme flood the Ottawa River discharges 9 900 m³/s into Lake of Two Mountains, while the average annual flow is in the order of 2 100 m³/s (Fig. 2.2).

In comparison, the drainage basin of the St. Lawrence River subsystem is formed by the Great-Lakes. At the outlet of Lake Ontario, the drainage area is about 777 000 km². Because of the Great-Lakes storage capacity, large quantities of water can be absorbed and eventually released at a steady rate. As a result, the St. Lawrence basin is one of the best naturally regulated systems in the world. Thus, while the St. Lawrence river is subject to periods of high and low water supply and annual increases in discharge rates caused by snow melt, the river has no significant flood peak. The mean annual flow rate of the St. Lawrence River is approximately 6 800 m^3/s. During an extreme flood (loo year flood recurrence interval), discharges reach 9 900 m^3/s (Fig. 2.2).

The Mille Iles River's waters come almost exclusively from the Ottawa River. As a consequence, the hydrological regime of the Mille Iles River is also characterized by an annual peak flood following the spring snow melt. Though the discharges of four tributaries with small drainage basins flow into the Mille Iles River - the Duchêne River, Chicot River and aux Chiens River within the study area, and the Mascouche River further downstream, their contribution to the Mille Iles' flow is considered insignificant compared to the Ottawa River's (Shawinigan 1981).

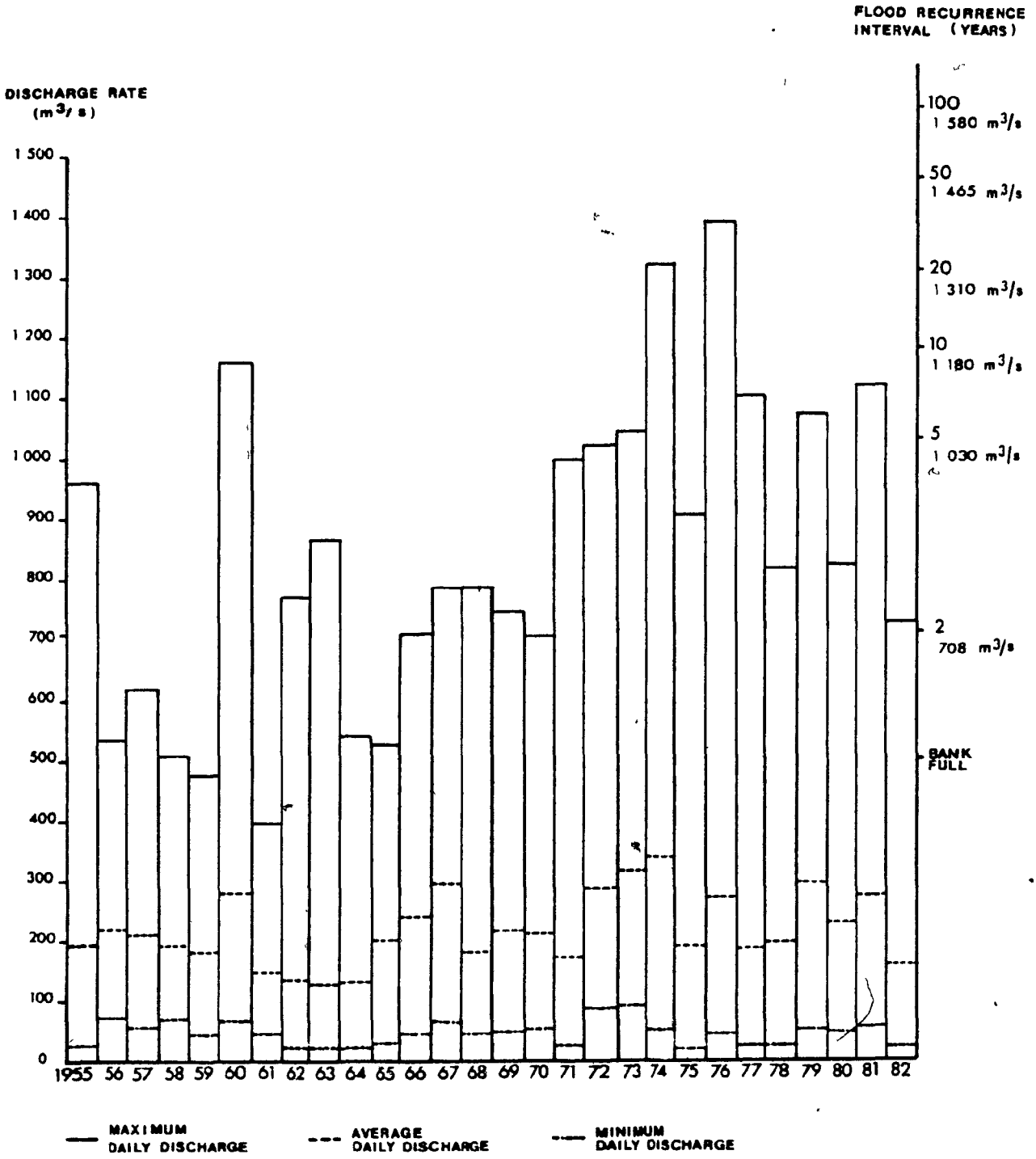
Even though the flows of the Ottawa River are regulated, the control measures have not completely eliminated the seasonal variations in discharge rates. As a result, the Mille Iles River experiences extremes in flow rates: For example, between 1955 and 1982, daily discharge rates reached a low of 18.8 m^3/s in August 1975 and a high of 1 390 m^3/s in April 1976. The average yearly flow rates of the river range between a low of 129 m^3/s in 1964 and a high of 337 m^3/s in 1974 (Fig 2.3). The bankfull capacity of the river corresponds to approximately 500 m^3/s (Bureau d'Audience Public (B.A.P.) 1982:54).

During the late 1950's and early 1960's, the river experienced a period of lower average yearly flow rates and peak discharge levels than during the 1970's. Then, in 1972, 1973, 1974, 1976, 1977, 1979 and 1981 discharges exceeded 1 030 m^3/s, the 5 year flood recurrence heights. The 1974 and 1976 flood heights exceeded 1 310 m^3/s, which correspond to the 20 year flood recurrence height.

The peak flood heights are usually experienced between mid-March and mid-June. April is traditionally the month which

Figure 2.3

YEARLY FLOW RATES



Station no. 020A003 Bois des Filion

experiences the highest discharge rates while the month of September experiences the lowest (Appendix II). During peak flows, water can take less than half a day to travel through the 40 km long river, with only a few hours difference between 100 and 2 year flood recurrence flood levels. During low water level periods, water can take up to a week to travel through the river (Shawinigan 1981).

By December, an ice cover forms over the entire river, except in the vicinity of the fast flowing waters of the Grand Moulin rapids which remain ice free throughout the winter. Ice breakup usually occurs during the month of March or April in response to the rise in seasonal discharge rates.

As a consequence of the hydrological regime of the Mille Iles River which has flows exceeding 1 390 m^3/s in the spring and flows as low as 18 m^3/s in the summer, the river has a large and active floodplain zone: along the southern floodplain, 83% of the study area lies within the high flood risk zone between the water line and the 20 year flood recurrence height. The majority of the floodplains between Fabreville and Ste. Rose and downstream of Auteuil are high flood risk zones. An even larger portion of the northern floodplain, 89%, lies within the high flood risk zone. The upper floodplain which acounts for only 11% of the floodplain is primarily confined to portions of Bois des Filion and Rosemere.

The majority of the study zone is, therefore, subject to fluctuations in water level, especially in the spring, which sustain important bio-physical processes and produce valuable riparian habitats, but represent high flood risk zones for certain human developments.

2.5 Water quality

The water quality of a water body influences the organisms which can live in it and thus determines the biotic potential of the environment. Water quality also influences human activities, such as recreation.

A 1981 study by the Shawinigan consulting firm presents information on nitrate, phosphorous, turbidity and conductivity for the river between 1970 and 1978. Overall, water quality is very poor. For example, though there were great fluctuations in the turbidity data between the years, 65% of the sample sites along the river exceeded the acceptable turbidity limit. Turbidity has an aesthetic significance and is a limiting factor controlling the amount of light penetrating the water and thus the potential for aquatic life. In the study zone, turbidity is highest along the lower portion of the study zone between the aux Chien river and the David bridge.

In all water quality parameters, the Shawinigan study shows that all pollutant levels are directly influenced by the presence of urban and industrial effluent sources. The location of effluent pipes explains the major variations in turbidity, especially when low flow levels are experienced. The water quality of the tributaries also affects the river's overall water quality, especially during low flow periods. Overall, water quality decreases systematically from upstream to downstream. The phenomenon is explained by the gradual accumulation of contaminants and their progression downstream.

The Shawinigan study reveals that seasonal flooding plays an important role in re-establishing water quality by dilluting and

flushing out pollutants along the river. During peak flows the increase in waters from the Ottawa river insure a greater dillution of local effluents and an improvement in water quality.

No studies have been performed on the floodplains role in ground water replenishment, sediment entrapment or filtration of pollutants.

Decreases in water quality have resulted in the loss of recreational potential. In 1972, there were 10 beaches along the river. By 1980, following the continuous deterioration of water quality, all of the beaches were closed.

2.6 Flora

Few studies have dealt with the Mille Iles River's riparian vegetation. Only two studies, one by Lagacé and Dubé (1977) and the other by Shawinigan (1981), address the subject in any detail. In addition to these studies, information on the river's flora was supplemented by the air photo interpretation exercise undertaken to determine land use changes (Ch.4). The results of the land use change study are discussed later on but the relevant vegetation information is intergrated in this section.

Because of the river's peri-urban location, a large portion of the floodplain zone has been strongly modified by human encroachment. By 1980, only 54% (536 ha.) of the study zone retained a vegetation cover. Since the area is characterized by a number of soil moisture conditions, from the aquatic to the terrestrial environments, a range of vegetation covers adapted to different moisture conditions are present: woodland, shrubland,

Table 2.1

Distribution of vegetation classes along the study zones in 1980

Vegetation class	Hectares		% of total floodplain	% of undeveloped floodplain
Shore marsh	7.87	ha.	1%	2%
Basin marsh	8.88	ha.	1%	2%
Meadow wetland	2.22	ha.	<1%	<1%
Shrub wetland	80.95	ha.	8%	15%
Wooded wetland	336.41	ha.	34%	62%
Disturbed wetland	99.84	ha.	10%	18%
	536.17	ha.	54%	100%

meadow land and marsh vegetation (Fig. 1.1).

Within the remaining 536 ha. of vegetated floodplain woodlands occupy 62% of the zone (Table 2.1). Silver maple forests are the most common forest association and represent approximately 58% of the forested cover (Shawinigan 1980). Silver maple forests typically support little undergrowth because few species can withstand the moisture conditions. Such forests are most common along the southern floodplain between Fabreville and Auteuil and in Rosemere along the northern floodplain.

The second most common forest association, a mixed deciduous forest composed of maples, ash, aspen, cottonwood and elm, is dispursed throughout the study zone. A thick undergrowth composed of poison ivy, touch-me-not, Canada nettle and sensitive fern usually characterizes this woodland cover.

The third most important forest association is the red maple forest which occupies approximately 5% of the forested floodplain. The red maple forest is usually Quebec's most common riparian forest. However, in the St. Lawrence lowlands it is often replaced by silver maple. Along the Mille Iles River, red maple forests succeed silver maple forests along the drier sites. Its natural habitat is characterized by inadequate soil drainage conditions resulting either from a raised water table or poorly drained soils located in depressions. In the case of the Mille Iles floodplains a raised water table following seasonal spring floods give rise to perfect habitat conditions. Small stands are present on both shores throughout the floodplains.

Disturbed wetland zones, where the natural vegetation cover has at one time been removed and is regenerating into one or more stable vegetation covers, is the second most common undeveloped

land cover occupying 18% of the vegetated floodplain study area. Grasses and forbs are the characteristic vegetation covers.

Shrub-sapling wetland is the third most important vegetation cover occupying 15% of the undeveloped floodplain. The dominant species include red and silver maple saplings, speckled alder and a variety of willow species. A large proportion of the shrub-sapling areas correspond to abandonned agricultural zones and represents a transitional vegetation cover from disturbed to woodland conditions.

Emergent and aquatic vegetation line the lower edges of the floodplains and occupy basin marshes. Because the floodplain boundaries only extend down to the shoreline, as defined by the 1977 flood risk maps, shore and basin marsh zones occupy only 4% of the floodplain study area. Along the southern floodplain, shoreline depressions around the Sauvé bridge, in front of Ile Locas and west of Auteuil support the largest areas of emergent and aquatic vegetation. Along the northern floodplain, the gently sloping shorelines of St. Eustache and Boisbriand and shoreline depressions in Rosemere, east and west of the CP bridge, also support emergent covers.

Finally, meadow wetlands form the transition between aquatic and forest vegetation covers and occupy less than one percent of the vegetated zones. Meadow species include reed canary grass, cut-grass, blue joint, manna grass, woolgrass, softrush and sedges. Reasons for the small coverage include the fact that the banks of the Mille Iles River are not conducive to the development of meadow wetlands. Today, the Rosemere floodplain west of the CP bridge along the north shore supports most of this vegetation cover.

2.7 Fauna

2.7.1 Fish

The number of fish species along the Mille Iles River have declined in the last twenty years. In 1964, the river supported 75 species, by 1976 only 45 species remained. The loss is attributed to water pollution and loss of adequate spawning grounds and habitats. Nonetheless, "Malgré les nombreuses perturbations du milieu, la faune ichtyenne a conservé une étonnante vitalité tant au point de vue du nombre que de la variété des espèces."(Munic. Laval 1976:30).

In 1976, a study by Mongeau and Massé noted the presence of two more species. A 1980 study by Mongeau, Legendre, Leclerc and Brisebois also recorded two other species. By 1981, the Shawinigan study had identified another 3 species. Thus, in 1980, the Mille Iles River was found to support at least 52 fish species (Appendix III). The most common species are sunfish and small mouth bass, perch and walleye, catfish, suckers and redhorse, pike and minnows.

Approximately half of the 52 fish species spawn in fast flowing waters and the other half in calm waters (Appendix III). The Grand Moulin rapids have been proven to be of great importance to the survival of the species which spawn in fast flowing water. In 1976, Mongeau and Massé identified the fish which depend upon the the Grand Moulin rapids for spawning. Lagacé and Dubé (1977) have also described the zone as an important spawning ground for the smallmouth bass (Shawinigan 1981:147). Some of the most economically valuable fish species (both commercially and recreationally), such as the sauger and

walleye, spawn in the rapids. The value of sport fishing along the river has not yet been evaluated. However, in 1980, only about 10 commercial fishing licenses were issued along the river (Shawinigan 1982).

Besides being an important spawning site, the rapids also play an important role in fish migration.

> Il ne semble plus, suivant les inventaires ichtyologiques, que le saumon de l'atlantique s'aventure dans la rivière des Mille Iles. Cependant, diverses espèces migratrices telles la laquaiche argentée, l'alose savoureuse et certaines espèces empruntent cette rivière pour se rendre dans le lac des Deux Montagnes et la rivière des Outaouais ou elles se reproduisent. Il ne faut pas oublier non plus que certaines espèces sportives ou non telles que le doré ou les cyprins effectuent des migrations locales (amont et aval du rapide du Grand Moulin) et que la libre circulation de ces espèces doit, continuellement nous préoccuper afin d'assurer la pérennité de ces espèces indigènes (Shawinigan 1981:169).

Finally, it must be stressed that the Grand Moulin rapids and the Lachine rapids southwest of Montreal are the only two remaining migration routes for species, such as the shad and the mooneye, to sites upstream of Montreal. The rapids of the des Prairies River, along the south shore of Laval, have been blocked by the construction of a hydro-electric dam.

Today, a water regulation project known as "projet archipel" is jeopardizing the existance of the Lachine rapids. As will be examined in detail later, a proposed flood control dam at the entrance of the Mille Iles River is also threatening the existance of the Grand Moulin rapids (Ch.5).

For the species which require shallow and/or calm waters for spawning, the river still offers a number of undisturbed sites. Spring flood waters provide excellent shallow water spawning sites for species such as the northern pike (Appendix III). The

density and diverstiy of submerged and emergent vegetation are the principal requirements for site selection. The seasonal occurrence of the flood and the flood height are both important factors in the success of reproduction. Species such as the northern pike depend upon early high floods for the best spawning sites to be made accessible. Shoreline encroachment along many portions of the floodplain have probably destroyed a number of the shoreline sites.

The most valuable shallow water spawning sites remain around the bay west of the Sauvé Bridge in Laval Ouest, along the St. Eustache shoreline, the bay east of highway 13 in Fabreville, extensive inland portions of the Boisbriand floodplain east of highway 13 (presently disturbed by hydro-electric pilons), the Boisbriand shoreline between highway 13 and Ile de Mai, the floodplain west of the St. Rose peninsula, the large shore marshes east of the St. Rose peninsula, around Ile Clermont, Ile Locas and Ile Gagnon, west of the CP bridge in Rosemere, around Ile des Gardes in Rosemere, and the bays around Auteuil in Laval.

Though the river's water quality has decreased over the years and floodplain encroachment has destroyed a number of spawning sites, the Mille Iles river with its range of flowing water conditions remains a valuable habitat for fish species.

> La rivière étant moins affectée au niveau de sa qualité aquatique (moins d'émissaires d'égouts) par rapport à d'autres secteurs dans la région de Montréal, il en résulte donc un potentiel élevé au niveau des abondances des espèces de poissons.
>
> La rivière des Mille Iles est considérée comme un endroit excellent (Massé et Mongeau 1976) pour l'Achigan à petite bouche. Deux endroits semblent être importants pour les sites de fraie soit le rapide de Terrebonne et le rapide du Grand Moulin. Le rapide du Grand Moulin ... touche en plus les populations de la rivière des Mille Iles et une partie de la populations du Lac des Deux Montagnes. Ce rapide revêt donc une

> importance très élevée par sa situation géographique. On peut considérer presque toute la zone du rapide comme un site potentiel pour la fraie et surtout sur la rive droite entre l'île Turcotte et la rive droite (Shawinigan 1981:177).

The number and diversity of fish species in the Mille Iles River is directly related to the condition of the shorelines and adjacent floodplains.

A healthy fish population is a principal requirement for the survival of the land based floodplain species which feed on fish. In addition, the diversity and abundance of fish adds to the floodplains attractiveness because of the direct recreational and commercial potential.

2.7.2 Birds and mammals

The avifauna which characterizes the area include three types of seagulls: the ring-billed gull, the herring gull and the great black-backed gull. In the nesting season the seagulls gather in large communities around the islands of the Grand Moulin rapids and shores of the municipality of Saint Eustache (Laval 1976, Shawinigan 1981).

Amongst Quebec's eight heron species, the study zone supports five: the great blue heron, the black crowned night heron, the green heron, the american bittern and the least bittern. The species have different nesting habitats, some nest in trees and others amongst the emergent vegetation, but they are all dependent upon the riparian habitat for nesting and feeding. Their primary foods consist of frogs, fish and aquatic arthropods (Gauthier and Lepage 1976; Shawinigan 1981).

The ideal habitat for herons and bitterns consist of gently sloping shorelines with shallow water zones which support a wide

variety of emergent and aquatic vegetation. The vegetation must, however, not be too densely distributed. The Mille Iles river's shorelines between the grand moulin rapids and the David bridge provide excellent heron habitat. The best sites are located immediately upstream of the Sauvé bridge and around the marshes and islands in the vicinity of the Laurentian Autoroute and the Lafontaine bridge (highway 117). From Rosemere down to the mouth of the river, utilization of the floodplain by herons is weaker (Munic. Laval 1976; Gauthier and Lepage 1976; Shawinigan 1981).

The shorelines and floodplains of the river are also used by migratory birds such as the Canada Goose and the Malard (Munic. Laval 1976).

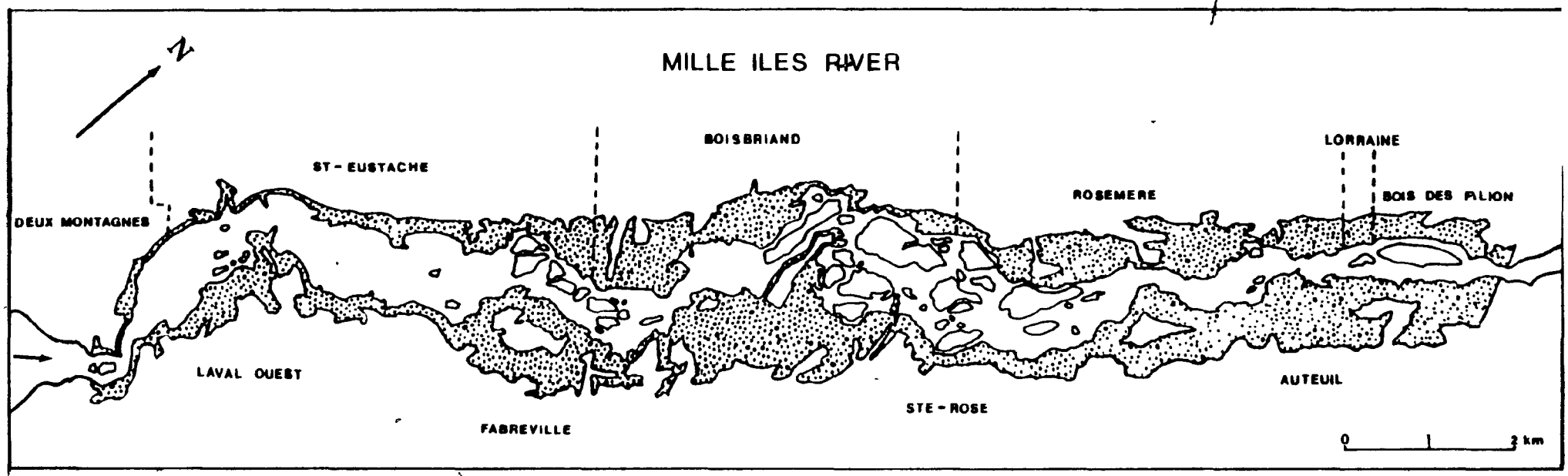
The Mille Iles River has, therefore, been recognized as an important habitat for avifauna, "Dans l'ensemble, les deux plans d'eau qui circonscrivent la ville de Laval recèlent donc sept (7) sites de nidification de plus ou moins grande importance, dont cinq (5) sur la rivière des Mille Iles." (Munic. Laval 1976:32)

The region, however, offers less valuable habitats for shore birds. According to the Shawinigan study (1981:100), "la région de Montréal est beaucoup moins propice aux oiseaux de rivage. L'absence ou la détérioration par l'homme, de large rives vaseuses dépourvues de végétation est sans doute la cause principale de cette rareté."

Finally, semi-aquatic mammals also utilize the river's floodplains. The most complete study on semi-aquatic mammals of the Mille Iles River is by Bergeron (1977). The most common mammals include muskrats, minks, otters and racoons. Though the river's floodplains offer adequate racoon, mink and otter habitats, the presence of mankind and the destruction of

map 22

STUDY ZONE - POLITICAL DIVISIONS



shoreline habitats have seriously reduced the wildlife potential (Shawinigan 1981).

The muskrat, however, has flourished along the river's floodplains. Bergeron (1977) states that the river is intrinsically suited to muskrats because of its shallow floodplain waters which support the necessary aquatic and emergent vegetation. Gently sloping shorelines (less than 15 degrees) offer the best muskrat habitat for nest building. The clay and loam soils of the floodplain provide good nest building materials. Muskrats construct underground galleries by excavating tunnels along the shorelines. As a result, water level fluctuations, wave effects and flow speeds are important criteria in selecting sites. As with the natural habitats of other floodplain species, natural muskrat habitats are increasingly subject to man-made modifications be they dikes, the accumulation of solid and liquid wastes or infilling.

2.8 Political divisions

The floodplain study zone encompasses parts of seven municipalities, six along the north shore and one along the south shore (Map 2.2).

The northern floodplain, which is narrower and encompasses only 375 ha. or 38% of the study area, is occupied by six municipalities : Two Mountains (8.80 ha.), St. Eustache (73.40 ha.), Boisbriand (127.95 ha.), Rosemere (130.20 ha.), Lorraine (12.05 ha) and Bois des Filion (23.10 ha). The municipalities of Rosemere and Boisbriand have jurisdiction over the largest

Table 2.2

The Mille Iles River region: population trend (1956 - 1981)

Year	Laval	Two Mountains	St. Eustache	Boisbriand	Rosemere	Lorraine	Bois des Filion
1956	69 410	5 830*	3 740*	- -	- -	- -	1 648
1961	124 741	7 274	5 463*	2 502	6 158*	197*	2 499
1966	196 088*	8 069*	7 319*	3 498*	6 429*	1 627*	3 219
1971	228 010	8 631	16 890*	7 278	6 710*	3 145*	4 061*
1976	246 243	8 957	21 248	10 132	7 112	5 388	4 346
1981	268 335	9 944	29 716	13 471	7 778	6 881	4 943
Projected increase							
1986	282 222						
1991	292 788						
1996	296 253						

* Change in municipal boundary since preceeding census.

(Source: Census Canada '56 - '81, and Munic. Laval 'Service d'urbanisme' 1983)

floodplain surface areas and together control over 69% of the northern floodplain.

In 1965, the towns of Laval Ouest, Fabreville, Ste. Rose and Auteuil along the southern floodplain and ten other Iles Jesus communities fused to form the municipality of Laval. The municipality of Laval has jurisdiction over the entire southern floodplain which encompasses 623 ha. or 62 % of the study zone.

2.9 Population trends

The Mille Iles river region experienced its greatest growth in population between 1956 and 1971 (Table 2.2). The large increases in population are explained by a general suburbanization process, an immigration from the urban centre to the outlying rural areas, which characterized the Montreal region between 1956 and 1971.

The population of Laval grew most rapidly between 1956 and 1966, the greatest growth occuring between 1961 and 1966. Since 1971, the mean annual growth rate for Laval has stabilized at approximately 1%. It is predicted that this trend will continue and that the Laval population will only increase by approximately 30 000 people between 1981 and 1991 (Laval Municipalite Regional de Comte (M.R.C.) 1983:10).

The Laval Ouest portion of the floodplain, the oldest region, is predicted to experience the least growth in the future. The Auteuil region, on the other hand, has the most growth potential of the entire Ile Jesus area (Laval MRC 1983:130; Munic. Laval 1976:15). The recent population growth in

the Auteuil region is reflected by the trends in housing development. The Auteuil region is the site of over 25% of the new housing construction in Laval since 1976.

The northern floodplain municipalities experienced their greatest population increase between 1961 and 1971, five years later than along the southern floodplain, and experienced another surge between 1976 and 1981. The five year delay in population growth is largely related to the relative inaccessibility of the northern shoreline. The increases in population are closely linked to the improvement in north shore accessibility with the construction of the Laurentian Autoroute in 1963 and highway 13 in 1974.

After 1971, immigration from Montreal to the northwestern suburbs decreased. The high costs of transportation and a downturn in the economy led to a reversal of immigration trends back toward the urban centre. Population increases after this date are a result of natural population expansion.

2.10 Contemporary land uses

Three studies discuss the nature of contemporary land uses along the Mille Iles River: a 1981 environmental impact study by the Shawinigan Consulting firm, a 1976 study by the municipality of Laval and a 1976 study by the municipality of Boisbriand. In addition, a macro-inventory of contemporary land uses based on 1980, 1 : 10 000 air photographs was undertaken to supplement the above information.

Originally, the Mille Iles River region was an agricultural

Table 2.3

Distribution of developed land uses along study zone in 1980.

Land use class	Hectares	% of total floodplain	% of developed floodplain
Residential	289.76 ha.	29%	64%
Transition	79.30 ha.	8%	18%
Cottage	11.82 ha.	1%	2%
Industrial/ commercial	14.63 ha.	1.5%	2%
Agricultural	24.90 ha.	2.5%	5%
Disturbed	44.07 ha.	4%	.9%
	464.48 ha.	46%	100%

zone and an area of summer cottages for urban Montrealers. In the early 1960's and 70's, due to favourable economic conditions, improved transportation networks, the attractive properties of the shoreline and a lower tax base due to the historical flooding problem, rapid development occured. Today, the region has evolved into a suburban, largely residential area.

The land use inventory performed for this study reveals that in 1980, 56% of the northern floodplain and 41% of the southern floodplain are under developed land occupations (residential, transitional, cottage, industrial, agricultural and disturbed land uses). In 1980, the residential developments are the dominant land use (Table 2.3).

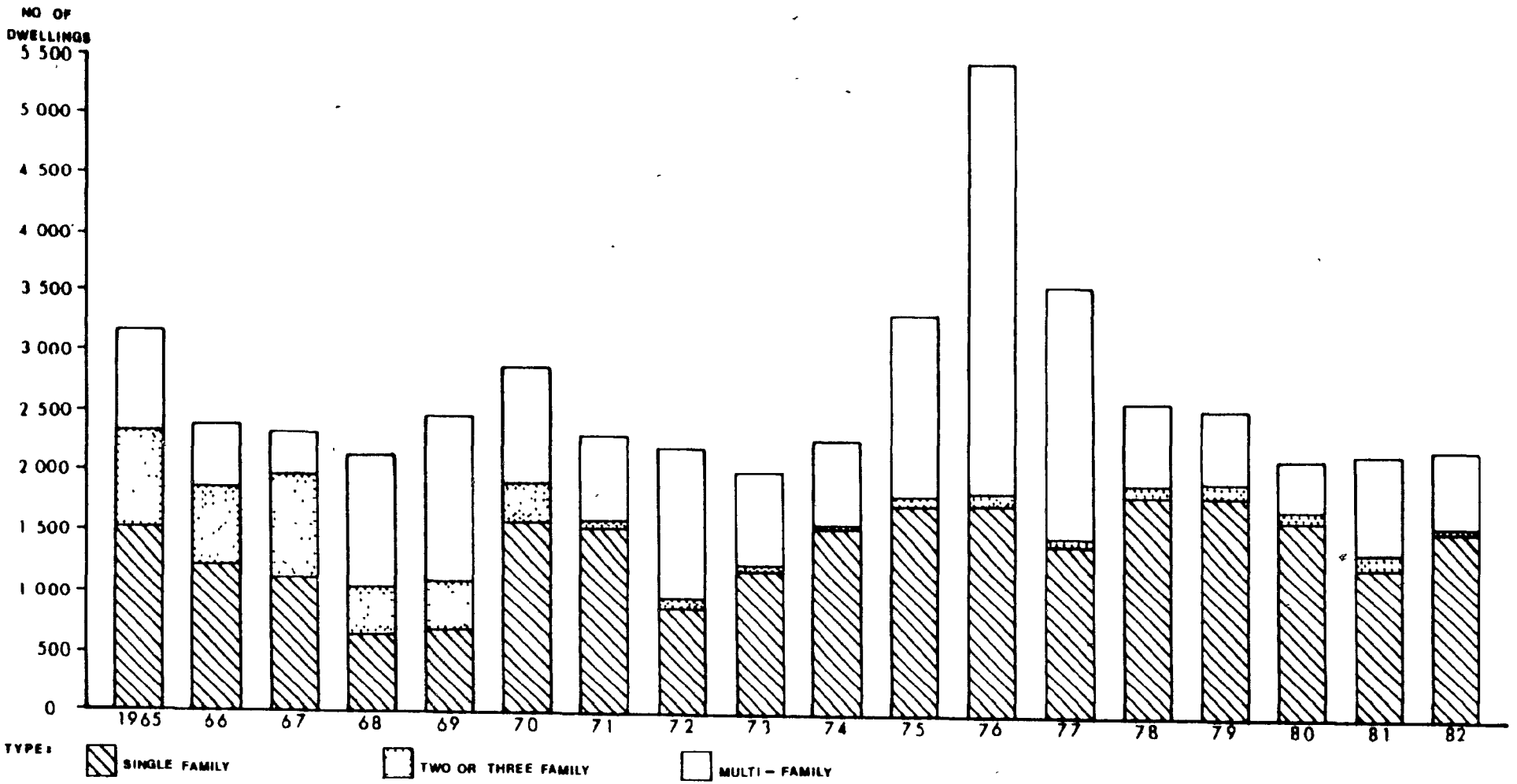
The residential zones, which consist of recent high quality constructions, are generally found along the least susceptible flood zones. Along the Laval floodplain, residential developments occupy large portions of the Laval Ouest, Fabreville and Ste. Rose areas. Along the northern floodplain, the municipalities of Bois des Filion, Deux Montagnes and St. Eustache support the largest residential developments.

The construction of residential dwellings peaked in 1976. Since then, it has steadily decreased (Fig. 2.4). The residential expansion coincided with the years of low flood peaks. The municipality of Laval has observed that the installation or extension of municipal services (water pipes and sewers) is a principal factor in the construction of new permanent residential dwellings and the transformation of cottages into permanent dwellings (Laval MRC 1983:104).

Transition zones, where summer cottages adjoin permanent single family dwellings and where summer cottages have been

Figure 2.4

RESIDENTIAL DEVELOPMENT TRENDS - MUNICIPALITY OF LAVAL (1965 - 1982)



(Source: Municipality of Laval 'Service d'urbanisme' 1983)

transformed into permanent dwellings, is the second most important developed land use and typically occupies higher flood risk areas. In the transition zones, many of the cottages are neglected and deteriorating while the permanent housing, often winterized cottages, are maintained and of higher quality. Within the transition zones, the proportion of cottages to permanent habitations can vary from 20% to 50% (Shawinigan 1981:107). The abandonment or neglect of cottages is explained by the high renovation and maintenance costs in relation to the value of the property, the property tax burden and the zoning and lot size requirements which may render all transformations or renovations impossible. Lot size requirements and zoning regulations have recently played an important role in the abandonment of cottages, because many of the dwellings were initially constructed in the absence of any management policies (Shawinigan 1981:107).

In 1980, agricultural activities only occupied 2.5% of the floodplains. Prior to the suburbanization process, the Mille Iles River region was regarded as the bread-basket of the Montreal region. Between the 1950's and the 1970's, agricultural practices along the floodplain study zone decreased and changed in nature from extensive cultivation to intensive market-gardening and horticulture. Today, numerous farms specialize in intensive green-house agriculture. A large proportion of the previously agricultural lands have been abandonned and permitted to regenerate into disturbed wetland, shrub wetland and wooded wetland conditions. While agricultural activities presently occupy a small portion of the floodplains, the activity is viewed as important source of employment for the

local populations (Laval MRC 1983:11).

In 1980, few areas were exclusively composed of cottages. Typically, the proportion of remaining cottages was higher on the immediate shoreline, the high flood risk apparently acting as a deterent to the transformation of cottages. Along the southern floodplain, three distinct cottage zones remained along the shoreline - one between Fabreville and Ste. Rose at the foot of the peninsula, and the last two are located east of Auteuil. No cottage zones remained along the northern floodplain.

The municipality of Laval recorded the presence of 2 601 cottages in 1970, more than 80% located within the study zone. By 1976 the number had dropped to 1 544 cottages and by 1981, 1 150 cottages remained. (Laval 1976:40 ; Laval, Serv. Estim. 1981:54). In six years, between 1970 and 1976, there was a 40% decrease in cottages. The decrease is the result of abandonment or transformation of the structures. No studies have determined what proportion of cottages have been simply abandoned as opposed to transformed.

A number of factors have led to a decreased rate of floodplain development in the study zone since 1976. Between 1975 and 1980, only 97 new constructions were erected on the floodplains, representing only 140 new housing units (Shawinigan 1980). Factors which have led to the downturn in development rate include:

- the unrealistic hopes of economic benefits from the Mirabel airport project,
- the presently abandoned project to link downtown Montreal and Saint Jerome with an express transportation system,
- increasing infrastructure and transportation costs,
- the downturn in the economy,

- the adoption in November 1978 of law 90 (Loi sur la protection du territoire agricole), which has imposed serious restrictions on the development of the floodplain, especially on the south shore downstream from Fabreville.

- and finally, stricter floodplain development regulations which are the product of the 1976 federal-provincial flood damages reduction program, which will be examined later (Ch.5).

2.11 The economic consequences of floodplain development

Since the 1950's, residential development along the Mille Iles River has expanded from the dry terrace sites to the lower floodplains. Continued floodplain development combined with ten years of high flood levels have resulted in escalating flood damage potentials.

Floodplain encroachment along the Mille Iles River has resulted in the destruction of valuable riparian habitats and engendered the most significant flood damages in the Montreal region. It has been estimated that the Mille Iles River region can experience over 55% of the floodplain damages in the Montreal region (B.A.P. 1982:27). It has been stated about the floodplains that

> .... L'envahissement de cet espace inondable par l'habitation permanente a couté au gouvernement québecois, à l'occasion des crues de 1974 et de 1976, respectivement $1 398 026 et $1 967 739 .... Ces chiffres ne représentent en rien les dommages réels subis par les riverains ... les dégats réels pourraient s'élever à plus du double (B.A.P. 1982:71).

The Shawinigan study (1981) reports that in 1974, the Mille Iles river residents suffered over 4 million of the 12 million dollars in flood damages which the Montreal area experienced. More than 1 500 single family dwellings, 900 cottages, 17 commercial and 7 public establishments were affected. During the

1972, '73, '74 and '76 floods, the municipalities of St. Eustache, Boisbriand, the Laval Ouest portion of the Laval shoreline, Rosemere and Bois des Filion were most affected (Shawinigan 1981:7). Estimates of the annual damages are in the order of $ 920 000 (December 1974) for Laval and $ 2.5 million for the entire Mille Iles river region (Shawinigan 1981:7; Munic. Laval 1976:39).

In 1976, the municipality of Laval determined that 430 permanent single family dwellings were affected by a 5 year flood recurrence height, 672 by a 20 year flood recurrence and 895 by a 50 year flood recurrence height. The mean value of the dwellings was established at $ 17 000 . More than half of the affected dwellings were located in the Laval Ouest region. Simultaneously, 432, 549 and 617 cottages were affected by the 1/5, 1/20 and 1/50 year flood recurrence heights. The average value of the cottages was fixed at more than $ 8 000 (Munic. Laval 1976).

Approximately 250 buildings along the Mille Iles River, 51 of them permanent dwellings, are affected by floods below the two year flood recurrence height (708 m^3/s) (B.A.P. 1982).

2.12 Conclusions

As a result of the hydrological regime of the Mille Iles River, which has flows exceeding 1 390 m^3/s in the spring and flows as low as 18 m^3/s in the summer, the floodplain is extensive and active, and supports a range of biologically rich habitats.

Based on the information presented in this chapter, it is evident that the floodplains support valuable bio-physical environments whose functions can be beneficial to man and whose existence are a direct result of the natural hydrological regime of the stream. Floodplain encroachment and structural flood-control works attempt to alter the natural bio-physical processses and pose a direct threat to the existance of the systems.

Though the wildlife potential has decreased over the years as a result of habitat destruction, the study zone still supports valuable habitats and wildlife populations. The survival of wildlife is linked to the presence of undisturbed riparian zones which meet adequate habitat requirements such as abundance and diversity of vegetation.

The remaining resources offer a range of management alternatives and provide wildlife habitat, commercial, recreational and educational potentials. Only a few large undistrubed zones with high wildlife potential remain.

Since the late 1950's, the riverine lands have been progressively encroached upon by flood vulnerable developments such as residential, commercial and industrial land uses. The flood hazard along the Mille Iles River, which is measured in terms of flood damages, has become important enough to attract the attention of the federal and provincial governments.

Given the present situation in which the Mille Iles River floodplains are characterized by a range of land uses/covers, from flood-vulnerable residential developments to flood-dependent riparian habitats, it is evident that a comprehensive floodplain management program has to adopt a number of short- and long-term

adjustments to ensure the reduction of flood damages along the developed zones and the rational use of floodplain lands along the undeveloped zones.

In 1976, the governments signed agreements to reduce flood damages across Quebec. Portions of the agreement specifically aim to reduce flood damages along the river. However, it can be argued (Ch.5) that the floodplain management scheme is not comprehensive because it emphasizes structural solutions and only aims to reduce flood damages. The policy is not based upon an understanding of the land use processes and does not consider the preservation or protection of the remaining valuable riparian habitats.

A comprehensive floodplain management policy must not only employ a range of flood damage reduction approaches, but must also be based upon an understanding of the human processes, such as the nature and extent of human encroachment into an area, and of the biophysical elements, such as the nature of riparian resources and their management potentials.

Before the new floodplain management policy is examined, the past managment policies, which have led to the present flood hazard conditions must be examined so as to develop an understanding of the flaws of the past system and the nature of the flood hazard which subsequently developed. In this manner, the physical adjustments and institutional arrangements required to stabilize and eventually mitigate the present flood hazard can be examined.

The following chapter investigates the past floodplain management policies in Canada and Quebec and their implications for the management of the Mille Iles River region.

Chapter 3: Floodplain management policies prior to the 1976 federal-provincial flood damage reduction program.

To understand the present and future riparian land use management policies along the Mille Iles River it is necessary to examine the past arrangements for dealing with floodplain management in Canada and Quebec.

The administrative arrangements for dealing with floodplain management have historically been highly fragmented amongst the senior and junior levels of government. While shoreline development has largely remained a provincial concern, floodplain development has become a local municipal concern. As will be seen, the consequences of this fragmentation of responsibilities is clearly observable along the Mille Iles River floodplains.

3.1 The Federal government's role in floodplain management

As a result of the Canadian constitution, articles 92 and 108 of the British North America Act (1867), the provinces have obtained the exclusive powers to legislate over property and civil rights, matters of local and private nature, over undertakings of local nature and over matters related to natural resources, including water resources. The federal government, on the other hand, has been given the powers to legislate over navigation, fisheries and interprovincial and international matters. The federal government may also legislate works which are judged to be beneficial to the whole nation or to two or more

provinces.

The role of the federal government in floodplain management, a level of government which has no direct control over land use regulations or local works, has been largely restricted to the construction of flood control structures linked to large river basin development projects in collaboration with provincial governments.

In the early 1900's, federal involvement in water resource management focused upon the construction of large scale water control projects for hydro-electric storage. The government was also involved in the construction of works for navigational purposes.

In the late 1940's and early 1950's, major flood events occured in Canada. In 1948, flooding along the Frazer River inundated 200 km^2, damaged over 2 000 homes and over 16 000 people had to be evacuated. In 1950, floods along the Red River affected 1 760 km^2 and caused extensive damages, especially in the Winnipeg region. In 1954, in the Toronto area, floods related to huricane Hazel resulted in flood damages and the loss of 80 lives (Page 1980:413).

Federal and provincial governments responded to the emergency situations by providing assistance to those suffering from flood damages. Although the primary responsibility for dealing with natural disasters rests with the provinces, it has been a long-standing practice of the federal government to assist the provinces, when requested, in situations where the costs of dealing with disasters exceed levels which they can be expected to bear on their own.

Cost-sharing arrangements for floodplain protection became

attractive to provincial and federal governments and were viewed as expedient solutions to many flood problems. Total compensation of $22 million was paid following the Fraser River flood, $25 million following the Red River flood and $25 million following hurricane Hazel (Page 1980).

Thus, despite the range of measures available for floodplain management, the federal government has traditionally provided ad hoc assistance in the form of structural solutions and post-disaster financial compensations. The government's lack of preparedness for comprehensively coping with flood hazards emphasized the need for coordinated flood control and water resource management research.

In an attempt to remedy the situation, in 1953, the federal government passed the Canada Water Conservation Act and the mitigation of floods was tackled on a large scale, involving the efforts of both federal and provincial governments. The Act provided federal contributions to the provinces for the construction of dams and other works for purposes of water conservation and flood control. Under the Act, the provinces were responsible for the projects, although responsibilities could be delegated to local authorities. Federal assistance was restricted to works of a "major character", could not exceed the amount invested by the province and could not exceed 37.5% of the total project cost.

Though, in principle the Act appeared attractive, in practice it was considered to be too restrictive and a long time elapsed before any agreements were concluded under it. Without joint participation in planning the programs, the federal government could only accept or reject plans proposed by the

provinces. The Act ignored a great many water resource issues. Only structural measures were eligible for assistance, thereby ignoring other approaches to flood hazard management. Financial contributions were provided only on the basis of the rigid cost sharing formula. Finally, problems were encountered in interpreting the meaning of projects of "major character" and in resolving administration and technical problems (Page 1980).

Through the Canada Water Conservation Act (1953), which limited financial assistance to major structural undertakings, the federal government forced floodplain management towards policies which consisted of strictly structural solutions. Disatisfaction with the constrainst of the Act and the growing awareness of the need for more comprehensive management schemes gave rise to a new act.

In 1970, the Canada Water Act repealed the 1953 Canada Water Conservation Act. Under the Act, the federal minister of the Environment can enter into an agreement with individual provincial governments for purposes of water resource management. Federal-provincial consultative committees are established which study problems, priorities, policies and formulate programs. The federal and provincial governments can then enter into joint agreements for the planning and implementation of flood control schemes. The Act was hailed by the federal government as a system which would emphasize joint planning and management of river basins, offer a range of planning alternatives and offer more possibility of federal participation in floodplain management. In the Act, no restrictions are placed upon the water related uses of the water resource management project. Though no cost-sharing formula is specified by the Act, most

Table 3.1

The "dollar-per-capita" formula for federal cost-sharing

Provincial expenditures per capita eligible for sharing	Federal share (%)
First dollar	0
Second and third dollars	50
Fourth and fifth dollars	75
and for the excess	90

Under this formula direct federal disaster assistance is not provided until the eligible flood damages in a province add up in dollars to the population of the province and the province requests federal assistance. As per capita dollar damages increase federal cost-sharing increases progressively.

studies are financed on a 50-50 federal-provincial basis (Fish. and Environ. Can 1976).

At the same time as the adoption of the Canada Water Act (1970), a federal policy on flood disaster relief began to emerge. Prior to 1970, the cost-sharing arrangements between federal and provincial governments for post-disaster relief had been negotiated individually on an ad hoc basis. Because the federal government had responded to individual provincial request by studying their national significance and their cost-benefit ratios, federal flood assistance was largely confined to major urban centers.

Since 1970, federal disaster assistance has been standardized and allocated under a cost-sharing formula entitled the "dollar-per-capita" formula (Table 3.1). Under the formula, a province is not entitled to federal disaster assistance until the eligible damages add up in dollars to the population of the province and the province requests federal assistance.

Not all types of damages are eligible for federal assistance. Summer cottages, antiques, damages to commercial establishments and crop damages are excluded. To date, financial assistance has been focused upon property damages, small businesses and the repair of transportation systems and public buildings.

Even with the adoption of the Canada Water Act and the new federal policy of flood disaster assistance, the policies of the federal government came under severe criticism. Though it had been claimed that the adoption of the Act would permit a "comprehensive planning approach to federal-provincial water resource management" (Page 1980:415), it was not clear whether

the federal government would provide financial assistance for the implementation of non-structural alternatives. The disaster assistance policies of the government were also thought to encourage the development of flood risk areas. The disaster assistance was viewed as "premium-free insurance" and property owners were found to have collected damage relief for a number of floods (Page 1980:416). In addition, the concerns for the restoration and preservation of open spaces, the maintenance of agricultural lands and the growing interests for the conservation of wetland flora and fauna pointed to the need for a re-assessment of the floodplain management strategies stimulated by the Canada Water Act.

Given these criticisms, the federal government re-assessed its programs under the Act in view of formulating a national strategy which would deal more comprehensively with flood threats and floodplain management. A new approach to floodplain management was announce on April 10, 1975, by the Hon. Jeanne Sauvé, minister of the Environment.

The new approach to floodplain management is based on the following principles (Page 1980:418; Fish & Environ. Can. 1976:1):

(1) programs of federal agencies concerned with flooding must be co-ordinated, both internally and with related programs at the provincial level. This coordination can take place through the federal-provincial agreements and through established federal inter-departmental co-ordinating mechanisms;

(2) the cornerstone of a co-ordinated program would be flood risk maps, as a basis for general agreement on the definition of flood prone lands;

(3) information on floods, on federal policies and programs and flood risk maps must be provided to the public, the municipalities and all others concerned;

(4) federal agencies such as the Canada Mortgage and Housing Corporation, which administers the National Housing Act, the Department of Regional Economic Expansion, which provides incentives to industries in regions of economic disparity and the Department of Public works, which constructs federal facilities, will not develop or support development in areas identified by the mapping program as high risk areas;

(5) federal assistance will be refused, with respect to new or further developments within high flood risk areas, once the public has been made fully aware of the hazard (through the use of flood risk maps);

(6) the provinces are asked to restrict their investments in flood risk areas and to encourage appropriate zoning regulations in such areas.

To put these principles into practice the federal government negotiates agreements with individual provinces. Variations exist in the agreements between governments, but all provinces must sign a "general agreement" and a "mapping agreement".

The "general agreement" has a life of 10 years and outlines the basic approach for decreasing flood damages and the policies agreed upon by the governments. All feasible structural and non-structural alternatives must be considered, including the possibility of letting some flooding occur. Effectiveness, costs and benefits associated with alternatives have to be considered when selecting an approach. Preference is to be given to measures that prevent vulnerable developments in flood risk areas. The general agreement also includes separate sub-agreements covering flood damage reduction studies, cooperative flood forecasting and others.

The "mapping agreement" delineates flood risk areas in which the policies of the "general agreement" will be applied. The federal minimum for delineating the flood risk area is the 100 year flood height, though it will support a province choosing to use a larger recurrence interval. Within the 100 year floodplain

zone, two flood risk zones are delineated. The flood risk mapping program has been given a great deal of attention because the federal government believes that the precise identification of flood risk areas is a prerequisite for the other programs. The flood risk maps are also viewed as performing an important role in the prevention of further development of floodplain areas were development already exists, the governments plan to carry out studies to determine the most effective measures to reduce or prevent flood damages.

On November 10, 1976, the province of Quebec was the second province to sign a federal-provincial flood damage reduction agreement.

3.2 Floodplain management in Quebec prior to 1976.

Article 92, of the British North America Act (1867), gives the provinces legislative authority over property and civil rights, over matters of a local and private nature and over local works. The provincial government is therefore theoretically reponsible for floodplain management which is a matter of local nature.

Though the BNA Act gives the provincial government all of the legislative authority to manage floodplain development, since the beginning, the majority of legislative powers controlling floodplain utilisation (e.g. zoning, land use regulations) have been transfered to lower levels of government, such as local municipal governments and para-public organisations such as Hydro-Quebec.

Today, the provincial level of government only retains legislative authority over the management and development of public lands - lands which are still owned by the provincial government. In Quebec, the majority of the water bodies, their stream beds and banks have remained the property of the provincial government.

The provincial ministries with powers to intervene in the development of public lands and shorelines are numerous (Appendix IV). The agencies usually have two functions. First, to supervise the development of public lands, and second, to insure the protection of public lands. The two functions can often contradict one another, especially within a single agency which can act as both the proponent and the controlling agent. Though numerous ministries have an input in riparian zone development, two ministries have played a dominant role in their management and development: the Ministère de l'Energie et des Ressources and the Ministère de l'Environnement.

The Ministère de l'Energie et des Ressources, known until September 21, 1979 as the 'Ministère des Richesses Naturelles' and the 'Ministère des Terres et Forêts', is the principal ministry responsible for the management of Quebec's public lands. The ministry controls the sale and rent of public lands, the allocation of permits and the acquisition of lands in the public's interest.

The ministry also enforces the application of the 'Réserve des Trois Chaînes' which delineates the extent of public lands along shorelines. When applied, the 'Réserve des Trois Chaînes' generally extends for 61 m (198 ft) above the normal high water level of waterways. Though most of the shorelines of Quebec's

water bodies are still part of the public domain some are now part of the private domain and thus outside provincial jurisdiction. Generally, the shorelines of riparian lands conceeded before June 1, 1884, have been transferred to the private domain. In such cases, the banks of non-navigable waterways down to the normal low water line are part of the private domain. After this date, the banks of non-navigable and navigable water bodies are subject to the 'réserve' and have not been transferred along with the adjacent riparian lands, and thus remain within the public realm. Under the 'réserve' the Ministère de l'Energie et des Ressources can grant or refuse a developer the permission to encroach upon the banks of a water body.

The Ministère de l'Environnement, known until September 21, 1979, as the 'Direction Générale des Eaux' of the 'Ministère des Richesses Naturelles', has played an even more significant role in shoreline management. Through the Loi sur le Régime des Eaux (L.Q. R-13), the ministry manages the beds and banks of waterways up to the height of the normal high water line without flooding. Above this height, the Ministère de l'Energie et des Ressources is responsible for the application of the 'Réserve des Trois Chaînes". If the banks have remained within the public domain, the ministry of the environment also controls all structural works that are likely to change currents, flood recurrence heights or influence any other aspect of the environment.

In the case of shorelines which have become part of the private domain and left provincial jurisdiction, the ministry of the environment remains somewhat responsible for the shoreline. However, the ministry has little legislative authority over its

development. The Loi du Régime des Eaux and Loi de la Qualité de l'Environnement, controlled by the ministry of the environment, are the most important laws controlling shoreline encroachment. The Loi du Régime des Eaux (1964), is primarily concerned with the management of Quebec's water bodies still in the public domain. The law determines what types of constructions are permitted under given conditions. Encroachment along stream shorelines is also controlled by the Loi de la Qualité de l'Environnement (1972), created to protect environmental quality. The powers of the law are much broader than those of the Loi du Régime des Eaux. Articles 20 and 22 of the Loi de la Qualité de L'Environnement are the only tools available to control shoreline degradation along privately owned lands.

By and large, the provincial laws controlling public shoreline development are adequate, if they are enforced. Unfortunately this has not always been the case. In addition, when enforced, violations must be handled through a court of law. This has proven to be a slow and tedious process,

> Dans les cas d'obstination, le seul recours possible est celui des tribunaux .avec les lenteurs que celà comporte. En effet, dans la région de Montréal, nous connaissons plusieurs cas de remplissage qui ont été faits sans autorisation et dont le règlement par les tribunaux n'est intervenu que plus de cinq (5) ans après le début des dits travaux. Certains dossiers sont même en marche depuis plus de dix (10) ans. Une telle lenteur ne peut pas faire autrement que finir par embourder l'administration (Beaudoin 1975:52).

On the other hand, the laws regulating and controlling floodplain encroachment and degredation have been practically nonexistant because most floodplains lands are privately owned and thus outside the provincial government's jurisdiction. In many cases, the destruction of riparian resources has been

Table 3.2

FLOOD DAMAGE REIMBURSEMENTS (1974 and 1976 FLOODS)

Categories	No. of demands		Amounts paid ($)	
	1974	1976	1974	1976
Individuals	5 078	6 781	5 725 275	6 657 245
Farmers	1 777	1 063	2 769 201	907 526
Small enterprises	547	457	2 193 305	2 050 316
Misc. groups	--	17	--	62 340
Temporary dwellings	--	176	20 498	19 793
Collective equipment	107	149	3 874 648	3 202 335
Emergency measures	73	280	1 950 912	2 046 339
School commissions	--	5	--	28 125
Operation costs	--	--	1 097 158	1 409 654
Provincial collective equipment			5 050 511	6 185 513
Provincial emergency measures			432 796	159 942
Total	7 874	8 928	23 449 340	22 729 128
no. of muncipalities	292	618		

(Source: adapted from Perrier 1978)

perfectly within the laws, if not openly sanctioned by property rights. In addition, in the case where floodplain zoning policies, lot size requirements and construction specifications have been developed and applied they have often conflicted with property rights.

> La technique du zonage au Québec apparaît dans les faits comme étant essentiellement négativiste... le pouvoir de zoner a été et est encore uniquement conçu et articulé par ses tenants pour "protéger" ou "préserver" certaines parties de leur territoire d'usage indésirables et/ou dommageables. Le zonage a donc servi aux authorités publiques comme outil juridique pour "contraindre" le droit de propriété et, en particulier, la propriété foncière en territoire urbain. Cette conjoncture négative et défensive était certes prévisible, voire fondée, dans un contexte socio-juridique où le droit de propriété (via la propriété foncière) a été et continue d'être envisagé comme possédant un caractère "inviolable" et "sacré" et d'une importance telle que la quasi-totalité du système juridique privé repose sur lui (Denis et Descoteaux 1976:31).

Structural measures, such as diking, have been the adjustments which have received the most attention in Quebec (Harvey 1976: B.A.P. 1982). Ad hoc relief and rehabilitation adjustments have also received some attention in recent years. The first provincial effort to provide public relief to flood victims occured in 1974 and was repeated in 1976 (Table 3.2). Consequently, until 1976, the provincial floodplain management policies consisted primarily of ad hoc structural adjustments and relief and rehabilitation measures.

3.3 Municipal responsibilities in floodplain management.

As a result of the Loi des Cités et Villes and the Civil

Code, floodplain management is largely a local municipal concern,

> Au Québec, le zonage s'est révélé être une technique de division et de classification du territoire en zones, technique comportant l'établissement, pour chacune des zones ainsi formées, des constructions ou usages permis ou prohibés, ainsi que les normes applicables. Ainsi dès l'origine, le zonage se retrouva intégré dans nos lois municipales générales (Loi des Cites et Ville; Code civil), les législateurs en ayant fait une responsabilité "facultative" presque exclusivement locale...(Denis et Descoteaux 1976:31)

Municipalities have been responsible for the control and regulation of floodplain development through the use of zoning regulations, lots size requirement, construction standards and requirements,

> La majorité des compétences en matière d'aménagement du territoire se situe à ce niveau. L'autonomie municipale quant à l'utilisation de leur territoire en fait le pivot de toute tentative de contrôle et de surveillance du développement. Ainsi, les municipalités riveraines constituent dans le cas du fleuve, les autorités les plus compétentes pour protéger les berges contre un developpement anarchique (Delisle, Descôteaux et Denis 1976:80).

However, the formulation and application of management schemes for the utilisation of floodplain lands has not been a priority for municipal governements,

> ...l'occupation des rives s'est historiquement effectuées sans considération des coûts sociaux. L'aménagement des zones riveraines s'est toujours réalisé sans plan directeur. Seules les pressions économiques ont gouverné le développement industriel ou agricole et la construction domiciliaire sur les berges, entraînant alors une mise en valeur chaotique des rives des cours d'eau...
>
> Le processus de dégradation des rives est aggravé par l'absence de loi statuant sur le dévelopement des berges. Des lois définissent des priorités d'utilisation des cours d'eau et précisent les droits des propriétaires riverains quant à l'utilisation de la rivière et à l'exploitation de son lit. On a par contre oublié la règlementation de l'occupation des

> berges, règlementation qui jusqu'ici relevait d'autres entités administratives que celles précisément occupées de l'utilisation des ressources. Seules les municipalités ont pouvoir de réglementer l'occupation de leur territoire et les exigences des cours d'eau ne semblent pas faire partie de leurs priorités (AQTE 1977:196).

As a result of the apathetic municipal attitudes toward floodplain management, local communities have not formulated or encouraged the adoption of land use regulations which would, in their views, reduce the growth of their tax base. Instead, municipalities have traditionally supported the adoption of structural adjustments, usually funded by senior levels of government, to protect the floodplain inhabitants from flood hazards.

3.4 Floodplain management along the Mille Iles River prior to 1976.

The divisions and fragmentation of jurisdictional responsibilities and the lack of incentives to the formulation and adoption of rational management strategies are reflected along the Mille Iles river floodplains.

Along the Southern floodplain, which is under the jurisdiction of the municipality of Laval, the boundary between the private and the public domain is established by the normal low water line. The banks of the Iles Jesus, the zone between the normal high and low water line, were conceeded to the Jesuites through a seignorial title (Ile Jesus in its entirety once having being the Laval seignory) more than two hundred years ago, and have therefore left the public domain. By and large, shoreline development has been under the control of private

individuals. In 1976, over 75% of the stream banks were under private ownership (Munic. Laval 1976). In this case, the provincial government has no direct control over shoreline development and the municipality of Laval is responsible for land utilisation through the use and enforcement of zoning regulations.

Along the northern floodplain, the stream banks, the zone between the normal high and low water lines have remained in the public domain. Any undertakings within this zone should be approved by the ministry of the environment. The 'Réserve des Trois Chaînes', however, has not been enforced by the Ministère de l'Energie et des Ressources and individuals have extended developments down to the low water line. Six municipalities occupy various portions of the northern floodplain and all have control, through individual zoning strategies, over the development of their riparian lands.

Overall, through the use of zoning regulations, the municipalities along both floodplains have encouraged the development of low density residential housing (single and double occupancy). The municipality of Lorraine has been the exception and has zoned its entire floodplain for public land use. The municipalities of Laval and Boisbriand are the only municipalities to have undertaken a systematic study of the shoreline accessibility and have formulated public access policies.

3.5 Conclusions.

Because of the fragmentation of responsibilities and the lack of coordinated and planned floodplain management policies, economic factors have controlled development along the floodplains of the Mille Iles River. Unsuitable developments have progressed unhindered and sometimes have been encouraged by municipal zoning strategies. Consequences of the absence of a comprehensive floodplain management policy have been the destruction of valuable riparian habitats and the unsuitable development of floodplain lands.

The following chapter investigates the land use trends which have characterized the Mille Iles River floodplains over the last two decades under the past lack of management and have produced the present flood-vulnerability.

Chapter 4: Floodplain development trends along the Mille Iles River prior to the 1976 federal-provincial agreements.

4.1 Introduction

Floodplain development along the Mille Iles river has proceeded without the guidelines of a comprehensive management strategy identifying the valuable riparian environments or the appropriate riparian land uses. As a consequence, the Mille Iles river region has lost valuable resources and become increasingly vulnerable to floods.

To reduce the flood damage potential and manage the remaining resources of the floodplain, the nature of the encroachment process must be understood. The following chapter investigates the nature and extent of human encroachment onto the river's floodplains and the land uses changes which have given rise to today's loss of resources and flood vulnerability.

An understanding of the nature of the land use changes and remaining undisturbed resources provides the basis for land use planning and helps to assure that development, protection and preservation is done in the most systematic and efficient manner. A study of riparian land use can be used in floodplain development planning to determine the extent of encroachment, identify the development trends which have resulted in increased vulnerability, delineate uses which are appropriate along the floodplain, determine which resources are best able to accommodate these uses, and to promote protective legislation and zoning for the remaining valuable sites.

4.2 Materials and methods

4.2.1 Materials

Existing aerial photographs were used to delineate and map past and present land uses and vegetation covers. Amongst the sets of existing continuous and stereoscopic aerial photographs, the following two sets were chosen. The earliest available set of air photographs, 1958 black and white prints at the scale of 1 : 36 000 were chosen as they provided the oldest information on the past distribution of riparian land uses. For data on recent land uses 1980 colour cut-films at the scale of 1 : 10 000 were chosen. The 1980 photographs are the most recent small-scale photographs of the area. They cover most precisely the riparian zone under study and are thought to accurately represent the 1976 floodplain conditions. The 1 : 10 000 coverage permitted the identification of certain plant species, while only dominant canopy vegetation could be established with the 1958 photographs.

A Bausch and Lomb Zoom Transfer Scope (ZTS) permitted the viewing of aerial photographs projected upon topographic base maps. The base maps consisted of the five Montreal region "Flood Risk Maps" (scale of 1 : 10 000) produced by the Inland Waters Directorate, Department of Fisheries and Environment Canada and by the Surveys and Mapping Branch of the Department of Energy, Mines and Resources, Ottawa 1977 (31 H 12-100-0101, 0102, 0201, 0202, 0302). The maps delineate the low water mark, the 20 year flood recurrence height and the 100 year flood recurrence height.

Controls on the ZTS allowed the correction of differences in air photographs and base map scales and provided optical corrections to accurately super-impose the images upon the base

maps. The ZTS controls enabled the correction of geometric anomalies in the photographic images due to tilt, relief, and lens distortion. In this manner land use and cover information from 1958 and 1980 photographs was traced onto transparent overlays placed over the base maps. Two sets of overlays were produced, one set containing 1958 and the other 1980 information. The transparent overlays could then be studied separately or super-imposed onto one another, revealing land use and vegetation cover changes.

4.2.2 Methods

The land use/land cover classification system adopted for this study is based on three systems: the Canadian Land Inventory System (1970), Golet's wetland classification system (1976) and Dansereau's Ecological Land-Occupation Classification (1977).

The hierarchical land use classification system devised by the Canadian Land Inventory represents the closest approach to a national system that has yet to be proposed in Canada. The system is designed to be amenable with data derived from remote sensors. The functions which lands fill are associated with types of land use and land cover.

Golet's wetland classification system, which is based largely on Dansereau's earlier works, was used to give the Canadian Land Inventory's land classes some of the dynamic properties of water. Through the use of various vegetation classes, Golet provides indicators of soil moisture conditions and the frequency and duration of flooding.

Table 4.1

LAND USE/COVER CLASSIFICATION

Groups	Categories	Classes	
Developed			
	Suburban	Residential	(R)
		Transition	(T)
		Cottage	(C)
	Industrial	Industrial/ Commercial	(I)
	Rural	Agriculture	(A)
		Disturbed	(D)
Undeveloped			
	Wild	Shore marshes	(sm)
		Basin marshes	(bm)
		Meadow wetland	(mw)
		Shrub/sapling wetland	(sw)
		Wooded wetland	(ww)
		Disturbed wetland	(dw)

Finally, Dansereau's work on land classification (1977) provides ecological criteria to evaluate the significance of land occupation changes. As Dansereau states (1977:1) "land occupation patterns can best be understood if they are graded according to the dynamics of their component ecosystems." According to Dansereau (1977), traditional classification systems rest upon the dichotomy of used versus unused land. This tends to reflect what man has done to the land. In such a system there is, however, "...no linear sequence from either the most intensively used or the most productive to the least used (or disturbed) or least productive in the scheme as a whole or in its subdivisions" (Dansereau 1977:3). By dividing the landscape into wild, rural, industrial and urban (or suburban in this case) land occupations, man's manipulation, exploitation and transformation of the environment can be assessed according to the energy expenditure and the depth of change induced in various parts of the landscape.

The land use classes were developed to permit floodplain areas with different development characterisics to be differentiated. The twelve classes chosen for the study were assembled into four categories which fall into two groups (Table 4.1).

Six land use classes fall within the 'developed floodplain' group (residential, transition, cottage, industrial, agricultural and disturbed) which describe zones in which human activities are overt. The natural riparian environment in these classes is modified to different degrees. The endemic vegetation is usually absent and the topography and drainage pattern modified. The six classes form a gradient reflecting degrees to which the

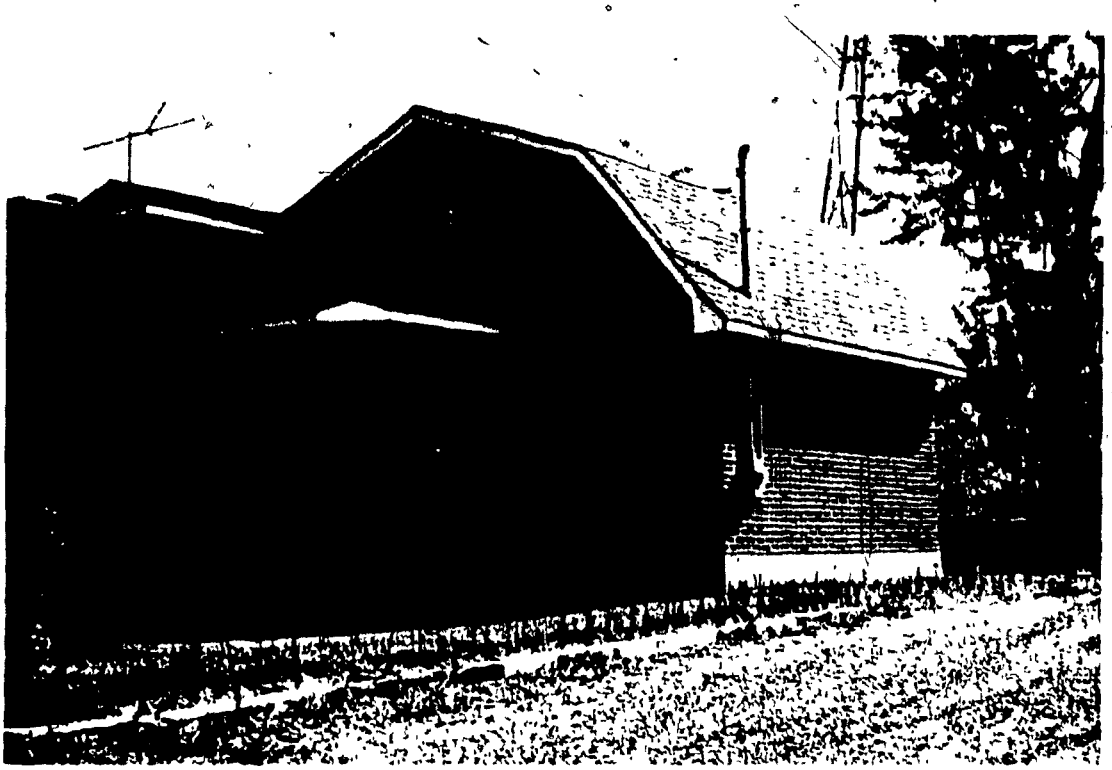


Photo. 4.1 (R) Residential zone

floodplain has been altered and the permanency of development. The six classes fall into three categories which correspond to suburban, industrial, and agricultural land occupations.

Six land cover classes fall within the "undeveloped floodplain" group (shore marsh, basin marsh, meadow wetland, shrub wetland and wooded wetland) which describe zones which have not been significantly modified by man. To fall within the undeveloped land cover classes, a parcel of land must have a complete vegetation cover. The vegetative classes encompass the range of riparian habitats from the saturated soils of the shoreline marshes to the seldomly flooded forests along the 100 year flood recurrence height (Fig. 1.1). The six classes form a gradient reflecting frequency, depth and duration of seasonal flooding which are key factors in determining the wildlife value of riparian zones and in establishing man's vulnerability to flood events.

The twelve classes used in the study are described as follows:

DEVELOPED FLOODPLAIN

Residential (R) - Permanent residential zones appear as areas irrevocably committed to development. These areas are characterized by a considerable amount of densely planned residential development consisting primarily of single family residences generally located on small, evenly spaced lots. Most constructions are recent and of high quality. Duplexes, apartment buildings and other multiple family dwellings are present but less common. Paved roads, driveways, parking lots and sidewalks also characterize this zone. A large proportion of the surface area has been rendered impermeable. To decrease flood damage potential, facilitate access to the water and to 'improve' the aesthetics of the shoreline, this zone has been modified by infilling and diking. The natural vegetation in residential areas has been extensively modified by human activity. Most indigenous vegetation has been removed. Well kept lawns and ornamental hedges, bushes and trees are common

Photo. 4.2 (T) Transition zone

Photo. 4.3 (C) Cottage zone

attributes. Ecologically, residential zones contain heavy investments derived from other ecosystems. The investments in the zone are large and varied (buildings, machinery, vehicles...). The soils in the area produce little or no consumable products as these are obtained from other ecosystems. Whereas the minerotrophic activities are sealed off, the biotrophic activities are limited to human functions at the expense of imported resources. In turn the residential zones contribute little to the floodplain ecosystem besides the periodic exodus of some of its waste (Dansereau 1977:14). Residential zones are the most flood vulnerable land use in the classification system: high-investment, ill-adapted structures and densely developed zones result in extensive loss of property and lives in the event of a flood. (Photo. 4.1)

Transition (T) - The transition land use class denotes zones characterized by the presence of permanent single family dwellings interspersed with seasonal cottages or cottages converted into permanent dwellings. As with residential areas, transition zones are irrevocably committed to development though because they have a smaller proportion of high-investment permanent dwellings they can be considered economically less vulnerable to flood events. Air photographs reveal zones of less clearly planned development. The shapes of houses and lots may vary more than in residential zones. From the ground, architectural styles reflect a range of adaptations to the floodplain environment: from well adapted cottages raised above the ground through the use of stilts, to ill-adapted permanent dwellings with "finished" basements (game rooms, laundry rooms) vulnerable to flood events. If the transition zone is largely composed of permanent residences, it is expected to have a low flood water absorption potential and high runoff properties. Because transition zones generally display less paved surface area and a range of architectural adaptations to the floodplain environment, the zones are considered to be less environmentally disruptive and flood-vulnerable than residential areas. (Photo. 4.2)

Cottages (C) - On air photographs cottage zones are distinguished from residential and transition zones on the basis of the size and type of buildings and the lack of clearly planned development patterns. The zones are often characterized by the presence of mature vegetation covers. Cottages usually display smaller roof areas and less regularly spaced lot divisions. Cottages are usually constructed of wood, clapboard and tarpaper. Many are abandoned or in disrepair. Financial investments are less important than in permanent residential dwellings. They are typically raised above the seasonally flooded ground surface through the use of stilts. The construction of cottages on stilts reflects a once popular adaptation to the floodplain environment which has now been replaced by infilling of natural topography. The more environmentally sound adaptation of cottages to flood waters is likely to have less impact on the flood water absorption potential of the soils and on the drainage of flood waters. Cottage zones are considered to be the best adapted and least environmentally disruptive and flood-vulnerable

Photo. 4.4 (I) Industrial/Commercial zone

Photo. 4.5 (A) Agricultural zone

Photo. 4.6 (D) Disturbed zone

suburban land use. (Photo. 4.3)

Industrial/Commercial (I) - Industrial and commercial land uses are usually distinguished by the presence of large buildings adjacent to large parking lots. Even more than in residential zones, the minerotrophic activities of the floodplain are sealed off and the biotrophic activities are limited to human processes. These zones require high expenditures of energy and depend upon other ecosystems. The vegetal and animal food which is consumed must be imported. The raw materials come from long distances. The zones are usually well linked to transportation systems and power transmission networks. Such areas are often located on the periphery of residential zones. Due to the extensive areas of impermeable surfaces which characterize this class, the absorption and storage capacity of flood waters is very modified. Secondary impacts of flooding in these areas can be considerable (loss of work days, disruption of services ...) and may outway the primary losses of flood damages to constructions in a residential zones. (Photo. 4.4)

Agricultural (A) - Agricultural areas are identified on air photographs by the presence of cultivated fields: a clear and abrupt transition from natural vegetation to carefully tended croplands, the geometrical shape of fields and linear ridging patterns of row crops, are all factors which distinguish agricultural zones from other land uses. This land use occupation is geared to high productivity at the phytotrophic level (Dansereau 1977). Its product is almost entirely exported. The specialized nature of the exploitation requires heavy investment (machinery, fertilizers ...), sophisticated management and constant attention to market. The activity is dependent upon the rich soils of the floodplain environment. Because the permeability of the ground surface in this category is less radically changed as compared to other developed riparian land uses the absorption and storage capacity of flood water in agricultural zones is less disrupted than in the suburban land uses. Though seasonal flooding is beneficial to agricultural lands, extreme flood events may lead to soil erosion if precautions are not adopted. Agricultural zones are potentially the least permanent of all developed riparian land uses, since such an area can revert to meadow or pasture land within one year's time. Pasture lands, where there is a complete vegetation cover (soils have not been tilled or cultivated) exist, fall into the disturbed wetland (dw) floodplain class. (Photo. 4.5)

Disturbed (D) - This class encompasses a number of miscellaneous disturbances. It represents zones along the floodplain where vegetation has been removed and the top soil exposed. On air photographs, these zones appear as patches of bare soil. They are often located at the periphery of developed zones. The disturbance may be of a natural or man-made origin. (Photo. 4.6)

Photo. 4.7 (sm) Shore marsh zone

Photo. 4.8 (bm) Basin marsh zone

Undeveloped Floodplain

Shore marsh (sm) - This class applies to wetlands located on active fluvial floodplains, adjacent to flowing water. Shore marshes occupy the low-lying and poorly drained areas associated with the floodplains and shorelines of streams. Seasonal flooding to a depth of 30 cm or more occurs annually during the spring flood. In most years, spring floods subside by early June. During the summer, the soil is saturated with a few inches of surface water occuring locally. By late summer, declining water levels may expose drawdown zones of emergent marsh vegetation and mud flats.

The dominant vegetation consists of robust, broad and narrow leaved marsh emergents (Golet 1976), such as pickerelweed, arrowhead, water plantain, water arum and golden club. Purple loosestrife commonly forms large stands near the upland periphery of the marsh zone. Floodplain shore marshes are by definition adjacent to open water and are frequently interspersed by channels or pools. Floating leaved plants and submergents, such as waterlilies and wild celery, are present in the open water areas. Duckweed is often abundant in the open water.

This is a class of outstanding value to waterfowl during migration, especially during the spring when shallow flood waters permit ducks access to supplies of plant seeds unavailable during the previous summer and fall. These shallow water zones are also important for certain fish species as spawning sites. Excellent muskrat habitat is left when the water subsides and emergent vegetation flourishes. Herons, bitterns and shorelines birds feed in shallow water areas. The zones are important in ground water storage and replenishment and in the filtration of sediments. (Photo. 4.7)

Basin marsh (bm) - These wetlands occupy topographically defined catch basins fed by local runoff and/or ground water. As with the shore marsh zones, the predominant vegetation consists of robust, broad and narrow leaved marsh emergents. Where open water areas occur, a variety of floating and submergent aquatic plants flourish.

Along with shore marshes, basin marshes are the most valuable all purpose waterfowl habitats. They are used for mating, nesting, feeding and brood-rearing. They provide valuable feeding habitat for wading birds like herons, egrets and bitterns. Stands of emergents support muskrats and nesting bird species. (Photo. 4.8)

Meadow wetland (mw) - This class applies to wetlands dominated by grasses and emergents. Normally, the meadow is inundated with less than 12 cm of water for only three or four weeks in the spring. Soils quickly dry as the ground water table falls below the surface. During the growing season the soil is dry, except in depresssions or drainage ditches where surface water may be present.

On air photographs, undisturbed meadow wetlands appear as zones of fine textured grasses and sedges of low stature, intermixed with a wide variety of forbs. Meadows can support

Photo. 4.9 (mw) Meadow wetland

Photo. 4.10 (sw) Shrub/Sapling wetland

dense stands of tall meadow emergents such as purple loosestrife, reed canary grass, blue-joint, woolgrass, cattail and mannagrass. Meadow emergents like soft rush, sedges, joe-pye weed and flowering rush are characteristic but rarely dominant.

The wildlife value of meadows depends on the availability of surface water. If such water is present nearby, fowl may rest there. Muskrat are nearly always present, but populations are higher where surface water is available. Song sparrows and red winged songbirds feed and breed in meadows. Pheasants and rabbits find food and cover during the fall and winter and sometimes breed there as well. (Photo. 4.9)

Shrub-Sapling wetland (sw) - This class applies to riparian zones dominated by shrubs and saplings. A wide variety of soil moisture conditions and shrubs are included in this class.

Within sapling shrub zones, tall slender shrubs are dominant. Red and silver maple saplings are the most common followed by speckled alders. The sapling shrub cover represents a more dynamic situation than the other shrub covers, since it is actually a transition stage between shrub and wooded wetland.

Bushy shrub wetlands generally occupy moist locations. Speckled alder, willow, red osier, high bush blueberry, buttonbush, swamp rose, viburnum, sweet gale, sheep laurel and bog laurel are all common. Open areas within this zone are usually occupied by meadow emergents like blue-joint, reed canary grass and sedges (e.g. Carex stricta).

Aquatic shrub wetland zones occupy depressions in which surface water is of greater depth and duration than other zones. They are often located on the periphery of shore and basin marshes. Buttonbush and willow are the most common aquatic shrub species.

Shrub wetlands offer habitat for a wide variety of wildlife, including both upland and wetland species. The kinds of wildlife present in any given area depend upon the shrub species, surrounding habitat types and access to open water zones. (Photo. 4.10)

Wooded wetland (ww) - This class applies to areas dominated by trees. Such zones occur throughout a range of soil moisture conditions. Sites may be subject to seasonal or occasional inundation. Large variations in water availability and soil fertility along the floodplain are reflected by the large number of tree species which occur along the zone.

Forests of silver maple are the dominant forest cover along the shorelines reflecting the frequency of flooding along the floodplain. These zones are often devoid of undergrowth.

Further up the floodplain, along the better drained less frequently flooded flats silver maple, sugar maple and ash may form a large part of the forest stand. This zone is characterized by the presence of dense undergrowth. Sensitive fern generally dominates the ground cover.

Along the upper portions of the floodplain, where flooding is less frequent, mixed forests of white and red ash, oak, maple and american beech are characteristic. The forest understory lacks a very dense herbaceous growth which typifies the previous wooded wetland.

Photo. 4.11 (ww) Wooded wetland

Wooded wetlands located along streams or near marshes are often valuable breeding areas for ducks. The value increases greatly if surface water persists through the nesting period and if brood areas are available nearby. Otherwise, wooded wetlands are most valuable to upland wildlife. They provide habitat for racoons, rabbits and grouse. Because of the structural diversity of vegetation, wooded swamps probably support a greater diversity of songbirds than any other wetland type. Many species of warblers, flycatchers, woodpeckers, grosbeaks and owls breed in these wetlands. If oaks are abundant and the wooded zone lies adjacent to open water, its food value to waterfowl can be great during spring and fall migration because of available mast crops. (Photo. 4.11)

Disturbed wetland (dw) - Natural vegetation cover in this class is greatly modified as a result of human or animal activity. This is the least valuable vegetation cover in terms of wildlife potential. A disturbed zone is by definition transitory and once repeated disturbances end, this zone regenerates into one or more of the stable vegetation zones described above.

Disturbed zones are characterized by the presence of pioneering vegetation which develop after the original natural vegetation has been removed. Such riparian zones occur most commonly on agricultural lands, after cultivation and periods of fallow, along hydro-electric corridors where regular mowing permits access and in areas where grazing occurs. On air photographs, disturbed vegetation zones often appear as discontinuities in vegetation cover - abrupt changes from forest to field.

In this riparian class, a number of disturbed and unstable vegetation types are grouped together. Pioneering vegetation is highly variable both in composition and sequence of appearance (Millar 1976:13). The vegetation of a disturbed zone does not always accurately reflect the moisture and soil conditions of the riparian zone over the long-term conditions. Although variable as to species, the vegetation of a disturbed zone is primarily coarsely textured forbs, mixed with grasses of low or mid-stature.

The value of the habitat to wildlife depends on the extent and degree of disturbance. Lightly grazed wetlands may approach meadows in their value, but heavily grazed or mowed areas can be nearly devoid of cover useful to animals larger than moles. Heavy grazing reduces the value of the zone by soil compaction and/or erosion, and by simple harrassment of wildlife. Some birds, such as robins, make extensive use of disturbed zones for feeding. (Photo. 4.12)

A field study was conducted in the summer and fall of 1983, using the above classification system, to ground truth the floodplain land uses and vegetation covers observed on the 1980 air photographs. The field survey technique was designed to be appropriate for the macro-scale of the air photograph land use

photo. 4.12 (dw) Disturbed wetland

study. Areas of each land use and land cover type were randomly sampled and visited. Points within these zones were described in terms of development characteristic for the developed land uses and in terms of floristic composition of the canopy for the undeveloped land cover types. Representatives of the major plant canopy species were keyed and identified in the field. Land use characteristics and canopy composition (relative dominance values) were derived from general observations and must therefore be considered subjective. Fundamental to this approach to ground control and mapping is the acceptance of photographic signature differentiation as a rational basis for the classification of land uses and land cover types.

Once the land use/cover information had been mapped for both 1958 and 1980, the areas of land use/cover were digitized and measured through the use of a Hewlett Packard 9845 B/C desk top computer, a peripheral hardware digitizer 9874 and a software package program designed to calculate area. The surface areas of land use covers were calculated to determine changes in the nature and extent of land uses. Random point samples were taken from the 1958 and 1980 base maps to obtain information on the nature of land use changes over the 22 year period.

Table 4.2

LAND USE/COVER CHANGES ALONG THE STUDY ZONE: 1958 - 1980

			% of total floodplain		% of developed floodplain	
			1958	1980	1958	1980
Developed						
	Residential	(R)	6	29	14	64
Suburban	Transition	(T)	14	8	33	18
	Cottage	(C)	7	1	17	2
Indus.	Industrial	(I)	1	1.5	2	2
Rural	Agricultural	(A)	12	2.5	29	5
	Disturbed	(D)	2	4	5	9
			(42%)	(46%)	(100%)	(100%)
					% of undeveloped floodplain	
Undeveloped						
	Shore marsh	(sm)	2	1	3	2
	Basin marsh	(bm)	1	1	2	2
	Meadow wetland	(mw)	1	<1	2	<1
	Shrub-sapling wetland	(sw)	8	8	14	15
	Wooded wetland	(ww)	31	34	53	63
	Disturbed wetland	(dw)	15	10	26	18
			(58%)	(54%)	(100%)	(100%)

4.3 Results

4.3.1 Major land use trends along the study zone

Table 4.2 presents the percentage distribution of land uses along the floodplain study zone in 1958 and 1980. Though, over the 22 years, the total surface area of developed land only increased by 4%, from 42% to 46% of the floodplains, the data obtained from the land use classification study reveal that there have been significant changes in the extent of certain land uses/covers along the Mille Iles River floodplains.

Four major land use/cover changes were observed:

- First, within the suburban land uses, the importance of transition and cottage zones decreased, while residential land use increased in surface area. Between 1958 and 1980, residential zones increased from 6% to 29% of the study zone and from 14% to 64% of the developed floodplain. Consequently, by 1980, the developed portions of the floodplains were dominated by highly flood-vulnerable permanent residential developments.

- Second, agricultural zones decreased from 12% to 2.5% of the floodplain and from 29 % to 5% of the developed floodplain. Agricultural activities, one of the most productive and suitable floodplain land uses, decreased from being the second most important developed land use in 1958, to being the fourth in 1980.

- A third important land use trend was the decrease in all of the undeveloped land covers, except for shrub wetlands which retained the same amount of floodplain area and wooded wetlands which increased in surface area. Shore marshes, and especially meadow wetlands, were affected. Between 1958 and 1980, meadow wetlands decreased from 1% of the floodplain, to occupy an insignificant portion of the study zone.

- The fourth important land use change was represented by an increase in wooded wetlands. Wooded wetland was the only wild land occupation to increase in surface area. Woodland increased from 31% to 34% of the study zone and from 53% to 63% of the undeveloped land uses. In 1980, wooded wetlands remained the dominant floodplain land use and wild land occupation.

Consequently, between 1958 and 1980, though the proportion of developed versus undeveloped floodplain surface area changed relatively little, important land use changes occured within the developed and undeveloped land use occupations: the study zone which had been characterized by the presence of wooded wetlands, transition areas and agricultural zones, evolved into a landscape dominated by wooded wetlands and permanent residential land use. A result of the suburbanization process has been the polarization of developed land occupations towards permanent residential uses and undeveloped land covers towards wooded wetland occupations.

a) The evolution of residential land use -

The data reveal (Table 4.2) that, between 1958 and 1980, the nature of developed land uses changed from extensive and low-investment occupations, such as transition zones, agriculture and cottages, to intensive high-investment permanent residential developments. Over the 22 years, residential zones increased by 23%, to occupy 29% of the total floodplain. In 1980, residential land uses occupied 64% of the developed floodplain, while transition zones occupied 18%, agriculture occupied 5% and cottage zones only occupied 2% of the developed floodplains.

A sample of randomly distributed points (Table 4.3) reveals that the primary sources of residential lands between 1958 and 1980 were transition zones and disturbed wetlands. For example, of the 1980 residential lands only 21% was residential in 1958: 35% was transitional and 14% was disturbed wetland, 12% was wooded wetland, 8% was cottage zones, 6% was under agricultural land use, 1% was disturbed, 1% was shrub wetland, 1% was industrial and 1% was basin marsh.

Table 4.3

Conversions and origins of land uses

CONVERSIONS OF THE 1958 LAND USES

R —	100%	R
T —	76%	R
	21%	T
	3%	D
C —	38%	T
	28%	R
	28%	C
	4%	dw
	2%	sw
I —	75%	I
	25%	R
A —	24%	sw
	20%	A
	20%	ww
	17%	dw
	12%	R
	3%	D
	2%	T
	1%	I
	1%	bm
D —	30%	D
	20%	R
	20%	ww
	20%	dw
	10%	T
sm —	61%	sm
	12%	sw
	9%	D
	9%	ww
	3%	I
	3%	mw
	3%	dw
bm —	40%	bm
	40%	ww
	20%	R
mw —	67%	sw
	33%	mw
sw —	55%	ww
	25%	sw
	6%	dw
	4%	sm
	4%	R
	2%	T
	2%	I
	2%	D
ww —	61%	ww
	12%	sw
	12%	dw
	6%	R
	4%	sm
	3%	T
	1%	I
	1%	D
dw —	29%	R
	25%	dw
	18%	ww
	9%	sw
	8%	D
	6%	T
	3%	I
	2%	A

ORIGINS OF THE 1980 LAND USES

R —	35%	T
	21%	R
	14%	dw
	12%	ww
	8%	C
	6%	A
	1%	D
	1%	sw
	1%	I
	1%	bm
T —	34%	C
	33%	T
	15%	ww
	10%	dw
	4%	A
	2%	D
	2%	sw
C —	93%	C
	7%	ww
I —	27%	I
	27%	dw
	18%	ww
	9%	A
	9%	sw
	9%	sm
A —	89%	A
	11%	dw
D —	24%	dw
	21%	ww
	10%	D
	15%	A
	15%	sm
	7%	T
	4%	R
	4%	sw
sm —	60%	OPEN WATER
	37%	sm
	3%	sw
bm —	67%	bm
	33%	A
mw —	50%	mw
	50%	sm
sw —	36%	A
	21%	sw
	17%	ww
	14%	dw
	7%	sm
	3%	mw
	2%	C
ww —	62%	ww
	15%	sw
	10%	A
	9%	dw
	2%	sm
	1%	bm
	1%	D
dw —	33%	dw
	31%	ww
	23%	A
	4%	sw
	3%	C
	3%	D
	3%	sm

(R-residential, T-transition, C-cottage, I-industrial/commercial, A-agricultural D-disturbed, sm-shore marsh, bm-basin, mw-meadow wetland, sw-shrub/sapling wetland, ww-wooded wetland, dw-disturbed wetland)

It must be noted that though there was a large increase in residential activity, only 28% of the 1980 residential land use was a product of encroachment upon wild land occupations, primarily disturbed wetland and wooded wetland (Table 4.3). The major source of residential land use was, therefore, a product of the conversion of less intensively developed land uses especially transition zones, followed by cottage and agricultural land uses: 76% of the 1958 transition zones, 28% of the cottage zones and 11.5% of the agricultural lands were converted to permanent residential land use by 1980 (Table 4.3).

A major consequence of the polarization of developed land uses towards intensive high-investment residential activities has been the replacement of suitable floodplain land uses by flood-vulnerable developments. Compatible floodplain land uses, such as productive agricultural lands which benefit from seasonal flooding and low density architecturally adapted cottage zones which minimize flood water displacement and flood damage potential, were abandoned or replaced by poorly adapted, high density residential developments whose existance is not dependent upon a floodplain environment and whose designs and high costs of construction and maintenance make them especially vulnerable to flood events.

In addition to increased flood damage potential, the construction of residential and industrial land occupations renders much of the floodplain impermeable and literally seals off the biotrophic activities of the riparian ecosystem.

Once residential developments are constructed, attempts to reduce flood risks and control flooding, by diking and infilling, result in more riparian resource degradation. The construction

Distruction of the natural land-water transition zone

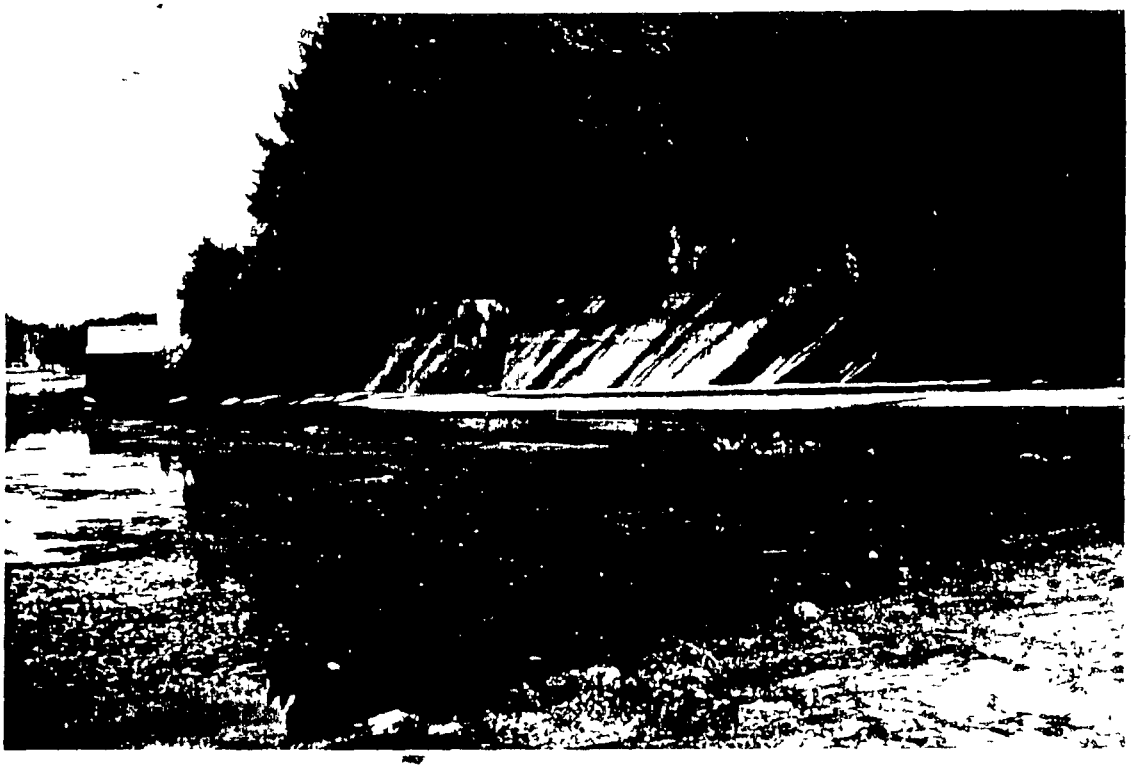


Photo. 4.13a

Photo 4.13b

Photo. 4.13 c

of dikes results in the destruction of shore marshes and the loss of the natural water-land transition zone (Photo. 4.13a,b,c). Infilling of floodplain lands to help floodproof vulnerable dwellings by raising them above certain flood heights, severely modifies terrain drainage (Photo. 4.14a,b,c). Infilling can decrease a floodplains natural flood water storage capacity, displace flood waters further up the floodplains, increase flow rates and friction and effect the erosional potential of flood water currents.

In summary, the evolution of developed land occupations towards residential land uses, a land use which is not floodplain-dependent, leads to increased riparian resource degradation and flood damage potentials.

By 1980, residential land use occupied 85% of Bois des Filion's floodplain, 80% of Deux Montagnes', 55% of St. Eustache's, 30% of Rosemere's, 26% of Laval's, 19% of Boisbriand's and none of Lorraine's.

b) The evolution of wooded wetlands-

The land use data also indicate that land cover changes have occured within the wild land occupations. Between 1958 and 1980, none of the vegetation cover types increased in surface area except for the wooded wetland class. Though the total undeveloped floodplain surface area decreased from 58% to 54% of the floodplain, wooded wetlands increased from 31% to 34% of the floodplain surface area (Table 4.2).

The increase in wooded wetland was accompanied by a decrease in disturbed wetland, meadow wetland and shore marsh (Table 4.2). The disturbance and destruction of shore marshes represents the

Examples of infilling

Photo 4.14a

Photo. 4.14b

Photo. 4.14c Shoreline infilling

loss of the most valuable riparian habitat which contains the highest flora and fauna diversity and constitutes the most important all purpose waterfowl habitat. Residential developments along the northwestern shoreline (St. Eustache and Boisbriand) and industrial developments along the southwestern shoreline (Laval Ouest and Fabreville) were largely responsible for the loss of shore marsh and meadow wetland cover types.

It appears that continued floodplain encroachment upon wild land occupations and the abandonment of extensive agriculture have resulted in the polarization of wild land occupation towards wooded wetlands. The random point sample (Table 4.3) reveals that the major sources of 1980 wooded wetlands was 1958 woodlands, which accounted for 62% of the 1980 wooded wetland area. Shrub wetlands accounted for 15% of the 1980 woodland surface, agricultural lands accounted for 10%, disturbed wetlands accounted for 9%, shore and basin marsh for 3% and disturbed wetland for 1%.

A major consequence of the polarization of wild land occupations towards wooded wetlands is the loss of vegetation diversity, which is the primary prerequisite for wildlife diversity. In 1980, wooded wetlands occupy 63% of the undeveloped floodplains, disturbed wetland 18%, shrub wetlands 15%, shore marshes 2% and basin marshes 2%. Meadow wetlands have decreased to occupy less than 1% of the undeveloped floodplains. In 1980, the most valuable wildlife habitats, the regions with the highest vegetation diversity are located on the south shore along the Laval floodplain between Fabreville and Ste. Rose and in the Auteuil area, and on the north shore, along the Boisbriand and Rosemere floodplains.

In addition to the loss of riparian habitat diversity, floodplain encroachment has led to the fragmentation of remaining resources. The fragmentation of vegetation covers effects the floodplain's wildlife and recreational potential. For example, although the total surface of shrub wetland remained the same between 1958 and 1980, the number of land parcels increased from 65 to 95, while the average size of the parcels decreased from 1.23 ha. to 0.85 ha . As wild land covers decrease in size and diversity, peripheral disturbances have more effect on wildlife in the interior. Units of land cover become isolated from one another and the shoreline, and the needs of riparian wildlife become increasingly difficult to satisfy.

Since 1979, agricultural law 90 has placed constraints on the development of agricultural lands. It has been estimated that 66% of Laval's woodlands are now zoned for agricultural purposes (Laval MRC, 1983:38). In this manner, large portions of the shrub and wooded wetlands along the Laval, Boisbriand and Rosemere floodplains are protected from encroachment. On the other hand, valuable riparian habitats such as marsh and meadow zones are unprotected and forced to accommodate the development pressures.

In view of this, it becomes apparent that the loss of vegetation diversity and the polarization of wild land occupations towards wooded wetland conditions is being encouraged by agricultural law 90 which arbitrarily protects agricultural lands, and thus, large tracts of shrub and wooded wetland from development.

In 1980, wooded wetland occupied 40% of Laval's floodplains, 35% of Rosemere's, 23% of Lorraine's and Boibriand's, 10% of Deux

Table 4.4

Discrepancies in upper and lower floodplain development

	Upper floodplain (20yr – 100yr)				Lower floodplain (water – 20yr)			
	% of total floodplain		% of developed floodplain		% of total floodplain		% of developed floodplain	
	1958	1980	1958	1980	1958	1980	1958	1980
R	11	43	22	68	6	27	15	63
T	19	8	38	13	13	8	32	19
C	5	1	10	1	8	1	19	2
I	1	3	2	5		1		2
A	12	3	24	5	12	2	29	5
D	2	5	4	8	2	4	5	9
	(50%)	(63%)	(100%)	(100%)	(41%)	(43%)	(100%)	(100%)
			% of undeveloped floodplain				% of undeveloped floodplain	
sm					2	1	3	1.5
bm	2		4		1	1	1.5	1.5
mw					1	1	1.5	1.5
sw	5	8	10	21.5	8	8	14	14
ww	21.5	18	43	48.5	33	36	56	63
dw	21.5	11	43	30	14	10	24	17.5
	(50%)	(37%)	(100%)	(100%)	(59%)	(57%)	(100%)	(100%)

(R - residential, T - transition, C - cottage, I - commercial/industrial, A - agricultural
D - disturbed,
sm - shore marsh, bm - basin marsh, mw - meadow wetland, sw - shrub wetland,
ww - wooded wetland, dw - disturbed wetland)

Montagnes', 8% of St. Eustache's and none of Bois des Filion's floodplains.

4.3.2 Discrepancies in upper and lower floodplain development

As has been noted for the floodplains in general, a polarization of land uses occurred between 1958 and 1980, and the region evolved into a landscape dominated by residential zones and wooded wetlands. When the land use data for the study zone are examined in terms of upper and lower floodplain development trends, discrepancies in the nature and extent of land use arise.

First, the data reveal (Table 4.4) that over the 22 year period, the upper floodplains have become, proportionally, far more extensively developed than the lower floodplains. Between 1958 and 1980, the total surface area of developed land uses along the upper floodplains increased by 13% as compared to 2% along the lower floodplains. By 1980, 63% of the upper floodplains and only 43% of the lower floodplains were under developed land uses.

Second, it becomes evident that the upper floodplains have become more intensively developed than the lower. By 1980, along the upper floodplains residential developments increased by 32% to occupy 43% of the upper floodplains, while along the lower floodplains residential developments increased by only 21% to occupy 27% of the area. Overall, land uses along the lower floodplains remained less intensive. By 1980, transition zones, a less intensive and flood-vulnerable occupation, occupied 19% of the developed portions of the lower floodplains as compared to

13% of the upper floodplains. Intensive industrial/commercial developments also increased more rapidly along the upper floodplains than along the lower. In 1980, industrial/commercial land use occupies 5% of the developed upper floodplains as compared to 2% of the developed lower floodplains.

An examination of the upper and lower floodplain development trends, therefore, reveals that while residential developments have increased greatly throughout the floodplain study zone, the upper floodplains have experienced greater rates of residential land use conversion and encroachment than the lower floodplains. This trend implies that the inherent flood risk associated with lower floodplain areas has, in itself, acted as a natural deterrent and curbed lower floodplain development rates. As a consequence, residential developments along the upper floodplains have spread rapidly and produced more flood vulnerable landscapes than that of the lower floodplains. Consequently, flood damages following flood events which exceed the 20 year flood recurrence height, as was the case in 1974 and 1976, can reach catastrophic proportions. If intensive residential developments continue to spread along the upper floodplains, the flood-vulnerability of the entire region increases.

Third, a random point sample reveals that along the upper floodplains the conversion of less intensively developed land occupations to permanent residential developments was not sufficient to accommodate the development pressures imposed upon the upper floodplains. As a consequence, wild land occupations were encroached upon. Between 1958 and 1980, 38% of the land use changes along the upper floodplains was a result of encroachment upon wild lands. In contrast, encroachment upon wild lands along

Table 4.5

Comparison of land use/cover changes between municipalities

	Laval		Deux Montagnes		St. Eustache		Boisbriand		Rosemere		Lorraine		Bois des Filion	
	1958	1980	1958	1980	1958	1980	1958	1980	1958	1980	1958	1980	1958	1980
R	4%	26%	69%	80%	4%	55%	6%	19%	9%	30%			47%	85%
T	17	6			20	21	3	12	4	9			43	9
C	7	2			6		10		11					
I	0,5	1			1	3		0.5	1	2.5		9		
A	13	2			10		22	9	3				10	
D	2	5	7	3	4	5	1	2	1	4		5		6
	(43.5%)	(42%)	(76%)	(83%)	(45%)	(84%)	(42%)	(42.5%)	(29%)	(45.5%)		(14%)	(100%)	(100%)
sm	1	1			7				2	2				
bm	1	1					1	2	0.5			9		
mw	0.5						2		1.5	0.5				
sw	10	8	6		5	1	6	11.5	5	7		22		
ww	30	40	18	10	19	8	33	23	49	35	19	23		
dw	14	8		7	24	7	16	20	12	9	81	32		
	(56.5%)	(58%)	(24%)	(17.5%)	(55%)	(16%)	(58%)	(56.5%)	(70%)	(53.5%)	(100%)	(86%)		
	623 ha.		9 ha.		73 ha.		128 ha.		130 ha.		12 ha.		23 ha.	

the lower floodplains has not been as important. Only 23% of the land use changes along the lower zones were a result of encroachment upon wild land occupations.

Consequently, in addition to having become more vulnerable to flood events, the upper floodplains have also experienced a greater loss in vegetation diversity than the lower floodplains. Basin marshes and wooded wetlands have experienced important losses in surface area along the upper floodplains. Disturbed wetlands, the least valuable wetland class, now occupies 30% of the wild land occupations along the upper floodplains. Though shore marshes and meadow wetlands were especially affected by encroachment along the lower floodplains, by 1980, the lower regions supported a greater range of wildland covers than the upper floodplains.

4.3.3 Comparison of land use trends amongst municipalities

A comparative analysis of the land use changes along the floodplains of the seven municipalities which occupy the study zone reveals distinct differences in floodplain land use. Individually, the seven municipalities present some strikingly different development trends (Table 4.5).

Even in 1958, contrasts in land use from one community to another characterized the floodplain landscape. For example, the municipality of Bois des Filion was already the most extensively developed floodplain, all of the area being under developed land occupations: 47% of the floodplain was under residential land use, 43% under transition and 10% under agricultural occupations.

In contrast, the adjacent municipality of Lorraine presented the least extensively developed floodplains, all of the land being under wild land covers: 19% was under wooded wetland and 81% under disturbed wetland conditions.

Similarly, the municipality of Deux Montagnes, 69% of its floodplain surface under residential land use, was juxtaposed to the municipality of St. Eustache one of the least developed riparian zones with only 4% of its land under residential land use.

On the other hand, some municipalies like St. Eustache and Laval exhibited similar land use patterns. For example, the floodplains of both municipalities supported approximately equal proportions of residential, transitional, cottage and agricultural land use.

Between 1958 and 1980, the study zone communities generally experienced increases in suburban and industrial land occupations, though some did more than others.

For example, the municipality of St. Eustache experienced the greatest growth in developed land uses which spread from 45% to 84% of the floodplain. The region sustained the greatest increase in residential zones which increased by 51%, from 4% to 55% of the floodplain. In contrast, residential development along the Laval floodplain, which had similar land uses in 1958, only increased by 22%.

Simultaneously, the community of St. Eustache experienced one of the greatest losses of agricultural activity. Agriculture decreased from 10% to 0% of the floodplain. Much of the 1958 agricultural land is permanently lost to residential developments.

Proportionally, the St. Eustache floodplain also experienced the greatest loss of wild land occupations, residential developments encroaching upon wild land uses regardless of their management potential or of the suitability of the land uses. Over the 22 years, nearly all of the shore marsh zones were encroached upon: shrub wetland decreased from 5% to 1% of the floodplain, wooded wetland decreased from 19% to 8% and disturbed wetland decreased from 24% to 7% of the floodplain. The loss of wild land occupations along the St. Eustache floodplain represents the greatest loss of wildlife potential along the study zone.

While the municipality of St. Eustache experienced a growth of developed land occupations, the floodplain of the municipality of Bois des Filion experienced an intensification of land use. By 1980, the Bois des Filion floodplain was both the most extensively and intensively developed floodplain zone: Residential developments increased 38% to occupy 85% of the total floodplain. The agricultural lands which had occupied 10% of the 1958 floodplains were permanently replaced by highly flood-vulnerable residential developments.

In contrast, the adjacent municipality of Lorraine remained the least developed floodplain zone. Though, the installation of a water treatment plant resulted in the growth of industrial and disturbed land uses to occupy 14% of the floodplain, the loss of natural floodplain was countered by an amelioration in the quality of the remaining vegetation cover. Over the 22 years, the zones of disturbed wetland were allowed to regenerate. In 1980, the Lorraine floodplain was occupied by basin marshes, shrub wetland, wooded wetlands and disturbed wetland. This is

the only riparian zone along the study zone which experienced an improvement in the quality of the wild land occupations. Through the use of a zoning policy which has designated the floodplain lands as public lands, no residential or flood-vulnerable developments have been permitted.

The Boisbriand floodplain experienced one of the smallest growth of residential land use but experienced the greatest loss in cottage developments and agriculture. Between 1958 and 1980, cottage land use disappeared and agriculture decreased from 22% to 9% of the floodplain. Though agriculture decreased greatly, the floodplain remains the study zone's most agricultural area.

While most of the municipalities, generally, lost their agricultural lands to suburban developments some of the agricultural lands along the Laval, Boisbriand and Rosemere floodplains were permitted to revert to wild land occupations. In this manner, consciously or unconsciously, the potential for future agricultural activity was preserved.

Thus, the land use policies of St. Eustache, Rosemere, Deux Montagnes and Bois des Filion have resulted in the spread of residential developments. The municipality of Deux Montagnes and Bois des Filion sustained an intensification of residential developments. By 1980, the Deux Montagnes and Bois des Filion floodplains offered the least wildlife potential and became the most flood-vulnerable landscapes.

On the other hand, the policies of the municipality of Boisbriand and Laval have resulted in the preservation of agricultural land, while the strategy in Lorraine has prevented nearly all floodplain encroachment. By 1980, the Lorraine, Laval and Boisbriand floodplains offered a variety of wild land

occupations. The Laval and Rosemere floodplains offered the greatest wildlife potential by supporting the greatest range of wild land occupations and the most extensive surface area of undeveloped floodplain.

The case of the Lorraine/Bois des Filion land use contrast exemplifies the degree to which individual zoning policies can give rise to different development patterns. Differences in land use development amongst the municipalities emphasizes that communities are comprised of people with different needs and aspirations.

The land use evidence does suggest that some communities seem to be more cautious in developing their hazard zones, while others encourage land uses regardless of the riparian resource management potentials or of the floodplain suitability of the developments. Some municipalities are taking advantage of the locational advantages of the riparian lands, thereby, degrading the environment and producing flood-vulnerable landscapes, while other communities more wisely refrain from doing so. It is concluded, that the communities possess different attitudes and responses to the development and management of their riparian lands.

The ramifications of unsuitable floodplain developments (loss of riparian resources, flood water absorption and storage capacity, ground water replenishment and the filtration of pollutants and sediments) are not confined to political boundaries. It is therefore, not equitable for those municipalities which deprive themselves of increased tax bases and their residents of the locational advantages of floodplain lands to have to suffer the impacts of adjacent floodplain

encroachment.

The repurcussions of differences in attitudes toward floodplain development accentuate the importance of improving communication between the individual municipalities. Through improved communication, communities can benefit from oneanothers experiences and expertise. Inequalities can be resolved, thus ensuring a more equitable and rational floodplain development process.

4.4 Conclusions

The objective of this land use study has been to identify the land use trends and development patterns which have resulted in riparian resource degradation and increased flood-vulnerability. The examination of the land use trends along the Mille Iles river floodplains identified five major land use trends which were responsible for the loss of riparian resources and increased flood damage potential:

1) the polarization of developed land uses towards residential land use, a land use which is ill-adapted and not directly dependent upon the floodplain environment, has produced a flood-vulnerable landscape,

2) the polarization of undeveloped land uses towards wooded wetland covers, a relatively less valuable riparian habitat, has resulted in the loss of vegetation diversity and wildlife potential,

3) the encroachment of residential land uses along the lower floodplains, at the expense of compatible land uses, has resulted in increased flood vulnerability,

4) the intensification of residential development along the upper floodplains, through the conversion of compatible land uses and the destruction of wild land covers, has resulted in the loss of wild life potential and produced the study zone's most flood-vulnerable

landscape unit,

5) the municipal differences in land use development reflects the anarchic development process which has characterized the floodplains and produced a heterogeneous landscape which supports extremes in floodplain land uses.

If floodplain degradation and increasing flood vulnerability are to be reduced, the above land use trends must be addressed.

First, a floodplain management policy must attempt to discourage the polarization of developed land uses towards residential conditions. To achieve this objective, the conversion of compatible floodplain land uses to intensive residential developments must be discouraged. Through land use regulations, low density floodplain-dependant land uses such as agriculture and cottaging can be encouraged. The encroachment of residential land use along the lower floodplains and the intensification of residential land use along the upper floodplains must be halted.

Second, a floodplain management policy must attempt to discourage the polarization of undeveloped land uses towards wooded wetland conditions. Riparian resource diversity and increased wildlife potential can be encouraged through the adoption of land use regulations which systematically protect a range of valuable wildlife habitats, including shore marshes, meadow wetlands and wooded wetlands.

Third, through the use of land use regulations and relocation strategies, a floodplain management policy must attempt to discourage the intensification of residential developments along the upper floodplains and the growth of residential land use along the lower floodplains.

Finally, the inequalities in floodplain development must be

identified. Municipalities which have taken advantage of floodplain resources at the expense and detriment of others must be encouraged to prevent further encroachment and to mitigate the consequences of their past policies. Individual municipalities must become aware of the values of their riparian habitats and plan land uses accordingly. To ensure the rational use of riverine lands a floodplain management policy must identify appropriate land uses, discourage flood-vulnerable developments and identify the management potentials of the remaining riparian habitats. Only through a planned process based on an understanding of the human and bio-physical elements can floodplain degradation and increased flood damage potential be corrected.

CHAPTER 5 : The 1976 federal-provincial flood damage reduction program.

5.1 Introduction

Until 1976, no specific policy coordinated the actions of the agencies involved in the management of Quebec's floodplains. The resources and the activities which effected them were managed as separate entities, by different levels of government, with little recognition of the interrelationships. The provincial and municipal governments, the two levels most frequently involved in implementing policy, each pursued the actions which maximized their benefits rather than ensuring the comprehensive management of floodplains. As a result, ill-suited floodplain land uses encroached unhampered by land use regulations, to be later translated into riparian resource degradation and increased flood damage potential.

The study of land use trends along the Mille Iles river's floodplains illustrates the nature of the encroachment which occured under the past management policy: A polarization of land uses toward residential and wooded wetland conditions, the encroachment of residential developments along the lower floodplains and their intensification along the upper portions, and finally, unequal floodplain development.

To reduce flood hazard and protect the remaining valuable riparian habitats, agencies involved in the management of Quebec's floodplains must coordinate their jurisdictional responsibilities and develop a management policy which integrates

a mixture of long- and short-term measures, so as to halt the past land use trends identified in chapter 4, plan for appropriate uses, stabilize and eventually, reduce the populations at risk.

In the hope of reducing flood damages and establishing a rational floodplain managment policy, on October 4, 1976, Quebec signed two agreements with the federal government, joining the flood damage reduction program under the Canada Water Act. The 1976 flood damage reduction program is presented by Environment Canada as a "new comprehensive approach" to floodplain management because it encourages the use of both structural and non-structural approaches to reduce flood hazard (Page 1980:411).

The following chapter describes the governments' involvement in floodplain management and the adjustments promoted in the program. The measures are examined in terms of the theoretical objectives of structural and non-structural arrangements, as described in chapter 1. In the light of past development trends, the effectiveness and foreseable consequences of the new measures are assessed for ensuring the reduction of flood damages and the rational use of floodplain lands.

5.2 The 1976 flood damage reduction program

5.2.1 The first agreement -

The first agreement signed by the federal and provincial governments in 1976, is a combined mapping and general agreement. Its purpose is to reduce flood damages in Quebec by controlling future floodplain encroachment.

The objective of the mapping aspect of the agreement is to provide information for government agencies, municipalities and individuals who have an interest in areas subject to inundation. The flood risk maps are designed to:

> a) inform individuals of the risk of flooding where they live or where they intend to build,
>
> b) induce individuals and government organizations to minimize undesirable effects of flooding on their activities,
>
> c) prevent unsuitable development of floodplain lands and, in particular, help municipalities to zone their flood prone areas,
>
> d) guide the purchase of open space for public use, and
>
> e) guide the Protection Civile du Québec and Emergency Planning Canada in planning emergency operations in advance of an impending flood (Min. des Rich. Nat. and Fish. and Env. Can., 1978:3).

The federal and provincial governments consider the flood risk mapping program essential to floodplain management. The precise delineation of flood risk areas is viewed as a prerequisite to the prevention of further development of the risk areas and the elaboration and enforcement of flood damage reduction measures. A total of 183 floodplain areas along the principal rivers of Quebec have been mapped.

Under the flood risk mapping portion of the general agreement, floodplains are divided into two flood risk zones. The first, or strong current, zone extends from the shoreline to the 20 year flood recurrence height. Buildings located in this zone are said to be exposed to strong currents and ice during floods. The second, or weak current, zone starts where the first ends and extends to the limit of the 100 year flood. Buildings in this zone are not as frequently subject to the driving action of flood waters.

Under the general agreement, the federal government, through agencies such as the Central Mortgage and Housing Corporation, the Department of Public Works and the Federal Department of Regional Economic Expansion, has undertaken to:

> a) to avoid subsidizing or building structures vulnerable to floods in the designated areas,
>
> b) encourage authorities under their jurisdiction (the provinces) to restrict their investments in flood risk areas, encourage appropriate zoning regulations and to impose constraints that will prohibit or, where suitable, make subject to requirements for adequate flood proofing, undertaking vulnerable to floods in the designated flood risk areas,
>
> c) withhold federal disaster assistance payments for new or further developments or moveables placed in a high flood risk area after it has been officially designated as such (Min. des Rich. Nat. and Fish. and Envir. Can., 1978:3).

In conjunction, the provincial government through departments and agencies, such as the Ministère des Affaires Municipales and the Société d'Habitation du Québec, has undertaken to:

> a) avoid subsidizing or building structures vulnerable to floods in the designated areas,
>
> b) encourage authorities under their jurisdiction (municipalities) to impose restrictions that will prohibit or, where appropriate, make subject to requirements for adequate flood proofing, undertakings in the designated flood-vulnerable areas (Ibid.).

In light of these commitments, the provincial government has promoted two adjustments to flood hazards: 1) a two-zoned floodplain land use system intended to prohibit all construction in the strong current zone and only authorize flood-proofed constructions in the weak current zones and 2) a flood-proofing program (Min. des Rich. Nat. and Env. Can. 1978) (Appendix V).

Finally, under the 1976 general agreement the federal

government has adopted a third adjustment, a flood damage relief and rehabilitation policy, designed to withold federal flood disaster assistance payments from new developments in the high flood risk zones. Along the low flood risk areas the federal government will provide disaster assistance, in time of need, according to the "Dollar-per-Capita" federal cost-sharing formula discussed in chapter 3 (Table 3.1).

5.2.2 The second agreement -

In the hope of providing immediate relief from flood related problems and reducing seasonal flood damages to existing developments in the Montreal archipeligo, on October 4, 1976, the provincial and federal governments signed a second joint agreement entitled "Convention Canada-Québec concernant les digues et les ouvrages de régularisation des eaux dans la région de Montréal". Through this agreement, the "Comité des ouvrages de contrôle des crues - Région de Montréal" was created. The committee is composed of members of the provincial and federal ministries of the environment (B.A.P. 1982:26,73). Under the agreement, the mandate of the committee was to determine the feasibility of

> 1) improving the regulation of the Ottawa river's discharge rates through the augmentation of the storage capacity of a number of reservoirs, namely the "Réservoir des Quinze",
>
> 2) the construction of dikes along the municipalities of Pointe-Calumet, Sainte-Marthe-sur-le-lac, Roxboro and Pierrefonds,
>
> 3) the construction of a flow regulation structure to reduce to 25 000 cfs (708 m^3/s), the maximum discharge rate of the Mille Iles River (B.A.P. 1982:9).

Since 1976, a feasibility study has favourably reported on

the augmentation of the storage capacity of the "Réservoir des Quinze" and the regulation of the Ottawa River. By 1982, improved regulation of the Ottawa was operative (B.A.P. 1982:44). Since the agreement, over $16 million have been expended on the construction of permanent dikes along the municipalities of Roxboro, Pierrefonds, Ste-Marthe, and Pointe-Calumet (Fish. and Environ. Can., 1977-78;95). Finally, on October 1, 1983, the design of a flood control structure at the head of the Mille Iles River was approved. Construction of the dam is planned to start in the fall of 1984.

According to the proponent, the "Comité des ouvrages de contrôle des crues", alias the Quebec Ministry of the Environment, the objectives of the flood control structure along the Mille Iles River are to

> 1) ... l'ouvrage de contrôle prévu a pour but de réduire les dommages causés par les inondations le long de la rivière des Mille Iles (Shawinigan 1981:16),
>
> 2) ... l'ouvrage de contrôle proposé a pour but de réduire la fréquence des inondations le long de la rivière des Mille Iles (B.A.P. 1982:43)

Under the premise that the discharges of the Ottawa River will continue to be controlled, six alternatives for the control structure were initially presented. In the end, alternative C3 was chosen (Appendix VI),

> (...) l'ouvrage de contrôle sera localisé à l'entrée de la rivière de Mille Iles, dans les municipalités de Laval et de Deux Montagnes, en amont des rapides du Grand Moulin. L'axe de l'ouvrage se situerait à une distance variant de 15 à 25 metres (50 à 80 pieds) à l'aval de l'axe central de l'actuel pont du CN .... L'ouvrage, d'une longueur totale de quelque 500 mètres (1 640 pi) ... comprendrait au total 10 vannes de 18 mètres (59 pi) de largeur .... (B.A.P. 1981:43).

According to the promotor, the flood control structure will

operate only when discharge rates (measured at the Bois des Filion gauging station) exceed 708 m^3/s (2 year flood recurrence height).

In march 1981, the costs of the structure were estimated to be $6 500 000. This figure is based on an average of 50 years and includes initial construction and annual operation costs. However, other costs, such as inflation, maintenance, periodic reconstruction, the possible need for the addition of a fish ladder and the construction of a lock, were not included in the original estimates (B.A.P. 1982:44,63). According to the agreement, 45% of the construction funds for structural measures are supplied by the federal government, 45% by the provincial government and 10% by local municipalities (Fish. and Environ. Can. 1976).

This approach to flood control along the Mille Iles river was chosen over others because of its cost-effectiveness: relocation of settlements below the 35 year flood recurrence line for the entire Montreal region was estimated at $200 million in 1974 (B.A.P. 1982:25), and diking along the river was estimated to cost about $25 million in 1979 (Shawinigan 1981:9).

5.3 The effectiveness of the flood damage reduction program

The 1976 federal-provincial flood damage reduction program attempts to reduce flood hazard along the Mille Iles River floodplains through the adoption of four adjustments to flooding: 1) land use regulations; 2) flood-proofing regulations; 3) a disaster relief and rehabilitation policy, and 4) a permanent

flood control structure.

In contrast to the past floodplain management policy, which was composed of ad hoc investments in structural flood control measures and disaster assistance payments, the senior levels of government developed, in 1976, a flood damage reduction program which they claim is a new comprehensive approach to floodplain management. The joint program emphasizes both structural and non-structural adjustments which attempt to reduce long-term flood damages and offers short-term solutions for existing developments in the hazard zones. Through the coordination of jurisdictional powers and responsibilities and the adoption of four types of flood hazard adjustments, the senior levels of government hope to stabilize and eventually reduce the populations at risk.

Based on an understanding of the principles of flood hazard adjustments (Ch 1), the bio-physical attributes of the Mille Iles River (Ch 2), the past management policies (Ch 3) and the subsequent land use trends along the river's floodplains (Ch 4), an examination of the application of the 1976 adjustments along the Mille Iles River sheds light on the effectiveness of the program for reducing flood damage potential and ensuring the rational use of floodplains along the river and across Quebec.

5.3.1 The effectiveness of the land use measures

The long-term objective of the land use management policy is to reduce flood damage potential along the hazard zones by controlling the human use of lands prone to flooding. This

approach to floodplain management reduces the interactions between man and the environment through the adoption of measures which change human behavior rather than the natural system. In the long-run, land use management may be the single adjustment most likely to reduce flood damage potential and insure the comprehensive use of floodplain lands.

As previously discussed, in chapter 3, land use management has traditionally been a municipal responsiblity. However, the formulation and application of floodplain land use schemes has not been a priority of municipal governments.

In 1976, under the general agreement of the 1976 flood damage reduction program, the provincial government announced a floodplain land use policy which promoted a two-zoned land use system. The two-zoned floodplain land use policy prohibits all construction in the lower floodplain, the 20 year flood recurrence zone, and authorizes only flood-proofed constructions in the upper floodplain, the 20 to 100 year flood recurrence zone.

In an attempt to enforce this land use management policy at the municipal level, the provincial government amended two laws: article 14 of laws 54 (December 1977) and article 30 of law 55 (December 1977) amend the "Loi des Cités et Villes" and the "Code Municipale" so as to give individual municipalites and regional counties the powers to impose or specify land use regulations such as lot size requirements, the proximity of undertakings to streams or lakes, and other construction regulations (Appendix V).

An examination of the provincial land use directives and the amendments to laws 54 and 55 reveal deficiencies in the

floodplain land use policy which undermine the effectiveness of the measures for reducing flood damage potential and ensuring the comprehensive use of floodplains: the land use policy does not identify appropriate and inappropriate land uses or incorporate directives for the protection of valuable riparian habitats.

In fact, through the promotion of a two-zone floodplain concept, which in principle prohibits development along the lower floodplains, the provincial policy openly encourages more intensive land use along the upper floodplains. The intensification of land uses along the upper floodplains, especially residential occupations, has been identified in chapter 4 as one of the land use trends along the Mille Iles River which has led to increased floodplain vulnerability and the destruction of valuable riparian habitats.

In addition to deficiencies of the provincial land use policy, a survey of the adoption and enforcement of the provincial floodplain land use directives along the Mille Iles River reveals that the measures have not been uniformly adopted.

First, at the municipal level, it is surprising to note that the municipalities of St. Eustache, Boisbriand and Deux Montagnes have ignored the directives of the 1976 agreement which stipulates that a floodplain is the zone between the shoreline and the 100 year flood height and, instead, have delineated their floodplains as the zone between the shoreline and the 10 year flood recurrence height (Lecours 1984 pers. com.; Shawinigan 1981:216; B.A.P. 1982:75).

Second, a survey of the land use regulations adopted in the communities of the study zone reveals that none of the municipalities have prohibited construction within the 20 year

flood recurrence height, as the provincial directives stipulate (Laws 54 and 55)(B.A.P. 1982:75). Except for the municipality of Lorraine which has zoned its floodplain public since the 1960's, the study zone communities continue to encourage the construction of single family dwellings along their floodplains, by zoning for low density residential developments. Some municipalities, notably Laval, have zoned small portions of the developed floodplains public, thus preventing further encroachment in the area. Nonetheless, residential developments, the most unsuitable floodplain land use, the growth of which has produced the present flood-vulnerable landscape, is not discouraged along either the upper or lower floodplains by the present municipal land use management practices.

In fact, the municipal attitudes toward floodplain land use depart from those of the provincial government. For example, during the public audience on the proposed flood control structure Mr. Bernard Ouellet, representative of the municipality of Boisbriand stated concerning floodplain land use,

> (...) la municipalité n'a pas l'intention d'interdire la construction en milieu inondable pour une simple raison, c'est que ce serait utiliser une expropriation déguisée que le ministère n'a pas voulu faire lui-meme (B.A.P. 1982:76).

Mr. Louis-Jacques Laflamme, representative of the municipality of Bois-des-Filion, stated,

> (...) je vais vous répondre que le Conseil de ville n'a pas montré d'intention de priver les gens de jouir de leur terrain à leur gré ... on rend le propriétaire conscient qu'il est mieux d'investir tout de suite $2 000 dans l'aménagement de son terrain au point de vue niveau que de dépenser $700, $800, $1 000 par saison pour les inondations (B.A.P. 1982:76).

The municipalities, which receive no financial incentives for the adoption and enforcement of land use regulations and stand to lose tax revenues, argue that they cannot deprive their citizens of their individual or property rights, and so, openly support and prefer the structural approaches to floodplain management (which are usually funded by the senior levels of government) rather than the land use management approaches. It therefore becomes apparent that the municipal and provincial levels of government have different views on the best approaches to floodplain management. The goals of the provincial government policy concerning floodplain land use, specifically developments along the high risk zones, cannot be achieved if the individual municipalities, the bodies ultimately responsible for policy implementation, do not adopt or enforce the prescribed regulations.

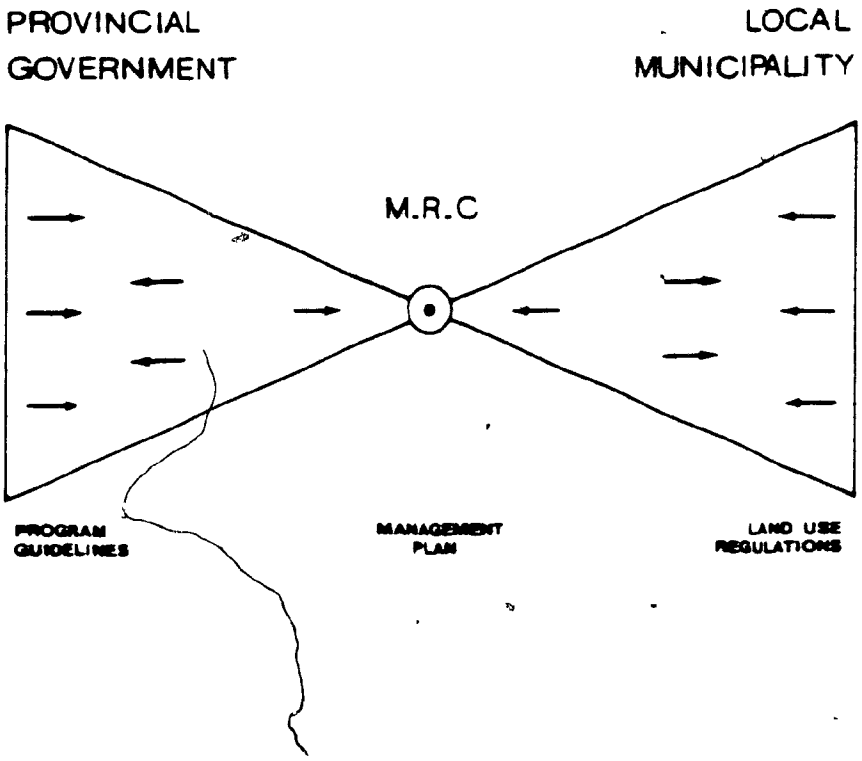
In the course of the research no official document stating the intentions of the provincial government to enforce its policies in the 20 year flood recurrence zone were encountered (B.A.P. 1982:77). In addition, it was revealed that both senior levels of governments, in contradiction with their 1976 commitments, had given loans for residential constructions in the floodplain,

> Malgré l'attitude des gouvernements fédéral et provincial, quant au développement domiciliaire en zone inondable, des informations recueillies en cours d'enquête, nous ont appris que les citoyens réussissaient quand même à obtenir, moyennant des conditions plus sévère, des prêts pour la construction, dans la zone d'inondation (B.A.P. 1982:78).

Thus, while the provincial guidelines recommend the adoption of a two-zoned land use management policy which prohibits

Figure 5.1

Allocation of land use and resource management responsibilities



(Source: Cermakian 1983)

development below the 20 year flood height, the guidelines have not been uniformly adopted by the local municipalities along the floodplain nor enforced by the senior levels of government. It must, therefore, be concluded that the 1976 land use management policy does not ensure the reduction of flood damage potential or the rational use of floodplain lands.

Since 1980, changes in Quebec's land use and resource management policy have had ramifications for the land use measures promoted in the 1976 program.

In April 1980, Law 125 "la Loi 125 sur l'Aménagement et l'Urbanisme" became operative. The objective of the law is to establish a framework for the elaboration and application of regulations concerning land use and resource management, through the use of existing municipal land use powers and the formation of a new regional level of management, the regional municipality - "Municipalité régionale de comté" (MRC).

Based on the notion of a "région d'appartenance", the Quebec landscape has been divided into over 100 MRC. Each MRC usually regroups a number of municipalities, but must be small enough "pour que le citoyen ne se sente pas perdu dans un trop grand ensemble" (Gouvernement du Québec 1980, in Cermakian 1983:26).

According to law 125, land use and resource management is now the responsibility of three levels of government (Fig. 5.1),

> L'aménagement est une fonction partagée entre trois paliers de decisions: la municipalité, la municipalité régionale de comté et le gouvernement. Chaque palier a son domaine de responsabilité propre.
>
> L'aménagment fait appel à la coordination et à la conciliation des choix et des actions des trois instances décisionelles, ce quis est traduit par un échange d'informations et par la concordance de leurs objectifs et projets respectifs (Gouvernement du Québec 1980, in Cermakian 1983:26).

Under the law, local municipalities remain the management unit. Municipalities retain authority over zoning, lot size requirements and construction regulations. However, the local municipal management plan and the land use regulations must conform to the objectives discribed in the regional management plan of the MRC. According to law 125, local municipalities have to respect the regional management plan,

> (...) chaque municipalité faisant partir du térritoire de la municipalité régionale de comté est tenue dans un delai imparti, d'adopter pour la totalité de son territoire, des règlements d'urbanisme, de zonage, de lotissement et de construction conformes aux objectifs du schéma d'aménagement régional, ou de modifier en conséquence les règlements qu'elle a déja.
>
> C'est ainsi que, dans son règlement de zonage, une municipalité pourra "régir ou prohiber ... la construction ou certains ouvrages, compte tenu soit de l'emplacement du terrain, soit de la proximité d'un cours d'eau, soit des dangers d'inondation, d'éboulis, de glissement de terrain ou d'autres cataclysmes"; une telle prohibition pouvant être totale ou ne visée que certaine catégorie d'immeubles que le règlement déterminera (Massey 1979:209).

The management and development priorities of the MRC are themselves the product of provincial guidelines and public policies. Ultimately, the Minister of Municipal Affairs is responsible for the application of the law. As of 1980, the MRC have four years to elaborate a regional management plan (Cermakian 1983:29).

Articles 113 and 115 of Law 125 are specifically aimed at the development of floodplain zones and give municipalities the powers to impose zoning restrictions and to prohibit, or make subject to flood-proofing requirements, undertakings in the flood risk areas. The law also gives the Minister of Municipal Affairs the power to impose zoning restrictions along a floodplain if a local municipality has not done so, ignoring the MRC guidelines.

In this manner, the floodplain land use policy of the 1976 flood damage reduction agreement has been instilled at the regional level.

In addition, according to the provincial guidelines, the MRC management plan must indentify flood vulnerable zones and areas of ecological significance,

> ... outre les grandes orientations d'aménagement et les grandes affectations du territoire, les éléments suivants : a) l'identification de zones ou l'occupations du sol est soumise à des contraintes particulières pour des raisons de sécurité publique telles les zones d'inondation, d'érosion, de glissement de terrains et autres cataclysmes ; b) l'identification des territoires présentant pour la municipalité régionale de comté un intérêt d'ordre ... écologique(Massey 1979:209).

Finally, through Law 125, the provincial government has given itself a tool by which valuable ecosystems, including riparian hbitats, can be protected from encroachment. It can, by decree, declare all or a portion of a territory à "zone d'intervention spéciale",

> Une telle zone d'intervention spéciale, pourra assurer: 1) la protection des sites présentant pour la collectivité une valeur particulière, notamment pour des raisons d'ordre historique, culturel, scientifique, èsthetique, récréatif ou écologique; 2) la protection, l'amélioration, le renouvellement ou l'exploitation des ressources naturelles présentant pour la collectivité un intérêt exceptionnel telles, les eaux et les rives adjacentes, les forêts, les mines, les carrières et les sablières (Massey 1979:209).

If utilised and enforced, law 125 can have important implications for floodplain development and riparian resource management in Quebec.

As a result of law 125, three MRC's have been established along the study zone. The MRC of Deux Montagnes encompasses the

municipalities of Deux Montagnes, St. Eustache and Boisbriand, the MRC of Terrebone regroups the municipalities of Rosemere, Lorraine and Boisbriand. The MRC of Laval overseas the management of the municipality of Laval. In 1984, each MRC in the study zone was in the preliminary stages of developing a land use management plan. Under the provincial guidelines each MRC has delineated the extent of its floodplain zone and identified development plans for the zones.

Though law 125 gives the government the power to protect ecologically sensitive zones by declaring all or a portion of a territory a "zone d'intervention", no such measures have been taken along the Mille Iles River. The regional municipality of Laval has stated that it cannot assume such responsibilities by itself,

> (...) la rivière des Mille-Iles ... recèlent une richesse extraordinaire pour le Québec à la fois sur les plans écologique, historique, culturel et scientifique. Une telle richesse devrait faire l'objet de la part du Gouvernement d'un décret de zone d'intervential spéciale.
>
> La mise en valeur ne peut être limitée au térritoire lavallois mais doit plutôt s'éffectuer globalement. Ceci implique donc une concertation au niveau des politiques et des interventions entre le gouvernement, la C.U.M, les M.R.C ..... seule une action concertée permettra la mise en valeur de ce potentiel (Laval M.R.C. 1984:35).

However, the Laval MRC has already made an effort to protect some floodplain zones through the acquisition of approximately 51 hectares of which a small portion is already managed as parkland (Laval MRC 1984:37).

Alone, it has been concluded that the 1976 floodplain land use policies cannot assure the rational use of floodplain lands. Under law 125, which gives rise to MRC's and incorporates the

1976 directives, the floodplain land use policies may be adopted and more uniformly enforced. On the other hand, the creation of a third level of administration does not insure the co-ordination of management plans internally amongst MRC's and may only complicate the adoption and enforcement process at the municipal level.

5.3.2 The efffectiveness of the flood-proofing measures

The purpose of the second adjustment promoted by the 1976 flood damage reduction program, flood-proofing requirements, is to decrease the flood damage potential to present and future floodplain constructions by altering the designs of the structures such that buildings are less susceptible to damages from flooding.

The 1977 amendments to laws 54 and 55 and the development of law 125 have also given the municipalities the powers to impose or specify flood-proofing requirements.

A survey of the adoption of flood-proofing measures across the study zone reveals that requirements vary from one municipality to another. Though they are all based on the suggestions put forth by the Ministère de l'Environnement some municipalites specify lot size requirements while others do not, some require the elevation of floors beyond certain limits, while others require the installation of flood pumps, specify the absence of basement windows etc... (Appendix V).

A positive side effect of the flood-proofing regulations is that the imposed constraints have been translated into higher

Photo. 5.1

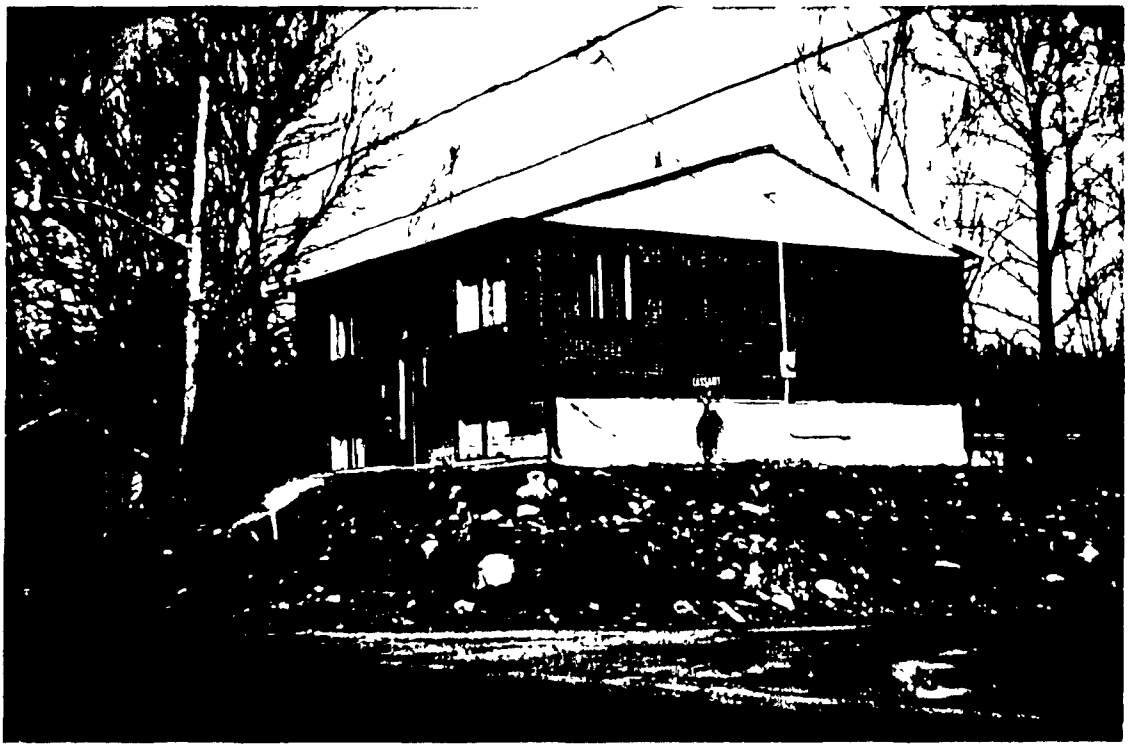


Photo 5.2

construction costs, and so, have decreased the number of demands for construction permits (Shawinigan 1981:217; B.A.P. 1982:75).

While the flood-proofing measures have made structures less vulnerable to flood damage, the adjustments to flood hazard have had negative impacts on the floodplain environment. The municipal regulations concerning construction and flood-proofing have encouraged property owners to infill their land and to raise their dwellings above certain flood heights. It is not uncommon to see homes perched on a mound of dirt two or three meters above the normal ground level (Photo 5.1 and 5.2). Undoubtedly, such developments alter the local slope and drainage conditions. Infilling and raising dwellings above flood heights in this manner can undoubtedly decrease a floodplain's natural storage capacity, displace flood waters further up the floodplain, increase flow rates and friction, and affect the erosional potential of flood water currents. Alternative architectural designs for floodplain buildings can permit development while avoiding the negative consequences of infilling and can deminish the impact of new constructions on the floodplain environment (Photo. 5.3a,b,c,d,e).

Thus, while the flood-proofing measures have reduced flood damage potential, they are resulting in increased floodplain degradation.

5.3.3 The effectiveness of the federal flood damage relief policy

The adoption of the flood relief policy is intended to

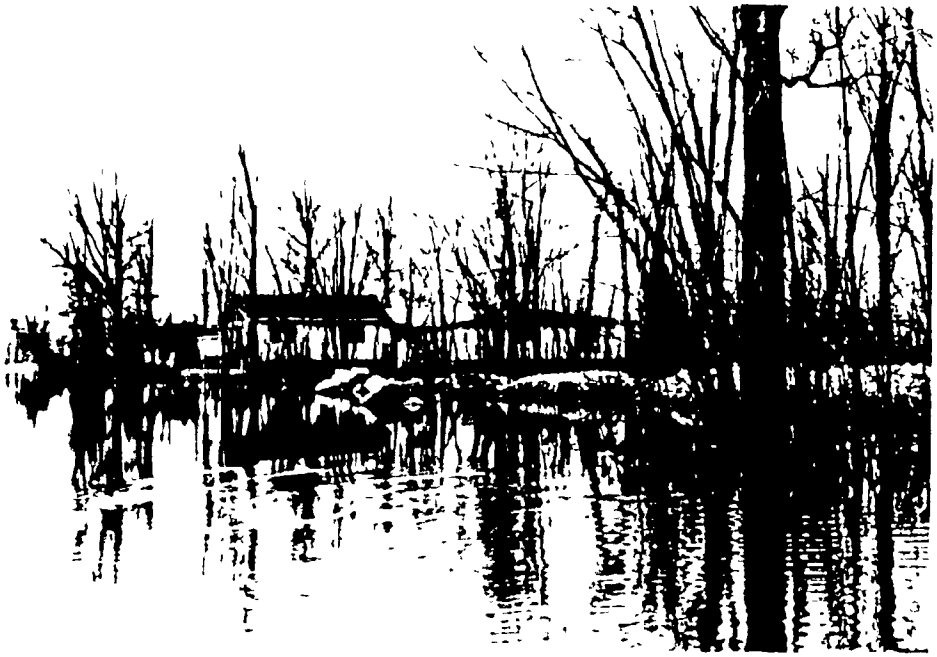


Photo. 5.3a Infilled floodplain in preparation for construction (1984 spring flood).

Photo. 5.3b Example of recently constructed dwelling raised above flood heights by infilling (1984 spring flood).

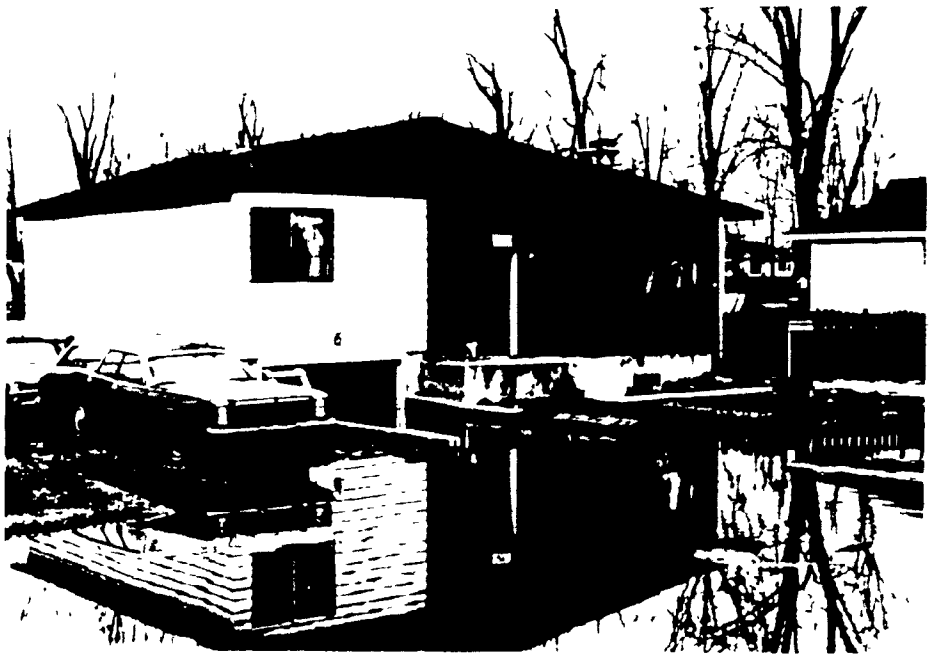


Photo. 5.3c In comparison to previous picture residential dwelling is unprotected by infilling measures (spring flood 1984)

Photo. 5.3d Cottage converted into a permanent residential dwelling - the structure has retained the cottage's "stilts" an adaptation to floodplain environments which is less disturbing than infilling.

Photo 5.3d Alternative architectural desing: this house is constructed on a pillar and raised above seasonal flood heights. As with the cottage "stilts" the disturbing effects of infilling are avoided.

discourage, on a long-term basis, floodplain encroachment by transferring the costs of flood damages back onto those who benefit from the locational advantages of floodplain environments. In this manner, the costs of flood hazards can be integrated into the land use decisions.

As of yet, the impact of the federal policy, to withhold disaster assistance, on the rate of floodplain encroachment trends are unknown. However, the federal-provincial agreement does not explicitly state Quebec's position with regard to providing flood disaster relief funds to people establishing themselves in the 20 year flood risk zones,

> L'entente Québec-Canada n'est pas explicite quant aux volontés du Québec de ne pas dédommager les propriétaires qui iraient s'y installer. Le décret de 1981 autorisant l'indemnisation des sinistrés à la suite des inondations, ne précise pas de critères d'admissibilité au dédommagement, dans le cas de la zone de récurrence de 20 ans (B.A.P. 1982:77-78).

The provision of provincial flood relief funds may counteract any impact the federal disaster assistance policy may have on the rate of floodplain encroachment.

5.3.4 The effectiveness of the flood control structure

On October 1, 1983, the project design was approved for the construction of a flood control dam at the entrance of the Mille Iles River. The goals of the flood control structure, as stated by the proponent (B.A.P. 1982:43), are to reduce the frequency of flooding along the river and to decrease flood damages. To achieve these objectives, the flood control structure has been designed to be operative when the river's discharge rate exceeds

708 m^3/s.

In principle, the purpose of a structural flood control measure in a comprehensive floodplain management program is to safeguard already established developments until their economic lives expire, thus reducing the traumas and costs of flood events in developed floodplain zones. The effectiveness of a structure is, therefore, measured in terms of its success in achieving these short-term goals. In a comprehensive management scheme, structural solutions are temporary tools to help in the transition from inappropriate to appropriate floodplain land use.

In view of an environmental impact study (Shawinigan 1981) and a public audience on the proposed project (B.A.P. 1982) a number of factors have emerged which jeopardize the effectiveness of the flood control structure for reducing flood damages and ensuring the rational use of floodplain lands.

For example, by having chosen 708 m^3/s as the discharge rate at which the structure would begin operating, the proponent has implied that discharges below 708 m^3/s do not result in significant flood damages. The municipality of Laval, however, has brought to their attention the fact that over 210 buildings in Laval, 51 of them permanent residences are not protected by such a flood control structure. Over 250 permanent and seasonal dwellings along the river will not be protected by the project (B.A.P. 1982:54). According to the municipality of Laval, peak flood heights would have to be decreased to 500 m^3/s to eliminate damages caused by flooding.

The proponent, provides no explanation or criteria for the selection of the 708 m^3/s discharge rate (B.A.P. 1982:53). It must therefore be concluded that the choice of a 708 m^3/s

discharge, which corresponds to a 2 year flood recurrence height, corresponds to a decision on the part of the proponent to exclude from flood protection the floodplain areas which are the most often flooded. Thus for these residents, the flood control dam will neither reduce the costs, nor the traumas of flooding. As a second thought, the construction of dikes along the unprotected zones has been proposed by the provincial government, if it is economically feasible (B.A.P. 1982:104).

The question now arises as to whether the flood control structure will reduce flood damage potential along the remainder of the floodplain: the zone between the 2 and 100 year flood recurrence heights. As stated earlier, a prerequisite to the operation of the flood control structure is the regulation of the Ottawa's discharge rates. The extent of the Mille Iles River's floodplains protected by the structure will, therefore, depend upon the flood water storage capacity of the Ottawa River's reservoirs in time of need. Thus, while the lower limit of the protected floodplain is established at 708 m^3/s, the upper limit of the protected floodplain will be variable, depending on the Ottawa River's discharges (B.A.P. 1982:60). In any event, the proponent has stated in the impact study that the structure is not designed to control flows exceeding the 100 year flood recurrence height, because such measures would cause excessive flood damages upstream along Lake of Two Mountains, Lake St. Louis and the des Prairies river.

The proponent views the control of the Ottawa River's discharge rates as a crucial factor in the control of flooding along the Mille Iles River. Without a reciprocal control of flood waters along the Ottawa, the operation of the Mille Iles

River dam would result in flood damages upstream. However, it must be emphasized that due to unforseen circumstances flood water storage along the Ottawa is not always possible and may indeed be the result of conflicting interests. For example, along the Ottawa River reservoirs store water for 52 hydro-electric stations. Approximately 42% of the storage capacity belongs to Environment Quebec, 19% to Hydro-Quebec, 12% to Hydro-Ontario and 23% to Public Works Canada. Thus, conflicts may arise between flood water storage and hydro-electricity production. If the reduction of the flood peak is the sole objective, the reservoirs should be emptied prior to the onset of the flood period so as to maximize the volume of the flood water storage. On the other hand, if hydro-electricity production is also an objective reservoirs must maintain a certain head of water essential for the production of electricity.

In addition, the structure's effectiveness at reducing the frequency and magnitude of floods is uncertain. The proponent claims that regardless of the Ottawa's peak discharge, the flood control dam will reduce by 10%, 90% of the floods along the river (B.A.P. 1982:58). During the public audience, the proponent's data and calculations were subject to severe criticism. In the commission's opinion a reduction of 5.4% of the peak flood, 90% of the time is extremely optimistic (B.A.P. 1982:58,64,72,103).

It must also be stressed that, as proposed, the flood control structure does not solve the flood problems related to ice accumulation or ice break up. These problems are common farther down the Mille Iles River, outside the study zone of this research. The flood control structure, may in some cases, aggravate the flood problems due to ice (B.A.P. 1982:61,72).

During the public audience, numerous people expressed concerns over the false sense of security which was being generated amongst both the present and future floodplain inhabitants by the construction of the dam which may encourage further floodplain encroachment.

Indeed, in its environmental impact study (Shawinigan 1982), the proponent identifies 26 vacant lots along the Mille Iles River floodplain which could be reclaimed once the flooding is regulated and eventually turned to residential land uses. Along the north shore, 23 hectares will be made available primarily in the municipalities of Boisbriand and Rosemere. Along the south shore, 200 hectares of land will be gained. Construction plans for residential developments on Iles Locas have already been submitted to the government: 45 single family dwellings and two six story buildings are planned. It is estimated that once the flood waters are regulated, as many as 200 units could be constructed annually along the floodplains (B.A.P. 1982).

Flood damages are also predicted to rise as property values increase once the dam is in operation. Increased rates of conversion of cottage and transition zones into permanent residential area is forseen. For example, it was found that flood victims,

> (...) semble prendre pour acquis qu'à la suite de la mise en place de l'ouvrage, la plupart des résidants moins fréquemment inondés vont embellir leurs maisons. Par conséquent, l'évaluation foncière ainse que la valeur marchande de leur propriété devraient augmenter. Le comité d'inondés de Fabreville a même inscrit en prémisse de son appui au projet d'ouvrage de contrôle, ce qui lui paraissait être une évidence, "Attendu que dans les aires déjà développées, il y aura amélioration des bâtiments et augmentation de la valeur des propriétés..." (B.A.P. 1982:80).

Needless to say, increases in property values ultimately represent a property tax gain for the municipalities. The municipalities estimate a 30% increase in tax revenues. Property values are expected to increase once the dam is in operation. It has been estimated that 20 acres of land could easily increase from an initial value of $500 000 to over $20 000 000 (B.A.P. 1982:80).

Given the probable effectiveness of the structure in controlling the frequency and magnitude of future floods and the lack of land use regulation enforcement, it is doubtfull that flood damages will be reduced in the long-run. In the event of an uncontrollable flood, the flood losses will only be increased.

While the effectiveness of the flood control structure is unsure, there are no doubts that the operation of the structure will have severe environmental repercussions.

The lower waters levels will be an impetus for the construction of dikes and infilling of properties by individuals (B.A.P. 1982:79).

In their environmental impact statement the proponent reveals that 1 100 ha. of floodplain land will be subject to less frequent flooding once the project is in operation (Shawinigan 1981:192). As a result of decreased flood frequencies and heights, the water table in the Mille Iles River area will drop. Because of dryer soil conditions along the upper floodplains a modification of the plant communities is forecasted. The environmental impact statement foresees the replacement of silver maple forests by sugar maple forest over a period of 50 years (Shawinigan 1981:189-201). They foresee a migration down-plain of shore marsh and meadow wetland vegetation. The construction

of the dam over the rapids, changes in the timing of floods, and decreases in the frequency and extent of flooding will have serious repercussions on the habitats of both semi-aquatic and aquatic wildlife species (Shawinigan 1981:197).

The conclusions must therefore be drawn that, presently, the effectiveness of the proposed flood control structure in reducing the flood damage potential and ensuring the rational use of floodplain lands is unclear.

Given the probable effectiveness of the structure in controlling the frequency and magnitude of future floods, the lack of adequate land use regulation, and the false sense of security which the permanent dam is creating, it is doubtful whether the structure, which is only designed to control certain flood levels, will in the short-run reduce flood damage potential. In the long-run, in the event of an uncontrollable flood, damages could be far beyond those experienced if the dam had not been constructed.

5.4 The interaction of the adjustments

While the individual adjustments have been shown to have deficiencies, an examination of the interaction of the four adjustments reveals further factors which prevent the program from being effective in ensuring the reduction of flood damages and the rational use of floodplains.

The matrix of interactions of adjustments to floods (Fig. 1.4) gives some indication of the suitability of the mix of the four measures promoted by the 1976 flood damage reduction

program. According to the matrix, none of the adjustments promoted by the program reinforce or encourage one another.

First, research in the adoption of land use planning measures has revealed that land use measures are discouraged by the adoption of structural solutions but reinforced by the adoption of both flood-warning and flood insurance systems - two adjustments which are not components of the 1976 flood damage reduction program. If land use measures are to be enforced, flood warning and flood insurance policies have to become a part of the floodplain management program. However, the federal government considers the adoption of a flood insurance program which combines flood risk maps, land use and flood insurance policies, to require too heavy government subsidies and a too "complex" administration (Page 1980:418).

Similarly, the adoption of flood-proofing requirements has been shown to be reinforced by flood warning systems, an adjustment which is not considered in the 1976 program.

The adoption of measures which place constraints upon flood relief and rehabilitation are thought to discourage the adoption of flood control and protection works and encourage flood-proofing, land use planning, flood warning systems and insurance programs. While the federal government has undertaken to adopt measures which restrict flood relief, the consequences of the policies are not yet observable. On the other hand, the policies of the provincial government are not clear and may in fact counter the policy of the federal government.

Finally, research into floodplain management has revealed that the adoption of flood control and protection works, such as the Mille Iles River dam, discourages the adoption of any other

adjustment except for an increased reliance upon flood relief measures. Presently, the purpose of the flood control project appears to be to reduce the flood risk so as to permit the construction and renovation of buildings in the flood risk zone. If the objective of the program is to stabilize and reduce the population at risk, the flood control structure should have been promoted and adopted as a temporary adjustment to help in the transition from unsuitable developments to suitable floodplain land uses. White (1975) has noted that the combination of structural solutions and reliance upon relief programs is one of the most common trends in ad hoc urban floodplain management programs.

As the flood damage program stands, all the adjustments discourage one another and reinforce the destruction of riparian resources and the increase in flood damage potential.

The question, therefore, emerges as to why such policies were originally adopted. Speculation points to the following conclusions. The stricter flood relief policy was probably the result of a federal decison to relieve itself of the financial burden of escalating flood damages.

The flood-proofing measures were probably promoted because they are the responsibility of individuals, and thus, are attractive adjustments for the senior levels of government because they do not require large financial expenditures.

The structural solutions, on the other hand, have received a great deal of support from the senior level of government because they are effective on the short-term basis and are regarded as generators of employment. Structural approaches have traditionally been the federal government's favorite approach to

flood problems. Structural solutions to flood problems are also attractive propositions for the provincial government since they are 45% financed by the federal government and for the local municipalities because they do not have to control floodplain encroachment through land use regulations and thus avoid losing or reducing their tax base. Structural solutions are also supported by individuals who stand to gain from reduced flood hazard. Structural adjustments not only tend to increase the values of developed properties, but, in many instances, permit the development of flood prone lands, permitting windfall gains which acrue to speculators.

Finally, land use management measures were probably promoted because research has demonstrated that they are effective long term solutions. A refusal to consider such an approach would reflect badly upon the senior levels of government which had to make an attempt to redress the past mistakes by relying upon structural solutions and financial ad hoc solutions. In addition, the implementation of land use regulations is a local municipal responsibility, which is an attractive proposition for the federal and provincial governments.

5.5 Conclusions

The objectives of a comprehensive floodplain management scheme are to

1) plan for appropriate land uses and maximize the benefits which accrue from them,

2) reduce the traumas and costs resulting from presently constructed ill-suited land uses,

3) prevent the expansion of ill-suited land uses,

4) protect valuable riparian habitats from encroachment.

The past land use trends along the Mille Iles River have resulted in a polarization of developed land uses towards residential developments, undeveloped land uses towards wooded wetlands, the intensification of residential land uses along the upper floodplains, the encroachment of residential developments along the lower floodplains and unequal floodplain development.

A study of the 1976 flood damage reduction program reveals that the adjustments promoted by the program do not attempt to address any of these land use trends. None of the adjustments rectify the polarization of land use process. In fact, the intensification of residential land uses along the upper floodplains is being encouraged by the two-zoned floodplain land use policy. Encroachment of the lower floodplains may be encouraged by the construction of the flood control dam which can generate a false sense of security. The operation of the dam also poses a serious threat to the remaining undisturbed wildlife habitats. Unequal floodplain development is not being corrected. The formation of an additional administrative level, the MRC, may only complicate the management process.

It must therefore be concluded that the 1976 flood reduction solutions will encourage floodplain development and in the long-run result in increased flood damage potential and floodplain degradation.

The structural solution to the flood hazard, namely damming, by regulating natural water level fluctuations and altering the valuable land water transition zones, will 1) encourage floodplain development by engendering a false sense of security, and 2) disturb the riparian habitats whose existence is a direct

result of erratic flood levels.

Following the construction of the dam, the Mille Iles River municipalities forecast a continuation of residential development along the floodplains and foresee increased transformation of cottages into permanent residences, where these conform to flood proofing and lot size requirements.

Decreased water level fluctuations and a lower water table will lead to a recolonisation down plain of riparian vegetation. All wildlife species will suffer a loss in habitat. This will result in increased competition for suitable sites and will apply additional pressures on the remaining sites.

The more environmentally sound solutions, namely flood risk mapping and zoning, have also failed to ensure the protection and rational use of floodplains. The administrative solutions proposed by the federal and provincial governments, such as flood-zoning and land use management, have not been uniformly adopted by the municipalities. However, as discussed, the policies have not been uniformly adopted, and so, floodplain development continues. The flood-proofing requirements encourage property owners to infill their land to raise dwellings above certain heights, thus altering local slope and drainage conditions.

To conclude, the 1976 floodplain management program does not ensure the protection and rational use of floodplain lands. The policies encourage further floodplain degradation and directly threaten the existence of the remaining biologically rich riparian habitats. The policies do not clearly delineate uses which are compatible in the floodplain zones and do not adequately consider the long term impacts of the structural and

non-structural solutions upon the riparian resources. The floodplain management strategy reflects crisis oriented responses such as damming. This illustrates the continuation of the general tendency to view natural floodplain processes as impediments to development and land use, rather than as continued bio-physical processes which enhance the human environment.

To ensure the rational use of riparian lands a floodplain management policy must identify appropriate land uses and the values of remaining riparian habitats. Only through a management scheme comprised of a systematic combination of long- and short-term structural and non-structural measures based on an understanding of human processes such as the nature and effects of encroachment and an understanding of the biophysical elements such as the nature of riparian resources and their management potentials can floodplain management policy become comprehensive.

Chapter 6: Implications, summary and conclusions.

Based on the information presented in the preceeding chapters the purpose of this final section is to discuss the implications of the past and present policies on the future of floodplain management along the Mille Iles River and across Quebec. Five aspects of floodplain management are discussed: 1) the changing mix of adjustments, 2) the financial arrangements, 3) the enforcement of policies, 4) the community differences and 5) the perception of the floodplain environment.

6.1 The implications of the changing mix of adjustments

The review of floodplain management policies in Quebec and along the Mille Iles River has revealed a changing mix of adjustments, from *ad hoc* structural and flood relief adjustments to an increasing awareness of non-structural adjustments such as land use arrangements and flood-proofing measures. Given that there is the need to protect already established settlements and to regulate future developments, it is clear that both short-term structural solutions and long-term land use measures must be coordinated to reduce the flood hazard.

Examples of both structural and non-structural adjustments can be found along the Mille Iles River. However, the construction of a permanent flood control structure at the entrance of the river indicates that structural solutions are going to continue to have a predominant role in floodplain management along the river. Evidence to support the likelihood of this trend is the failure of local municipalities to enforce

land use regulations and the open endorsement of the adoption of structural solutions.

As previously discussed, a major problem associated with the reliance upon structural adjustments is that over time settlements intensify in the hazard zones. Structural approaches to floodplain management often contribute to increased flood hazard potential and to higher flood losses which in turn are used to justify increased reliance upon flood control structures. Indeed, municipalities along the Mille Iles River are considering the possibility of re-zoning their floodplains to permit more development once the dam is operative (B.A.P. 1982). The inevitable conclusion is that eventually a flood of greater magnitude than the design capacity of the dam will occur, resulting in catastrophic damages due to continued and increased occupance of hazardous areas. Continuing emphasis upon physical adjustments represents an acceptance by municipalities that flooding and associated damages will continue in the future as they are one of the costs of residing in areas subject to inundation.

Flood control structures must occupy a niche in floodplain management, but only that. Unless there is a marked change in the mix of adjustments applied to Quebec's floodplains, structural measures will remain the dominant approaches and there will be no overall decrease in flood losses. Measures must be adopted to insure that structural measures do not become ends in themselves.

6.2 The implications of the financial arrangements

A major factor which encourages the adoption and reliance

upon certain measures is the financial arrangements which accompany them. Under the 1976 federal-provincial flood damage reduction program the construction of flood control structures are partially funded by the senior levels of government. Through the agreement the costs of structural measures are spread amongst the municipal, provincial and federal levels of government. In other words, the occupants of the floodplain are not assuming the direct costs of flood protection as taxpayers across Canada each assume a portion of it as well. Conversely, land use measures directly affect hazard zone residents by depriving them of certain rights or by restricting their behavior.

The range of adjustments considered or adopted in a management strategy is considerably affected by the financial arrangements linked to the individual measures. In this manner, financial arrangements lead to the consideration of a narrower range of measures and work against the development of a comprehensive management scheme.

Along the Mille Iles River, past and current financial arrangements are resulting in a disjointed approach to management. The cost-sharing aspects of the financial arrangements for the flood control dam have provided an incentive for the adoption of the structural adjustment. Comparable funds are not available for flood-proofing, land use management, land acquisition, relocation of settlements, flood insurance programs and related non-structural adjustments. Thus, from the view point of a municipality or of a province, the adoption of structural solutions is attractive - the benefits of the project being direct while the costs are spread out beyond those immediately affected by flooding.

It is, therefore, natural that the residents of flood-prone lands should have a tendency to favour structural measures. The implications of such financial arrangements are important. When cost-sharing programs such as the Mille Iles River dam are available it would be an imprudent community leader who does not seek them for his jurisdiction.

A conclusion is evident: an indepth study of cost-sharing adjustment financing is required. As financial arrangements presently stand under the federal-provincial flood damage reduction program, the underlying financial agreements cause a distortion toward the adoption of physical measures. To permit the development of comprehensive floodplain management policies, governments must eliminate the incentives which bias the choice of floodplain management measures. Governments must either stop financing structural measures or start financing land acquisiton programs, land use management, flood warning systems, settlement relocation, flood-proofing and agricultural subsidies for floodplain occupancy so as to balance the incentives.

6.3 The implications of policy enforcement

As the review of land use measures along the Mille Iles River has indicated, one of the major difficulties in using non-structural adjustments to regulate floodplain development is the systematic enforcement of the policies. To be easily adopted and enforced, jurisdictional and administrative complications must be minimized to facilitate policy application. To be effective, land use regulations must be adopted and enforced as early as possible. While there are examples of regulations being adopted and enforced, there are numerous examples of omissions

and violations.

In the past administrative arrangements for dealing with floodplain management were highly fragmented. Since the 1976 joint agreements and the development of a regional level of land use management (MRC's) the administrative arrangements for dealing with floodplain management have been further complicated. Presently, no individual agency or single level of government has at its disposition a wide range of measures for floodplain management.

In Quebec, little hope exists for the development of an administrative body which oversees all aspects of the management and exploitation of the entire floodplain environment. In the words of Bernard Harvey (1976:208),

> ... la concentration du pouvoir de décision quant à l'utilisation des ressources à l'interieur d'un organisme ou d'une institution semble peu probable. Les intervenants, qu'ils soient gestionnaires gouvernementaux, utilisateur industriels où même utilisateurs individuels, sont conscients de leur besoins et de leurs droits en rapport avec l'utilisation des ressources. C'est ainsi que l'on voit certaines administrations surveiller jalousement leurs juridictions et même exiger davantage de pouvoir. L'on assiste aussi à la prise en charge par certains ministères gouvernementaux, provinciaux ou fédéraux, de certaines responsabilités assumés jusqu'ici au niveau local et même par des particuliers. C'est le cas notamment de la protection contre les inondations et de l'aménagement des berges et des cours d'eau. Les tentatives d'occupation de secteurs nouveaux d'activité par des organismes public et para-public donnent lieu à des luttes de juridiction qui ne sont pas sans retarder le processus de rationalisation de la gestion de l'eau au Québec.

It can, therefore, be concluded that a reduction in the administrative and institutional obstacles presented by the agencies does not appear to be a priority objective of the governments involved in floodplain management.

6.4 The implications of community differences

Municipal differences in floodplain development patterns emphasize that the communities have different perceptions, goals and attitudes toward hazard zone land use. The attitudes and responses to floodplain management should be taken into account when developing and enforcing a management strategy. A standardized approach to floodplain management, such as the 1976 federal-provincial flood damage reduction program, may not be as appropriate and effective an approach as one which recognizes the discrepancies. The differences in attitudes also emphasizes the importance of improving communication between the levels of of government and the communities.

6.5 The implications of the perception of the floodplain environment

To date in Quebec's development of floodplain management policies and programs, the riparian ecosystem has not been understood and recognized as a management unit. Because of a lack of understanding and through the fragmentation of jurisdictional responsibilities the floodplain ecosystem has been divided into "shoreline" and "foreshore" spaces. Control over the use and development of these zones has gone to provincial, regional, municipal and para-public levels of government. The activities which effect the riparian environment have been uncoordinated. Consequently, the governments have managed their resources indepently, pursuing the actions which maximized their benefits instead of attempting to ensure the comprehensive management of the entire riparian ecosystem.

To develop a comprehensive floodplain management policy the

artificial political boundaries imposed upon floodplain ecosystems, which hinder co-ordinated strategies, must be abolished and the riparian ecosystem must be recognized as a viable management unit. Agencies involved in floodplain management must develop an understanding of the resources being managed and their interrelationships.

6.6 Summary and conclusions

Over the years, floodplain management policies along the Mille Iles River and across Quebec have slowly evolved from *ad hoc* structural approaches to a flood damage reduction policy which attempts to integrate a wider range of structural and non-structural arrangements. Given the past prejudices and present financial arrangements structural measures remain and are likely to remain the dominant approaches to floodplain management. Nonetheless, though the present policies and arrangements are subject to criticisms they provide hope for future improvements in floodplain management.

Today, institutional barriers stand in the way of progress. The federal levels of government, if it is to effectively decrease flood damage potential and insure the wise use of riparian lands, must encourage social and behavioral research into floodplain management. Hindsight evaluation programs on floodplain management schemes must be developed to improve present strategies. Future research must focus upon the interactions of structural and non-structural adjustments, the optimum combinations of short- and long- term measures and on the means of eliminating the biases which encourage the adoption of

expedient short-term solutions.

Riparian ecosystems are valuable resources which enhance the quality of everyday life. As natural systems they condition and are conditioned by regional growth and urbanization. The quality of a region's natural resources influence the development of an area and its ability to provide a safe, healthy and pleasant environment for life. Any meaningful effort to guide development must recognize the existence of a limited resource base which development must accomodate if environmental problems are to be minimized.

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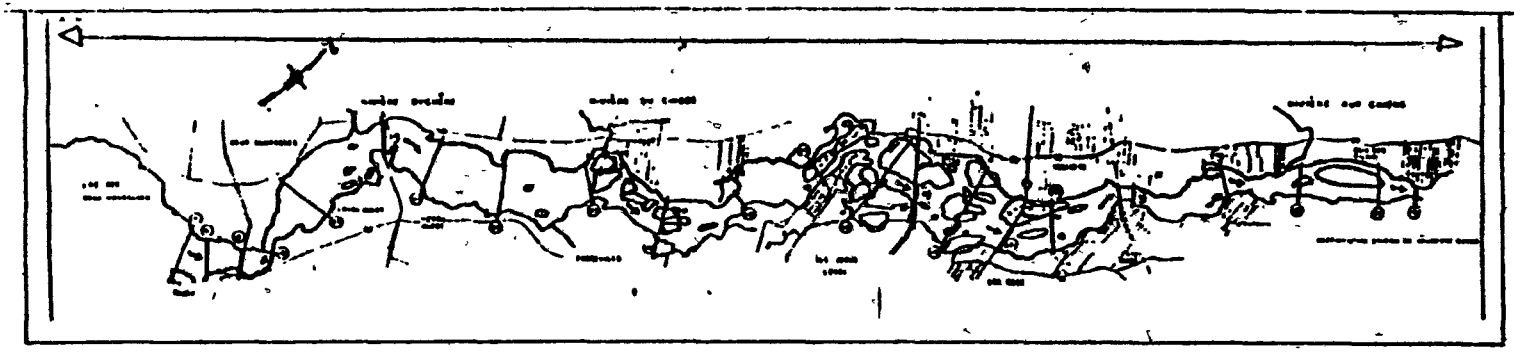
Appendix I

Study zone

(Source: Inland Waters Directorate, Dept. of Fisheries and Environment Canada and by the Surveys and mapping branch of the Dept. of Energy, Mines and Resources, Ottawa, 1977; maps 31H 12-0100-0101. 0102, 0201, 0202, 0302, Scale 1 : 10 000)

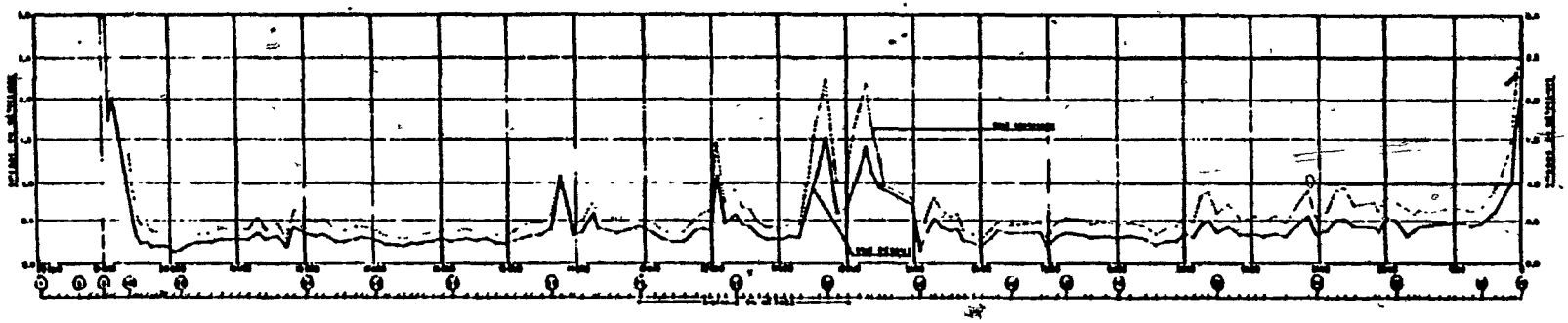
Appendix II

Hydrodynamic zones and discharge trends

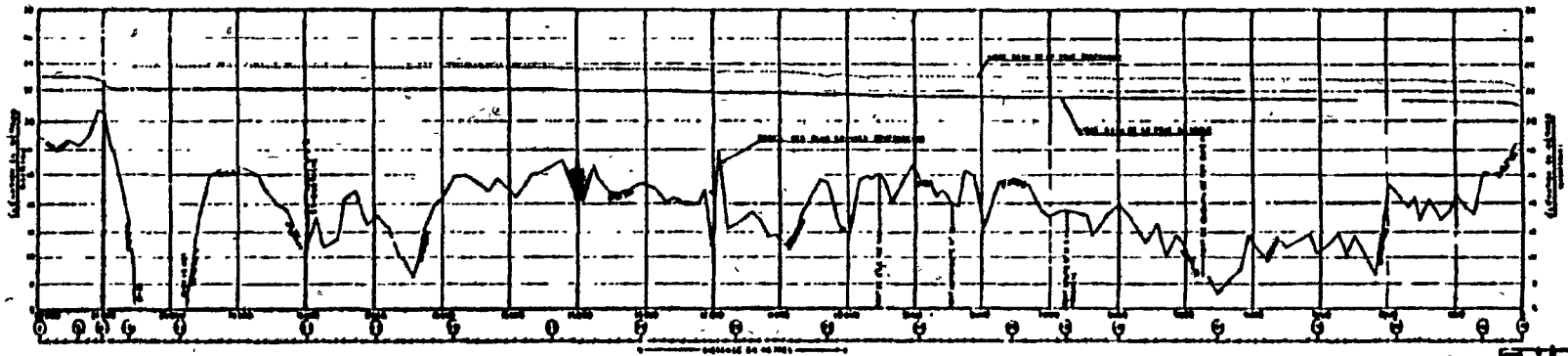


LÉGENDE

VUE EN PLAN DE LA RIVIÈRE DES MILLE ÎLES



PROFILS DES VITESSES



PROFIL LONGITUDINAL

SHAWINIGAN

3

(Source: Shawinigan 1981)

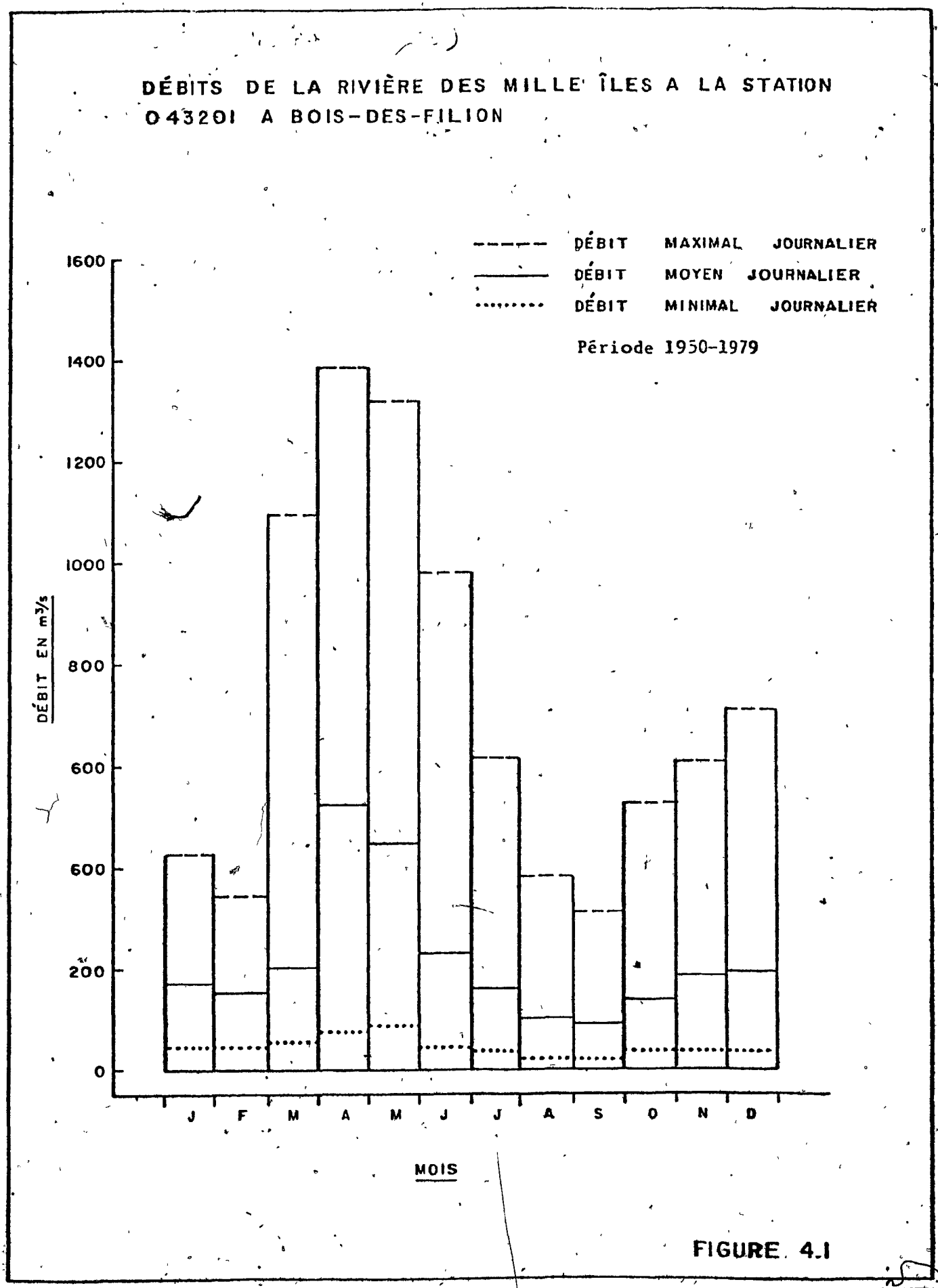


FIGURE 4.1

Appendix III

Mille Iles River: list of fish species and spawning habitats.

(Source: Shawinigan 1981)

TABLEAU 6.7* Inventaire ichtyologique dans le secteur de l'étude.

ESPECES	SECTEUR D'ETUDE		Fraie	Sp.rencontrées dans le Rapide du Grand Moulin	ESPECES	SECTEUR D'ETUDE		Frai	Sp.rencontrées dans le Rapide du Grand Moulin
	Lac des Deux Montagnes	Riv. des Mille Iles				Lac des Deux Montagnes	Riv. des Mille Iles		
1. Lamproie argentée *(Ichthomyzon unicuspis)*	1	-	R	2	13. Umbre de vase *(Umbra limi)*	-	1	C	2
2. Esturgeon de lac *(Acipenser fluvescens)*	1	1'	R	1	14. Grand brochet *(Esox lucius)*	1	1	C	1
3. Lépisosté osseux *(Lepisosteus osseus)*	1	1	C	2	15. Maskinongé *(Esox masquinongy)*	1	-	C	2
4. Poissons-castor *(Amia calva)*	1	1	C	2	16. Couette *(Carpiodes cyprinus)*	1	-	C	2
5. Laquaiche argentée *(Hiodon tergisus)*	1	1	R	1	17. Suceur rouge *(Moxostoma macrolepidotum)*	1	1	R	1
6. Alosa sapidissima *(Alosa sapidissima)*	1	-	R	1	18. Suceur blanc *(Moxostoma anisurum)*	1	1	R	1
7. Gaspareau *(Alosa pneusoharengus)*	1	-	R	2	19. Suceur jaune *(Moxostoma valenciennesi)*	1	1	R	1
8. Alose à gésier *(Dorosoma cepedianum)*	1	1	R	2	20. Suceur cuivre *(Moxostoma hubbsi)*	-	1	R	1
9. Grand coregone *(Coregonus clupeaformis)*	-	3	C	1	21. Meunier noir *(Catostomus commersoni)*	1	1	R	1
10. Truite arc-en-ciel *(Salmo gairdneri)*	2	2	R	1	22. Meunier rouge *(Catostomus catostomus)*	1	1	R	1
11. Truite brune *(Salmo trutta)*	2	2	R	2	13. Carpe *(Cyprinus carpio)*	1	1	C	2
12. Eperlan arc-en-ciel *(Osmerus mordax)*	-	1	R	1	24. Chatte *(Notemigonus crysoleucas)*	1	1	C	1

* Voir légende à la fin du tableau

TABLEAU 6.7 * - Inventaire ichtyologique dans le secteur de l'étude. (suite...)

ESPECES	SECTEUR D'ETUDE		Frai	Sp.rencontrées dans le Rapide du Grand Moulin
	Lac des Deux Montagnes	Riv. des Mille Iles		
25. Ouitouche *(Semotilus corporalis)*	1	1	C	2
26. Mulet à cornes *(Semotilus atromaculatus)*	1	-	C	2
27. Naseux des rapides *(Rhinichthys cataractae)*	1	1	R	2
28. Bec-de-lièvre *(Exoglossum maxillingua)*	1	1	R	2
29. Méné émeraude *(Notropis atherinoides)*	1	1	-	1
30. Tête rose *(Notropis rubellus)*	1	-	R	2
31. Méné à nageoires rouges *(Notropis cornutus)*	1	1	R	2
32. Queue à tâche noire *(Notropis hudsonius)*	1	1	C	2
33. Menton noir *(Notropis heterodon)*	1	-	C	2
34. Méné bleu *(Notropis spilopterus)*	1	1	R	2
35. Méné paille *(Notropis stramineus)*	1	1	R	2
36. Méné pâle *(Notropis volucellus)*	1	1	R	2
37. Museau noir *(Notropis heterolepis)*	1	1	C	2
38. Méné d'herbe *(Notropis bifrenatus)*	1	1	C	2
39. Méné d'argent *(Hybognathus nuchalis)*	1	1	C	1
40. Tête-de-boule *(Pimephales promelas)*	1	1	C	2
41. Ventre-pourri *(Pimephales notatus)*	1	1	C	2
42. Barbue de rivière *(Ictalurus punctatus)*	1	1	R	1
43. Barbotte brune *(Ictalurus nebulosus)*	1	1	C	1
44. Barbotte des rapides *(Noturus flavus)*	1	-	R	2
45. Anguille d'Amérique *(Anguilla rostrata)*	1	1	C	1
46. Lotte *(Lotta lotta)*	1	3	R	1
47. Fondulé barré *(Fondulus diaphanus)*	1	1	C	2
48. Omisco *(Percopsis omiscomaycus)*	1	1	R	2

* Voir légende à la fin du tableau.

TABLEAU 6.7 * – Inventaire ichtyologique dans le secteur de l'étude.

ESPECES	SECTEUR D'ETUDE		Frai	Sp. rencontrées dans le Rapide du Grand Moulin	ESPECES	SECTEUR D'ETUDE		Frai	Sp. rencontrées dans le Rapide du Grand Moulin
	Lac des Deux Montagnes	Riv. des Mille Iles				Lac des Deux Montagnes	Riv. des Mille Iles		
49. Bar perche *(Morone americana)*	1	–	C	2	58. Perchaude *(Perca flavescens)*	1	1	C	1
50. Achigan à petite bouche *(Micropterus dolomieui)*	1	1	R	1	59. Fouille-roche *(Percina cuprodes)*	1	1	C	2
51. Achigan à grande bouche *(Micropterus salmoides)*	1	–	C	2	60. Raseux-de-terre *(Etheostoma nirum)*	1	1	R	2
52. Crapet-soleil *(Lepomis gibbosus)*	1	1	C	1	61. Dard à ventre jaune *(Etheostoma exile)*	–	1	C	2
53. Crapet à longues oreilles *(Lepomis megalotis)*	1	–	C	2	62. Dard barré *(Etheostoma flabellare)*	1	1	C	2
54. Crapet de roche *(Ambloplites rupestris)*	1	1	C	1	63. Malachigan *(Aplodinotus grunniens)*	1	–	C	2
55. Marigane noire *(Pomoxis nigromaculatus)*	1	1	C	2	64. Chabot tacheté *(Cottus bairdi)*	1	–	R	2
56. Doré noire *(Stizostedion canadense)*	1	1	R	1	65. Chabot visqueux *(Cottus cognatus)*	–	3	R	1
57. Doré jaune *(Stizostedion vitreum)*	1	1	R	1	66. Crayon d'argent *(Labidesthes sicculus)*	–	1	C	2

LEGENDE DU TABLEAU:

Secteur de l'étude

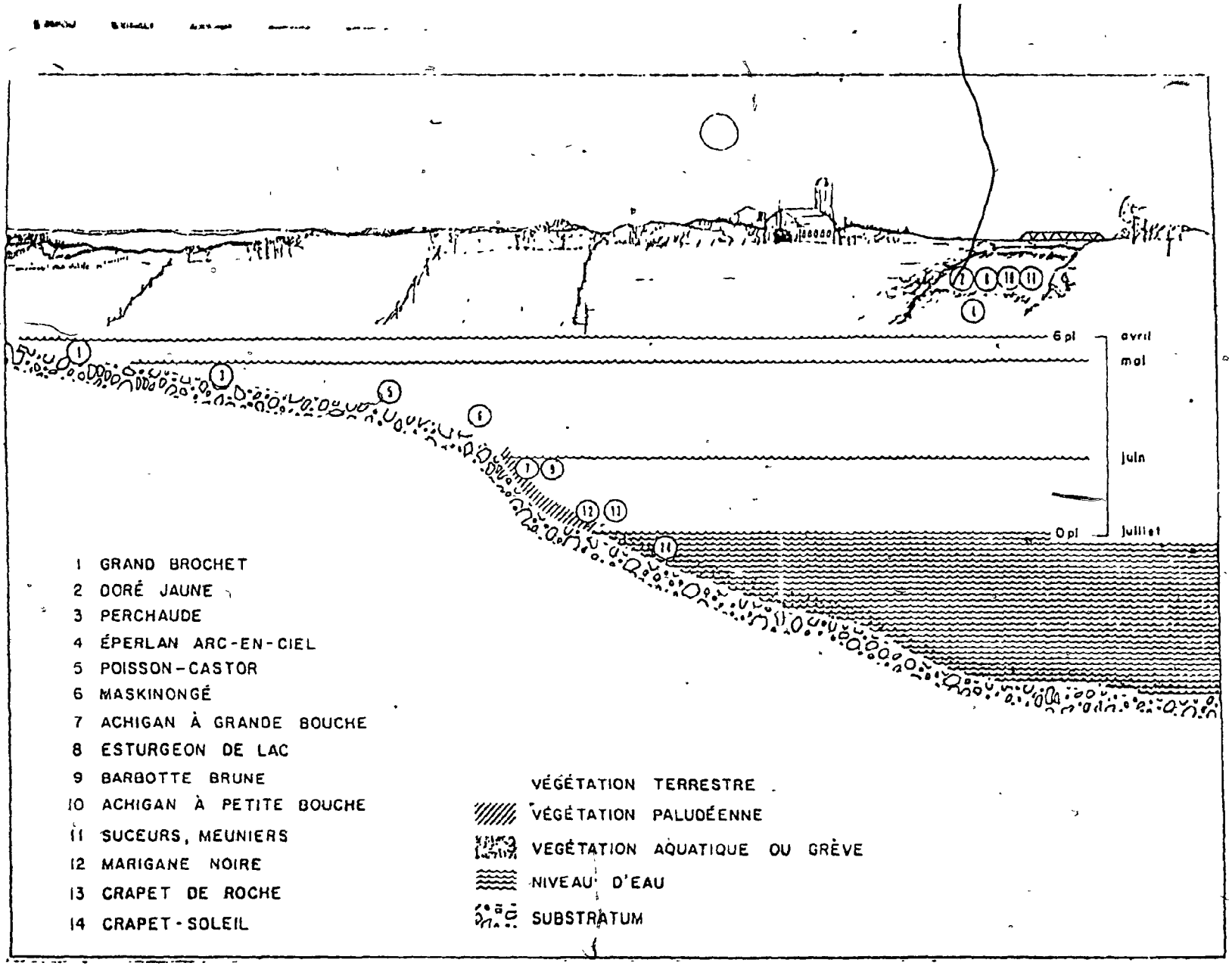
1. D'après Mongeau et Massé, 1976
2. D'après Mongeau, Letendre, Leclerc et Brisebois, 1977
3. Nouvelle espèce recensée au cours de la présente étude

Frai

R. Frai en eau courante
C. Frai en eau calme

Espèces rencontrées dans le Rapide du Grand Moulin

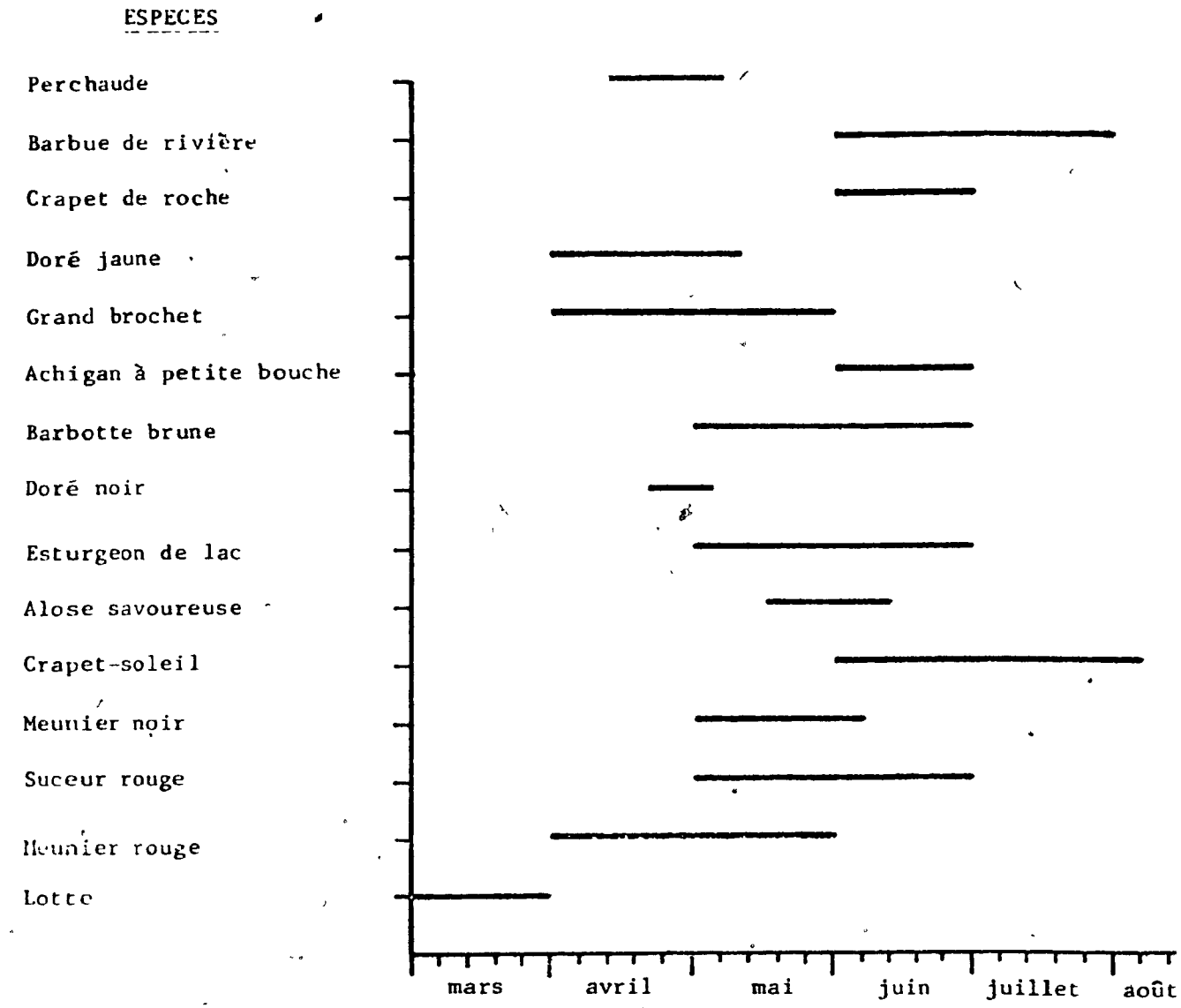
1. oui
2. non



(Source: Baribeau, Lanouette et Tessier 1981)

Fig. 9 Lieux et périodes de fraye des principales espèces de poissons sportifs du couloir fluvial, entre Montréal et le lac Saint-Pierre. (Tirée de Massé, 1974)

(Source: Shawinigan 1981)



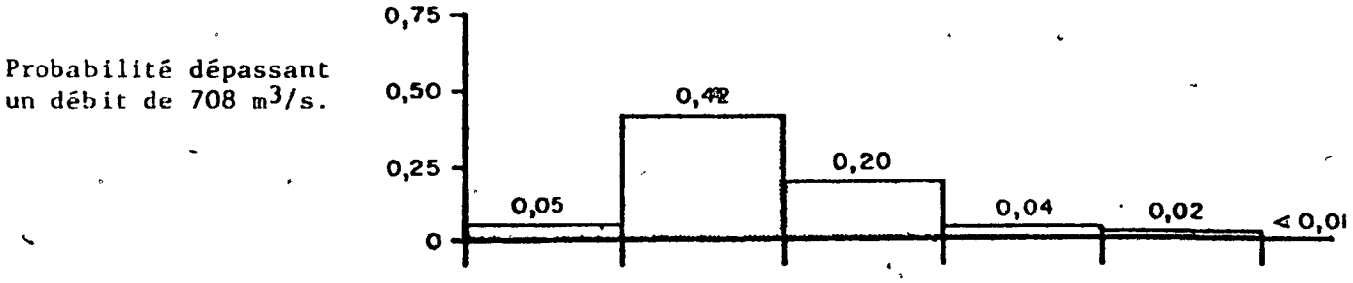


FIGURE 6.7 Probabilité des crues dépassant 708 m^3/s par rapport aux période de fraie des différentes espèces de poissons (d'après tableau 4.2).

Appendix IV

List of provincial agencies with powers to intervene in floodplain development

x - exploitation
0 - control

Tableau 6.1 : Juridictions des intervenants concernant les empiétements

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
A) NIVEAU FEDERAL	Propriétés havres (Québec, Trois-Rivières, Montréal)	x	Acte de l'Amérique du Nord Britannique (1867, Imp. 30-31 Vict., ch. 3) - article 108, annexe 3
	Iles (couloir fluvial)	x	Acquisition de gré à gré
Cabinet des ministres (... Gouverneur en Conseil)	Δ	Δ	Δ
Ministère des transports	Protection des eaux navigables contre ouvrages et gestes pouvant nuire à la navigation	o	- Loi sur la protection des eaux navigables (S.R.C. 1970, ch. no-19) Articles 5, 19, 20
	Pouvoir d'acheter, de louer, d'exproprier ou d'acquérir autrement des terrains riverains pour des aménagements portuaires	x	- Loi sur les commissions de port (S.R.C. 1970, ch. H-1) Articles 3, 10, 11, 12, 13, 19
	Pouvoir de réglementer les travaux dans les limites du port	o	
	Contrôle et gestion des quais et jetées autres que ceux du Conseil des ports nationaux	o	- Loi sur les ports et jetées de l'Etat (S.R.C. 1970, ch. G-9) Articles 4, 7, 11
	Travaux d'entretien et de réparations sur les ports, jetées et brise-lames	x	- Article 5
	Création de ports publics; agrandissement ou diminution de l'aire de tout port public	x	- Loi sur la marine marchande du Canada (S.R.C. 1970, ch. S-9) Article 590

(Source: Delisle, Descôteaux et Denis 1977)

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
✓ Ministère des travaux publics	Constructions sur les berges, remplissage pour un ouvrage public	x	- Loi sur l'expropriation (S.R C. 1970, ch. 16, 1er supp.) Article 37
	Gestion des barrages, havres, chemins, ponts et édifices canadiens et tous autres biens employés à l'amélioration de la navigation	x	- Loi sur les travaux publics (S.R C. 1970, ch. P-38) Articles 9, 12, 20
	Creusage, dragage et modification du lit; construction d'ouvrages aux fins de la navigation	x	- Article 37
	Construction, réparations majeures et autres travaux connexes relatifs aux ports, jetées et brise-lames	x	- Loi sur les ports et jetées de l'Etat (S R.C. 1970, ch. G-9) Article 5
✓ Ministère des pêches ~~et de l'environnement~~	Réglementation des installations de pêche dans les cours d'eau	o	- Loi sur les pêcheries (S.R.C. 1970, ch. F-14) Article 24
✓	Délimitation, contrôle et mise en valeur de zones fauniques	o	- Loi sur la Convention concernant les oiseaux migrateurs (S.R.C. 1970, ch. M-12) Article 4
	Gestion, administration et surveillance des terres acquises (... de gré à gré ou autrement) aux fins de la protection de la faune	o	- Loi sur la faune du Canada (S.C. 1973, ch. 21) Articles 3, 4, 10

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
B) NIVEAU PROVINCIAL			
Lieutenant-gouverneur en Conseil (... Conseil des ministres)	Approbation de tout plan directeur d'aménagement impliquant le lit et les rives du fleuve, des rivières, des lacs et de la mer;	o	Règlement d'application de l'article 2 de la Loi du régime des eaux (A.C. 1792-76 du 19.05.1976, (1976) G.D. II, 3445) - Article 2
	Pour la période s'étendant du 16 mars 1916 au 4 décembre 1974, autorisation de toute aliénation ou bail du lit et des rives du fleuve, des rivières et lacs navigables et flottables, et de la mer;	ox	- Loi du régime des eaux (S.R.Q. 1964, ch. 84) Article 2
	Décision, ou autorisation selon le cas, de toute expropriation, aux conditions qu'il détermine;	o x	- Loi de l'exoropriation (L.Q. 1973, ch. 38) Article 35
	Autorisation de toute imposition de réserves pour fins publiques;	o	- Loi de l'expropriation (L.Q. 1973, ch. 38) Articles 74 et 35
	Peut, seul, déclarer un territoire ou partie de territoire arrondissement historique ou arrondissement naturel;	x	- Loi sur les biens culturels (L.Q. 1972, ch. 19) Article 45
	Concession de forces hydrauliques faisant partie du domaine public (... aux municipalités, aux coopératives d'électricité et à l'Hydro-Québec);	x	- Loi du régime des eaux (S.R.Q. 1964, ch. 84) Article 3
	Concession directe et gratuite des terres publiques, pour fins notamment de quais ou jetées; (N.B. "terres publiques" comprend les parties de lit du fleuve Saint-Laurent qui appartiennent au Québec par droit de souveraineté)	x	- Loi des terres et forêts (S.R.Q. 1964, ch. 92) Article 4 - 20 Article 6 alinéa 2

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
	Autorisation et de l'emplacement et des plans et devis pour la construction de canaux, écluses, murs, chaussées, digues et autres travaux semblables dans les cours d'eaux, devant servir au fonctionnement d'usines, moulins, manufactures et machines lorsque ces ouvrages affectent la propriété publique ou celle des tiers, ou des droits publics ou privés;	ox	- Loi du régime des eaux (S R Q. 1964, ch. 84) Article 6
	Autorisation préalable des plans et devis relatifs à la construction et au maintien de tout barrage, digue, chaussée, écluse, mur et autres ouvrages destinés à retenir les eaux;	o	- Loi du régime des eaux (S.R.Q. 1964, ch. 84) Articles 71 et s.
	Réservation et appropriation de terres de la Couronne (... dont le lit du fleuve) pour des fins publiques, comme des sites de quais, jetées, jardins publics ou parcs, des bassins de sédimentation des eaux vannées, etc...	o	- Loi des terres et forêts (S.R.Q. 1964, ch. 92) Articles 20, 21
	Création de réserves écologiques sur tout territoire public;	o	- Loi sur les réserves écologiques (L.Q. 1974, ch. 29) Article 2
	Autorisation de construire des routes et des ponts;	o	- Loi de la voirie (S.R.Q. 1964, ch. 133) Article 16
	Ordonner l'étude de tout projet d'autoroutes, la préparation de plans et devis de tout projet d'autoroutes, et la construction d'autoroutes;	ox	- Loi des autoroutes (S.R.Q. 1964, ch. 134) Article 15

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
Ministère des richesses naturelles	Concession des lits et rives du fleuve (domaine public) par vente, location ou permis d'occupation	o	- Loi du régime des eaux (S.R.Q. 1964, ch. 84) Article 2
	Elaboration de plans de mise en valeur des ressources	o	- Loi du ministère des richesses naturelles (S.R.Q. 1964, ch. 83) Article 2
	Réalisation de travaux et ouvrages (protection contre les inondations, l'érosion et les glissements de terrain) en milieu hydrique	x	- Article 2
	Extraction de graviers sur les terres de la Couronne	x	- Loi des mines (L.Q. 1965, ch. 34) Article 129
- (Parlement)	Autorisation législative des concession de force hydraulique faisant partie du domaine public, de plus de 300 chevaux au débit ordinaire de 6 mois	o	- Loi du régime des eaux (S.R.Q. 1964, ch. 84) Article 3
Ministère des terres et forêts	Concession des terres publiques par vente, location ou permis d'occupation (et aussi révocation)	o	- Loi des terres et forêts (S.R.Q. 1964, ch. 92) Articles 20, 41, 42
	Réservation des terres de la Couronne pour des fins publiques (quais, jetées, parcs, jardins publics, rampes de lancement)	ox	- Loi des terres et forêts (S.R.Q. 1964, ch. 92) Articles 20, 41, 42
	Application de la réserve des trois chaînes (Disposition en propriétaire du lit et des berges des cours d'eau)	o	
	Aménagement et conservation des terres publiques	ox	- Loi du ministère des terres et forêts (L.Q. 1974, ch. 26) Article 3

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
	Constitution et gestion de réserves écologiques sur des terres publiques	o	- Loi sur les réserves écologiques (L.Q. 1974, ch. 29)
	Conjointement avec le ministère des richesses naturelles, gestion des aspects fonciers du milieu hydrique dans le domaine public	o	- Loi du régime des eaux (S.R.Q. 1964, ch. 84) Article 2
Ministère des transports	Construction, réparation et entretien des routes et ponts et pouvoir d'exproprier pour ces fins	x	- Loi du ministère des transports (L.Q. 1972, ch. 54) Article 3
	Amélioration des systèmes de transports	x	- Loi des transports (L.Q. 1972, ch. 55) Article 3
	Construction et réparation des voies de circulation et acquisition des immeubles et servitudes (par achat ou expropriation); déterminer la largeur, le profil, le niveau, les matériaux et le mode de construction des routes, ponts, chaussées, remblais, murs de protection, détourner ou changer les cours d'eau traversant ou longeant une route, etc.; drainage des routes et ponts	x	- Loi de la voirie (S.R.Q. 1964, ch. 133) Articles 16, 21, 23, 48, 77, 78, 79, 91
	Approbation de tous plans et devis pour la construction d'autoroutes et autorisation d'acquérir les immeubles et autres droits réels nécessaires	x	- Loi des autoroutes (S.R.Q. 1964, ch. 134) Articles 16, 17
	Transport entre les deux rives du fleuve, aménagement des installations utiles et acquisition (achat ou expropriation) de tous les immeubles nécessaires	x	- Loi de la Société des traversiers du Québec (L.Q. 1971, ch. 65) Articles 3, 16

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
	Autorisation de construction et d'entretien de voies ferrées à travers, le long ou sur les cours d'eau, ainsi que l'érection des quais nécessaires et utiles	ox	- Loi des chemins de fer (S.R.Q. 1964, ch. 290) Article 9
Ministère des affaires culturelles	Désignation d'arrondissements historiques ou naturels et réglementation des travaux, ouvrages, projets et activités dans des zones (... études d'impact)	o	- Loi sur les biens culturels (L.Q. 1972, ch. 19) Articles 1, 45
~~Ministère du tourisme,~~ de la chasse et de la pêche	Gestion de la pêche et de la chasse	x	- Loi du ministère du tourisme, de la chasse et de la pêche (S.R.Q. 1964, ch. 199) Article 2
	Etablissement de terrains pour la récréation et le tourisme (camping, pique-nique)	o	
	Etablissement de réserves de chasse et pêche et réglementation des activités dans des réserves (sanctuaires d'oiseaux, frayères à poissons)	o	- Loi de la conservation de la faune (L.Q. 1969, ch. 58) Article 77
Office de planification et de développement du Québec (OPDQ)	Préparation de plans d'aménagement du territoire et coordination de l'exécution de ces plans (ex. couloir fluvial)	o	- Loi de l'O.P.D.Q. (L.Q. 1968, ch. 14) Article 2
~~Services de protection~~ de l'environnement	Approbation de tout plan directeur d'aménagement impliquant le lit et les rives du fleuve	o	- Règlement d'application de l'article 2 de la Loi du régime des eaux (A.C. 1792-76 du 19.05.1976, (1976) G.O. II, 3445) Article 2

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
	Intervention pour la préservation de la qualité de l'environnement (interdiction de travaux, et plans d'aqueduc et d'égoût)	o	- Loi de la qualité de l'environnement (L.Q. 1972, ch. 49) Articles 2 et s.
	Etablissement de réserves pour fins expérimentales	o	- Loi de l'expropriation (L.Q. 1973, ch.38) Article 74 - Loi de la qualité de l'environnement (L.Q. 1972, ch. 49) Article 2 (e)
Ministère de l'agriculture	Subventions aux corporations municipales pour l'exécution de travaux de drainage et exécution de tels travaux	x	- Loi du ministère de l'agriculture (S.R.Q 1964, ch.101) Articles 2 - 27
	Prêts pour la réalisation de travaux de drainage	x	- Loi du crédit agricole (S.R.Q. 1964, ch. 108) Article 45 - Règlement concernant la Loi du crédit agricole (A.C. 2782 du 20.09.1972 (1972) G.O., II, 8962)
Ministère des affaires municipales	Application de la Loi de la Société d'habitation du Québec	o	- Loi de la Société d'habitation de Québec (L.Q 1967, ch. 55) Article 79
	Administration et mise à exécution des lois municipales, notamment la Loi des cités et villes et le Code municipal (... surveillance et assistance des municipalités)	o	- Loi du ministère des affaires municipales (S.R.Q. 1964, ch. 169) Article 2
C) NIVEAU MUNICIPAL			
Municipalités	Pleine juridiction sur les cours d'eau qui les bornent jusqu'au milieu de ce cours d'eau. Réglementation d'urbanisme (zonage, construction, lotissement); plan directeur d'aménagement	o	- Code municipal - Article 16 (1); 392 et s.

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
	Pouvoir d'exproprier pour des fins municipales (parcs, espaces verts, bases plein-air, terrains de jeux, etc...)	o	- Article 787
	Pleine juridiction dans les limites de leur territoire (plan directeur, zonage, parcs, terrains de jeu). Police et protection des cours d'eau qui les bornent	o	- Loi des cités et villes (S.R.Q. 1964, ch. 193) Articles 426, 429
	Construction d'ouvrages en cours d'eau (quais, jetées, murs, etc..) avec autorisations (MRN et MTF) dans le cas du fleuve	x	
	Pouvoirs spéciaux inclus dans la charte (pouvoirs supplémentaires et dérogatoires)	x	- Chartes
Conseils de comté	Juridiction territoriale	o	- Loi de la division territoriale (S.R.Q. 1964, ch. 5) Article 13
	Zonage et élaboration de plans directeurs pour fins de comté (en particulier dans le cas de cours d'eau dans le territoire de comté)	o	- Code municipal - article 422
Communautés urbaines	Elaboration de schémas d'aménagement pour leur territoire	o	- Loi de la communauté urbaine de Québec (L.Q. 1969, ch. 83) - Loi de la communauté urbaine de Montréal (L.Q. 1969, ch. 84)

ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
D) ORGANISMES PUBLICS ET PARAPUBLICS			
Commission hydro-électrique de Québec (Hydro-Québec)	Ouvrages pour la production d'énergie et expropriations à ces fins (droits d'expropriation, d'accès de passage pour production et transport d'énergie)	x	- Loi d'Hydro-Québec (S.R.Q. 1964, ch. 86) Articles 29 et s.
Société Inter-Port de Québec	Aménagement d'un complexe portuaire et industriel et expropriation à ces fins	x	- Loi constituant la société inter-port de Québec (L.Q. 1974, ch. 57) Articles 4, 5
Office des autoroutes du Québec	Préparation des plans et devis, construction, administration et entretien des autoroutes; acquisition de tous immeubles et autres droits réels nécessaires	x	- Loi des autoroutes (S.R.Q. 1964, ch. 134) Articles 15 - 17
Commission municipale du Québec	Tribunal d'appel en matière de protection de l'environnement (... entend les appels d'ordonnance ou de refus d'autorisation du directeur des Services de protection de l'environnement)	x	- Loi de la Commission municipale (S.R.Q. 1964, ch. 170) - Loi de la qualité de l'environnement (L.Q. 1972, ch. 49) Articles 96 et s.
Société d'habitation du Québec	Autorisation, préparation et réalisation le cas échéant, de programmes de rénovation municipale, de désignation de zones, de programmes de dégagement de terrains, d'acquisition et d'aménagement de terrains	x	- Loi de la Société d'habitation du Québec (L.Q. 1967, ch. 55) Articles 27 et s.; 32 et s.; 66-c); 66-1); et 78-a) et b)

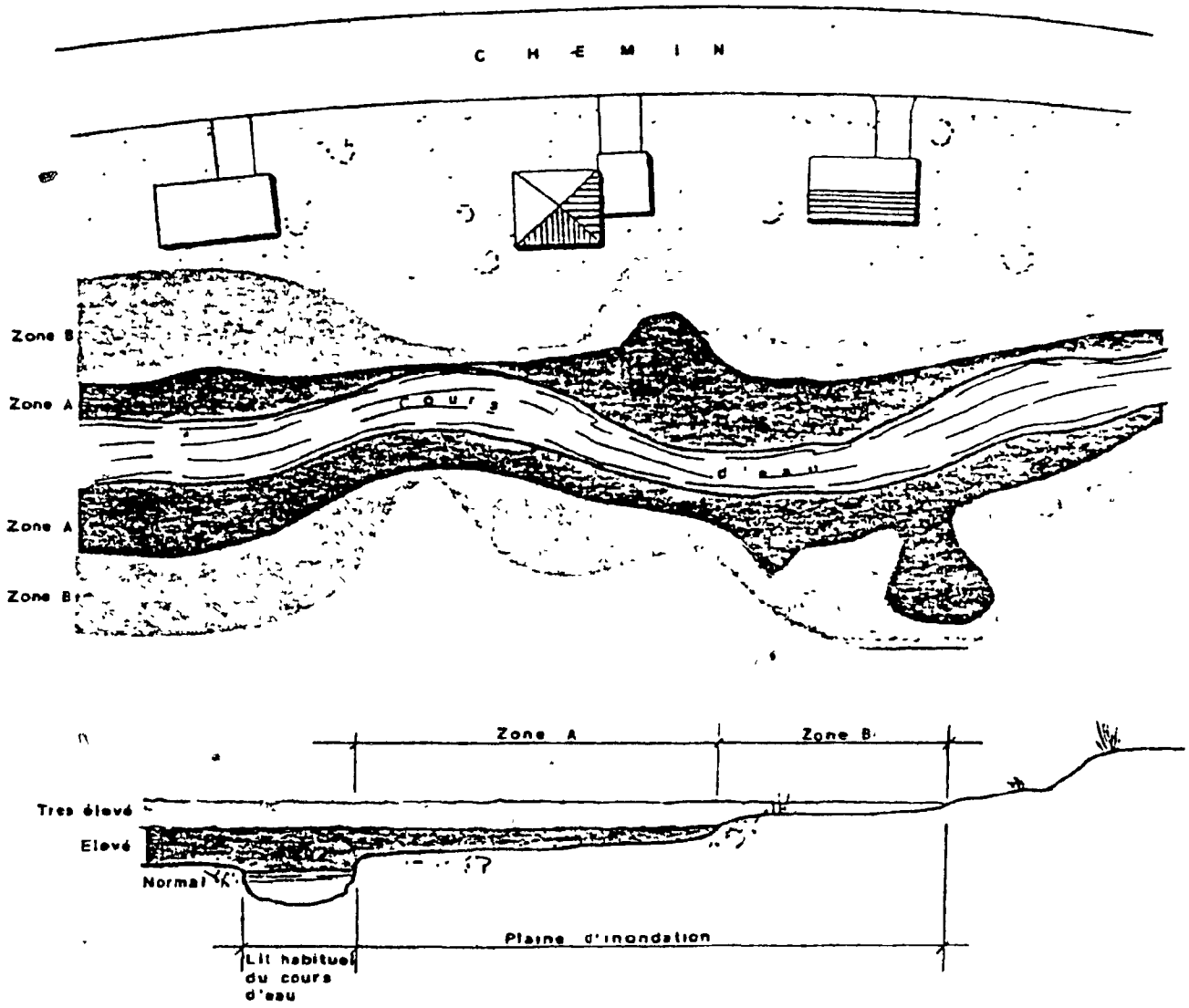
ORGANISMES	JURIDICTIONS	FONCTIONS	LOIS ET ARTICLES
Conseil des ports nationaux	Propriété et administration des ports (Québec, Montréal, Trois-Rivières)	x	- Loi concernant le conseil des ports nationaux (S.R.Q. 1970, ch. N-8) Articles 7, 10, 11, 12, 14
	Etablissement d'une ligne de démarcation sur la rive	x	
	Construction de quais et autres installations portuaires et acquisition (achat, expropriation) des terrains nécessaires	x	
Administration de la voie maritime du St-Laurent	Construction, entretien et mise en service d'une voie en eau profonde entre le port de Montréal et le lac Erié, et acquérir les terrains requis pour ces ouvrages (de gré à gré ou par expropriation)	x	- Loi sur l'administration de la voie maritime du Saint-Laurent (S.R.C. 1970, ch. S-1) Articles 4 et s.
E) INDIVIDUS ET INDUSTRIES			
	Construction et aménagement des berges	x	Droits réels (droit de propriété, servitudes, droit d'usage, etc...)
			- Code civil
	Construction et aménagement dans le lit avec autorisation du MRN	x	- Loi du régime des eaux (S.R.Q. 1964, ch. 84)

Appendix V

Provincial two-zoned floodplain land use system, flood-proofing program, laws 54, 55 and 125, and list of municipal land use regulations

Two-zoned floodplain land use system

Croquis 1 Territoire inondable



(Source: Larouche, Min. de l'Environnement 1980)

(Source: Larouche, Min. de l'environnement 1980)

Two-zoned floodplain land use system

Les moyens à employer sont de deux ordres. En premier lieu, on doit préparer une carte indiquant les endroits où le danger d'inondation est grand (zone A)* et ceux où le danger d'inondation est moins grand mais quand même réel (zone B)**. Le ministère de l'Environnement travaille déjà à la préparation de telles cartes et pourra les rendre disponibles aux municipalités à mesure qu'elles seront complétées.

En deuxième lieu vient la réglementation. Les règles suivantes sont proposées:

a) les interdictions:

- aucun puits ou installation septique ne peut être installé dans un territoire sujet à inondation à cause des dangers de contamination;

- dans un territoire où le danger d'inondation est élevé (zone A)* aucun édifice public et aucun bâtiment ne peut être construit;

b) les contraintes particulières:

- les voies de communication doivent être au-dessus de la cote d'inondation;

---

* Zone A: zone généralement délimitée à partir des critères suivantes:
1. période de récurrence d'environ 20 ans,
2. territoire sujet à une inondation soudaine,
3. niveau élevé de l'inondation,
4. autres facteurs circonstanciés.

** Zone B: zone où le danger d'inondation est plus faible que dans la zone A; elle est délimitée, d'un côté, par la limite de la zone A et, de l'autre côté, par la limite du territoire qui serait couvert par une inondation dont la période de récurrence est d'environ 100 ans.

4.2 Objectifs visés

L'objectif d'une intervention sur l'implantation dans les plaines inondables est de minimiser les pertes tant individuelles que collectives, d'épargner à une population insécurité et danger en période d'inondation et d'éviter aussi des situations possibles d'insalubrité en ces mêmes périodes.

4.3 Mesures proposées

	Puits ou installation septique	Réseaux d'égouts	Voies de communication	Construction
Dans un territoire où le danger d'inondation est ELEVE	Aucun	Doivent empêcher le refoulement	Doivent être au-dessus de la cote d'inondation	Aucun édifice public ou bâtiment résidentiel
Dans un territoire où le danger d'inondation est MOINDRE	Aucun	Doivent empêcher le refoulement	Doivent être au-dessus de la cote d'inondation	. Les constructions sous la cote doivent être étanches et sans ouvertures . le rez-de-chaussée doit être au-dessus de la cote

Provincial flood-proofing regulations

Face à ses engagements, la position du Gouvernement du Québec est la suivante:

- DANS LA ZONE DE GRANDS COURANTS, TOUTE CONSTRUCTION DOIT ETRE PROHIBEE;

- DANS LA ZONE DE FAIBLES COURANTS, SEULES LES CONSTRUCTIONS IMMUNISEES PEUVENT ETRE AUTORISEES.

On entend par mesures d'immunisation les restrictions suivantes qui s'appliquent à toutes constructions résidentielles, commerciales ou industrielles:

1°.- aucune ouverture (fenêtre, soupirail, porte d'accès à un garage, etc.) n'est permise sous la cote de la crue dite centenaire;

2°.- dans le cas de constructions sans cave en béton, aucun plancher de rez-de-chaussée ne doit être permis à un niveau inférieur à la cote de la crue dite centenaire;

3°.- toute la surface externe de la partie verticale des fondations située sous la cote dite centenaire doit être couverte d'une membrane hydrofuge à base d'asphalte-caoutchouté d'une épaisseur minimale de 1/16 de pouce;

4°.- le plancher de la fondation doit être construit avec une contre-dalle de base (dalle de propreté) dont la surface aura été recouverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de 1/16 de pouce;

5°.- le béton utilisé pour l'ensemble de la fondation doit avoir un résistance en compression de 3 000 psi à 7 jours et de 4 000 psi à 28 jours; les fondations en bloc de béton (ou l'équivalent) sont prohibées;

6°.- les fondations de béton doivent avoir l'armature nécessaire pour résister à la pression hydrostatique que provoquerait une crue dite centenaire;

7°.- le poids du bâtiment ou de la partie du bâtiment doit être supérieur à la poussée hydrostatique exercée sur lui lors d'une crue;

8°.- le drain principal d'évacuation doit être muni d'un clapet anti-retour;

9°.- chaque construction doit être équipée d'une pompe d'une capacité minimale d'évacuation de 2 000 gallons impérials par heure; (CONSTRUCTION D'EDIFICE 25'X40

10°.- La construction de structures ou de parties de structures situées sous la cote pour un récurrence de 100 ans devra avoir été approuvée par un membre de l'Ordre des Ingénieurs du Québec.

Ces mesures sont la position actuelle du gouvernement du Québec. D'autre modifications peuvent survenir ultérieurement car nous nous interrogeons présentement sur les différentes formes d'immunisation et autres mesures à prévilégier pour diminuer les dommages causés par les inondations.

PIECE 3

NORMES SUGGEREES

CONSTRUCTION ET REALISATION D'OUVRAGES SUR UN LOT SITUE DANS UN TERRITOIRE SUJET A INONDATION

ZONE DE GRANDS COURANTS*

Dans un territoire sujet à inondation et désigné "zone de grands courants", TOUTE CONSTRUCTION DOIT ÊTRE PROHIBÉE.

ZONE DE FAIBLES COURANTS**

Dans un territoire sujet à inondation et désigné "zone de faibles courants", SEULES LES CONSTRUCTIONS IMMUNISÉES PEUVENT ÊTRE AUTORISÉES.

On entend par mesures d'immunisation les restrictions suivantes qui s'appliquent à toutes constructions résidentielles, commerciales ou industrielles.

1°.- aucune ouverture (fenêtre, soupirail, porte d'accès à un garage, etc.) n'est permise sous la cote de la crue dite centenaire;

2°.- dans le cas de construction sans cave en béton, aucun plancher de rez-de-chaussée ne doit être permis à un niveau inférieur à la cote de la crue dite centenaire;

3°.- toute la surface externe de la partie verticale des fondations située sous la cote dite centenaire doit être couverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de 1,6 mm;

4°.- le plancher de la fondation doit être construit avec une contre-dalle de base (dalle de propreté) dont la surface aura été recouverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de 1,6 mm;

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* "Zone de grands courants" signifie la zone qui s'étend depuis le rivage jusqu'à la ligne des eaux de la crue statistiquement susceptible de se reproduire une fois tous les vingt ans, c'est-à-dire celle dont la probabilité annuelle est de 5 pour cent.

** "Zone de faibles courants" signifie la zone qui s'étend depuis la limite de la zone de grands courants jusqu'à la limite des eaux de la crue statistiquement susceptible de se produire une fois à tous les cent ans, c'est-à-dire celle dont la probabilité annuelle est de 1 pour cent.

5°.- le béton utilisé pour l'ensemble de la fondation doit avoir une résistance en compression de 143 k Pa à 7 jours et de 191 k Pa à 28 jours; les fondations en bloc de béton (ou l'équivalent) sont prohibées;

6°.- les fondations de béton doivent avoir l'armature nécessaire pour résister à la pression hydrostatique que provoquerait une crue dite centenaire;

7°.- l'ensemble structure-fondation doit être suffisamment lourd pour résister aux sous-pressions;

8°.- le drain principal d'évacuation doit être muni d'un clapet anti-retour;

9°.- chaque construction doit être équipée d'une pompe d'une capacité minimale d'évacuation de 151 l/min (pour une résidence d'environ 8 m x 13 m);

10°.- la construction de structures ou de parties de structures situées sous la cote pour une récurrence de 100 ans devra avoir été approuvée par un membre de l'Ordre des Ingénieurs du Québec.

PUITS, INSTALLATIONS SEPTIQUES, ÉGOUTS

La construction de puits ou d'installations septiques est interdite dans les zones de grands courants et de faibles courants; tout réseau d'égouts situé dans ces zones doit être conçu de façon à éviter le refoulement en période de crue.

VOIES DE COMMUNICATION

Dans les deux zones précitées, toute voie de communication doit être au-dessus de la cote d'inondation.

Excerpt from amendments to laws 54 and 55
Ministere des Affaires Municipale 1978.

4- LE TERRITOIRE SUJET A INONDATION

11/129b. 1. le conseil peut — > lauss etc

"393a. 1. La corporation de comté peut, par règlement: -> lauss

b) réglementer ou prohiber la division, la subdivision, la construction ou certains ouvrages, compte tenu... des dangers d'inondation....."

4.1 La situation

10/

Si le débordement saisonnier de certains cours d'eau n'a pas empêché des gens de s'établir dans la plaine inondable et ne semblait pas incommoder outre mesure cette population, on observe toutefois depuis un certain temps une augmentation du niveau des crues et aussi une augmentation des réclamations pour dédommagement. Il est sans doute temps d'intervenir pour éviter que d'autres personnes ne s'exposent par négligence ou par ignorance aux risques que représentent les inondations.

Les inondations sont d'abord dues à des causes naturelles mais l'action de l'homme fait de plus en plus sentir son effet. Le déboisement des bassins de drainage et le remplissage du chenal d'écoulement de divers cours d'eau que provoquent certaines formes d'urbanisation ou d'exploitation des ressources sont pour une bonne part responsables de cette augmentation du niveau des crues. On ne peut prévoir de changement important à cette situation bien qu'un contrôle des débits de quelques cours d'eau soit envisagé. La valeur des ouvrages de prévention est d'ailleurs limitée puisqu'il arrive que de tels ouvrages se brisent ou bien ne suffisent pas à la tâche dans des situations vraiment exceptionnelles. L'expérience des Etats-Unis dans le contrôle des inondations démontre justement que les dépenses de prévention et les dommages causés par les inondations croissent parallèlement.

Il y a donc lieu d'intervenir à l'autre extrémité du processus c'est-à-dire en contrôlant l'implantation dans les plaines d'inondation. En somme, il s'agit de prévenir plutôt que de guérir. Toutefois, si des travaux venaient modifier l'étendue du territoire inondable, l'occupation pourra progressivement être ajustée au fil des ans.

Si le débordement saisonnier de certains cours d'eau n'a pas empêché des gens de s'établir dans la plaine inondable et ne semblait pas incommoder outre mesure cette population, on observe toutefois depuis un certain temps une augmentation du niveau des crues et aussi une augmentation des réclamations pour dédommagement. Il est sans doute temps d'intervenir pour éviter que d'autres personnes ne s'exposent par négligence ou par ignorance aux risques que représentent les inondations.

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4.2 Objectifs visés

L'objectif d'une intervention sur l'implantation dans les plaines inondables est de minimiser les pertes tant individuelles que collectives, épargner à une population insécurité et danger en période d'inondation et d'éviter aussi des situations possibles d'insalubrité en ces mêmes périodes.

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4.3 Mesures proposées

- dans tout territoire sujet à inondation:
  - aucun puits ou installation septique
  - les voies doivent être au-dessus de la cote d'inondation
  - les réseaux d'égouts doivent empêcher le refoulement

- dans un territoire où le danger d'inondation est élevé:
  - aucun édifice public ou bâtiment résidentiel

- dans un territoire où le danger d'inondation est moindre:
  - les constructions sous la cote doivent être étanches et sans ouvertures
  - le rez-de-chaussée doit être au-dessus de la cote

Les moyens à employer sont de deux ordres. En premier lieu, on doit préparer une carte indiquant les endroits où le danger d'inondation est grand (zone A) et ceux où le danger d'inondation est moins grand mais quand même réel (zone B). Le ministère des Richesses naturelles travaille déjà à la préparation de telles cartes et pourra les rendre disponibles aux municipalités à mesure qu'elles seront complétées.

En deuxième lieu vient la réglementation. Les règles suivantes sont proposées:

a) les interdictions:

- aucun puits ou installation septique ne peut être installé dans un territoire sujet à inondation à cause des dangers de contamination;

- dans un territoire où le danger d'inondation est élevé (zone A*) aucun édifice public et aucun bâtiment ne peut être construit;

- les réseaux d'égouts doivent empêcher le refoulement

- dans un territoire où le danger d'inondation est élevé:
  - aucun édifice public ou bâtiment résidentiel

- dans un territoire où le danger d'inondation est moindre:
  - les constructions sous la cote doivent être étanches et sans ouvertures
  - le rez-de-chaussée doit être au-dessus de la cote

Les moyens à employer sont de deux ordres. En premier lieu, on doit préparer une carte indiquant les endroits où le danger d'inondation est grand (zone A) et ceux où le danger d'inondation est moins grand mais quand même réel (zone B). Le ministère des Richesses naturelles travaille déjà à la préparation de telles cartes et pourra les rendre disponibles aux municipalités à mesure qu'elles seront complétées.

En deuxième lieu vient la réglementation. Les règles suivantes sont proposées:

a) <u>les interdictions</u>:

- aucun puits ou installation septique ne peut être installé dans un territoire sujet à inondation à cause des dangers de contamination;

- dans un territoire où le danger d'inondation est élevé (zone A*) aucun édifice public et aucun bâtiment ne peut être construit;

*Zone A: zone généralement délimitée à partir des critères suivants:
1. période de récurrence d'environ 20 ans,
2. territoire sujet à une inondation soudaine,
3. niveau élevé de l'inondation,
4. autres facteurs circonstanciés.

b) <u>les contraintes particulières:</u>

- les voies de communication doivent être au-dessus de la cote d'inondation;

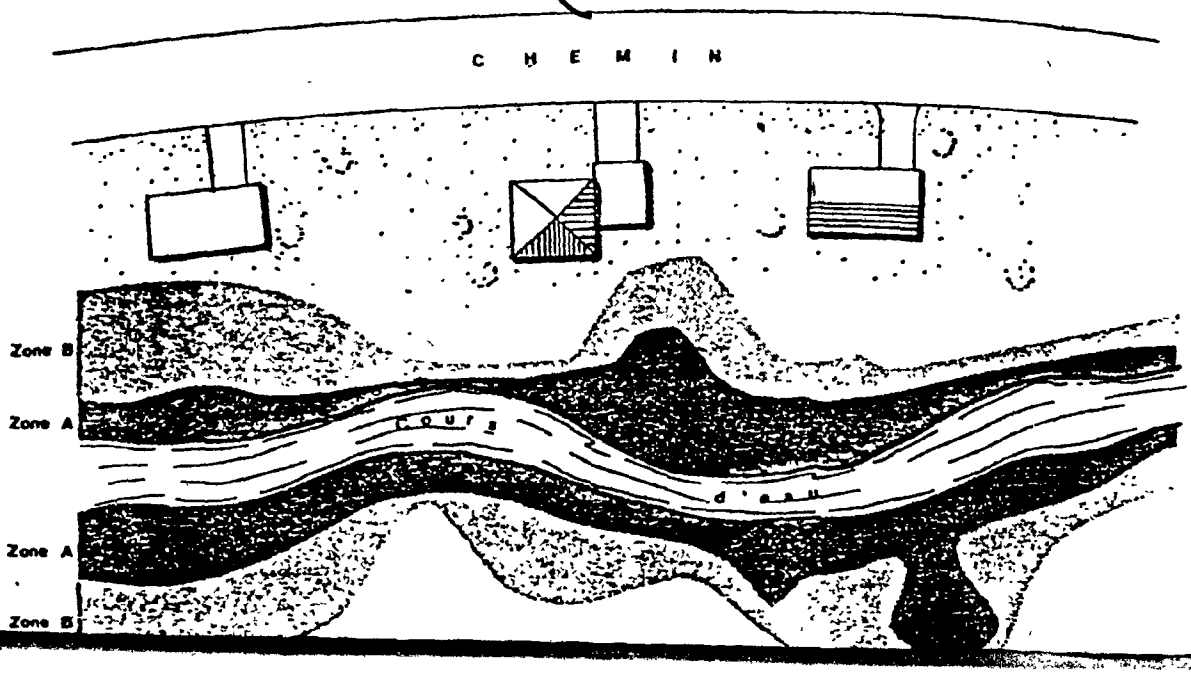
- les réseaux d'égouts situés dans des territoires inondables doivent être construits pour éviter le refoulement et ainsi pouvoir fonctionner en toute circonstance;

- dans les territoires où le danger d'inondation est plus faible (zone B)*, les constructions sous la cote d'inondation doivent être étanches, être en mesure de résister à la poussée du sol, à la pression hydrostatique de l'eau à son niveau maximum et ne pas avoir d'ouverture; le plancher du rez-de-chaussée doit être situé au-dessus de cette cote d'inondation identifiée sur les cartes préparées à cette fin. Avant d'entreprendre des travaux, une personne aurait donc avantage à s'adresser à un spécialiste (ingénieur).

1 of

*Zone B: zone où le danger d'inondation est plus faible que dans la zone A; elle est délimitée, d'un côté, par la limite de la zone A et, de l'autre côté, par la limite du territoire qui serait couvert par une inondation dont la période de récurrence est d'environ 100 ans.

Croquis K Territoire inondable



et ainsi pouvoir fonctionner en toute circonstance;

- dans les territoires où le danger d'inondation est plus faible (zone B)*, les constructions sous la cote d'inondation doivent être étanches, être en mesure de résister à la poussée du sol, à la pression hydrostatique de l'eau à son niveau maximum et ne pas avoir d'ouverture; le plancher du rez-de-chaussée doit être situé au-dessus de cette cote d'inondation identifiée sur les cartes préparées à cette fin. Avant d'entreprendre des travaux, une personne aurait donc avantage à s'adresser à un spécialiste (ingénieur).

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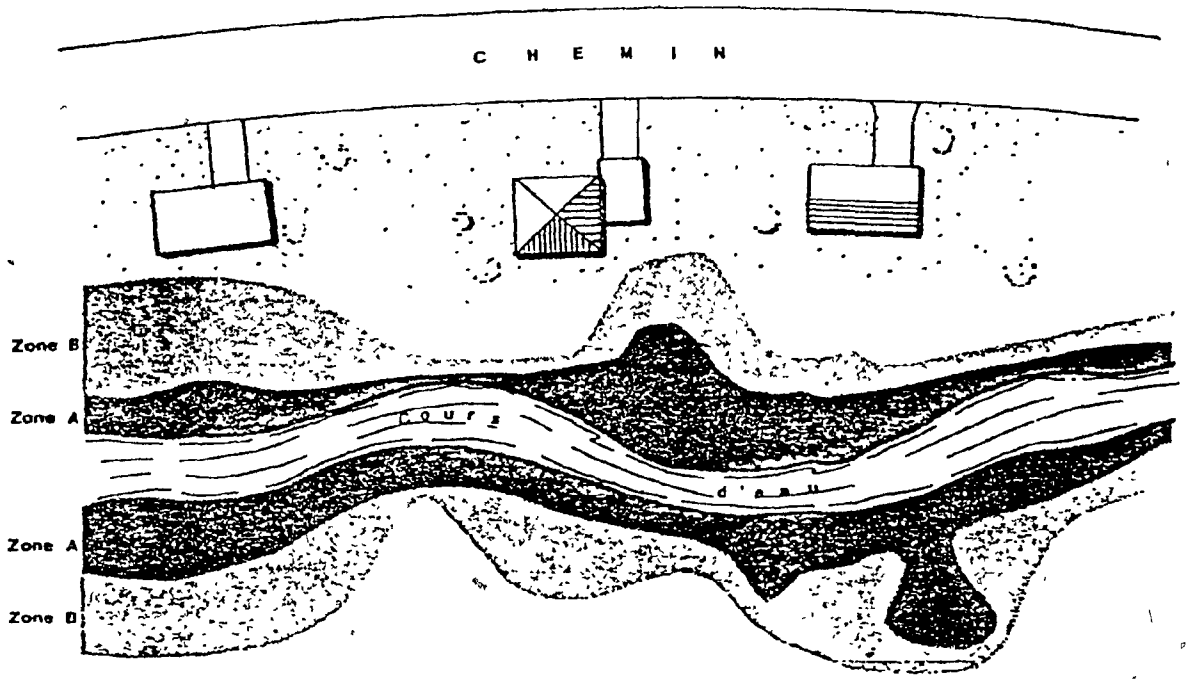
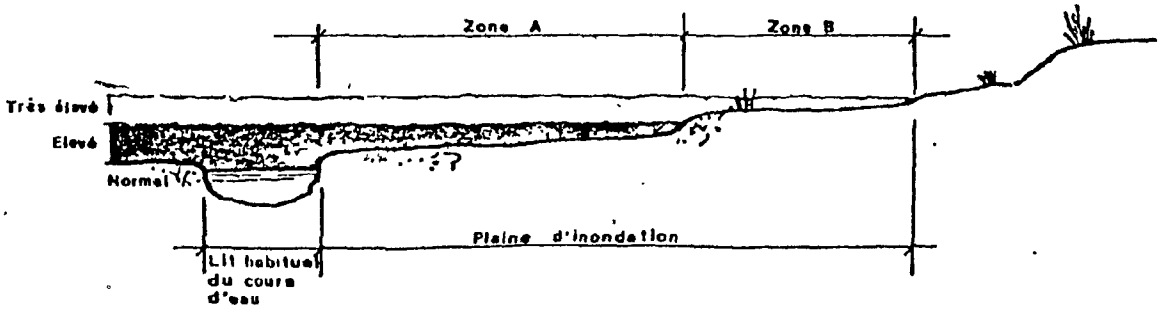
*Zone B: zone où le danger d'inondation est plus faible que dans la zone A; elle est délimitée, d'un côté, par la limite de la zone A et, de l'autre côté, par la limite du territoire qui serait couvert par une inondation dont la période de récurrence est d'environ 100 ans.

Croquis K Territoire inondable



2 of 2



Excerpts from law 125

4. LE TERRITOIRE SUJET A INONDATION

Loi 125:

- "113. Le conseil d'une municipalité peut adopter un règlement de zonage pour l'ensemble ou partie de son territoire.

  Ce règlement peut contenir des dispositions portant sur un ou plusieurs des objets suivants:

  16° régir ou prohiber, par zone, la construction ou certains ouvrages, compte tenu ..., soit des dangers d'inondation, ... , toute prohibition faite en vertu du présent paragraphe pouvant être totale ou ne viser que certaines catégories d'immeubles qu'il détermine;
  ...

- 115. Le conseil d'une municipalité peut adopter un règlement de lotissement pour l'ensemble ou partie de son territoire.

  Ce règlement de lotissement peut contenir des dispositions sur un ou plusieurs de objets suivants:

  4° régir ou prohiber, par zone, une opération cadastrale, compte tenu, ... , soit des dangers d'inondation, ... , toute prohibition faite en vertu du présent paragraphe pouvant être totale ou ne viser que certaines catégories d'immeubles que détermine le règlement; ..."

4.1 La situation

Si le débordement saisonnier de certains cours d'eau n'a pas empêché des gens de s'établir dans la plaine inondable et ne devrait pas incommoder outre mesure cette population, on observe toutefois de-

PROVINCE DE QUEBEC
VILLE DE LAVAL

REGLEMENT NUMERO L-4442

Tel que modifié par les règlements numéros L-4723, L-4784, L-5235

concernant le lotissement et la construction en territoire riverain et en territoire sujet à inondation dans la Ville de Laval.

SEANCE régulière du Conseil de la Ville de Laval, tenue le 3 juillet 1979 à 8.02 heures, au lieu ordinaire des séances dudit Conseil, conformément aux dispositions de la loi, et à laquelle assemblée étaient présents les conseillers:

Pierre Aubry, membre du Comité Exécutif
Georges Audet
Irwin H. Bigman
Ronald Bussey
Raymond Clément
Achille Corbo
Raymond Fortin, membre du Comité Exécutif
Yves Gauthier
Raymond Goyer
Roch Hébert
Richard Lagrois
Jean-Louis Lambert, président intérimaire du Comité Exécutif
Yvon Lambert
Jean-Louis Mathieu
Jacqueline Morin
James C. O'Brien
Jacques E. Renaud
Emilien Robichaud
Gilles Vaillancourt, membre du Comité Exécutif

REGLEMENT NUMERO L-4442

ARTICLE 1- Pour les fins du présent règlement, à moins que le contexte n'implique un sens différent, les termes utilisés ont la signification donnée ci-après:

Cote d'inondation	: niveau géodésique servant à définir la limite du territoire sujet à inondation;
Lac	: lac des Deux-Montagnes;
Lot riverain	: tout lot adjacent à une rivière ou un lac sur un ou plusieurs de ses côtés;
Rivière	: rivière des Prairies et rivière des Mille-Iles;
Territoire riverain	: territoire formé de l'ensemble des lots riverains;
Territoire sujet à inondation	: territoire en bordure d'une rivière ou d'un lac s'étendant depuis la rivière ou le lac jusqu'à la ligne des eaux lorsqu'elle atteint une cote d'inondation déterminée.

1 of

DISPOSITIONS GENERALES APPLICABLES AU TERRITOIRE RIVERAIN

ARTICLE 2- Outre les dispositions des règlements en vigueur concernant la construction ou toutes autres matières, la superficie d'un lot riverain doit être au minimum de deux mille (2,000) mètres carrés si l'un des services d'aqueduc ou d'égout est existant et de trois mille (3,000) mètres carrés lorsque ni les services d'aqueduc et d'égouts n'existent.

ARTICLE 3- a) La profondeur minimum de toute cour adjacente à une rivière ou un lac doit être égale à la plus grande des deux dimensions suivantes:

- quinze (15) mètres
  ou
- la hauteur du bâtiment, jusqu'à un maximum de quarante-cinq (45) mètres.

b) La profondeur minimum de la cour avant doit être égale à la

Cote d'inondation	: niveau géodésique servant à définir la limite du territoire sujet à inondation;
Lac	: lac des Deux-Montagnes;
Lot riverain	: tout lot adjacent à une rivière ou un lac sur un ou plusieurs de ses côtés;
Rivière	: rivière des Prairies et rivière des Mille-Iles;
Territoire riverain	: territoire formé de l'ensemble des lots riverains;
Territoire sujet à inondation	: territoire en bordure d'une rivière ou d'un lac s'étendant depuis la rivière ou le lac jusqu'à la ligne des eaux lorsqu'elle atteint une cote d'inondation déterminée.

2 de 2

DISPOSITIONS GENERALES APPLICABLES AU TERRITOIRE RIVERAIN

ARTICLE 2- Outre les dispositions des règlements en vigueur concernant la construction ou toutes autres matières, la superficie d'un lot riverain doit être au minimum de deux mille (2,000) mètres carrés si l'un des services d'aqueduc ou d'égout est existant et de trois mille (3,000) mètres carrés lorsque ni les services d'aqueduc et d'égouts n'existent.

ARTICLE 3-

a) La profondeur minimum de toute cour adjacente à une rivière ou un lac doit être égale à la plus grande des deux dimensions suivantes:

- quinze (15) mètres
  ou
- la hauteur du bâtiment, jusqu'à un maximum de quarante-cinq (45) mètres.

b) La profondeur minimum de la cour avant doit être égale à la plus grande des deux dimensions suivantes:

- cinq (5) mètres
  ou
- 60% de la hauteur du bâtiment, jusqu'à un maximum de vingt-cinq (25) mètres.

c) La profondeur minimum de toute cour latérale doit être égale à la plus grande des deux dimensions suivantes:

- trois (3) mètres
  ou
- 25% de la hauteur du bâtiment additionnée de la projection orthogonale de la profondeur du bâtiment sur la ligne séparative de terrain.

REGLEMENT NUMERO L-4442

ARTICLE 4- Les dispositions des articles 2 et 3 ne s'appliquent pas aux lots subdivisés ou construits avant l'entrée en vigueur du présent règlement. De plus, les dispositions des articles 2 et 3 ne s'appliquent pas:

1) A une partie du lot 358 aux plan et livre de renvoi officiels de la paroisse cadastrale de St-Vincent-de-Paul, montrée en grisé sur le plan portant le numéro 3949 préparé par le Service d'Urbanisme de la Ville de Laval en date du 13 décembre 1979, à la condition que la superficie du terrain à bâtir soit d'au moins 939 mètres carrés. (Règl. L-4723, en vigueur 80-04-11).

"2) A des parties du lot 13 aux plan et livre de renvoi officiels de la paroisse cadastrale de St-François-de-Sales, montrées en grisé sur le plan portant le numéro 4342 préparé par le Service d'urbanisme de la Ville de Laval en date du 17 juillet 1981."
(Règl. L-5235, en vigueur 82-02-10).

DISPOSITIONS PARTICULIÈRES APPLICABLES AU TERRITOIRE SUJET A INONDATION

ARTICLE 5- Les plans préparés par le Ministère des Richesses Naturelles du Québec et le Ministère d'Etat à l'Environnement du Canada, portant les signatures des Honorables Yves Bérubé du Québec et Len Marchand du Canada en date du 11 mai 1978, à l'échelle 1 :10 000 et portant les numéros
31 H 12 - 100-0101, 31 H 12 - 100-0102, 31 H 12 - 100-0103,
31 H 12 - 100-0202, 31 H 12 - 100-0203, 31 H 12 - 100-0302,
31 H 12 - 100-0303, 31 H 12 - 100-0304, 31 H 12 - 100-0403 et
31 H 12 - 100-0404 font partie intégrante du présent règlement.

ARTICLE 6- La zone d'inondation de la crue centenaire identifiée sur les plans mentionnés à l'article précédent désigne le territoire sujet à inondation aux fins d'application du présent règlement.

ARTICLE 7- Outre les dispositions des règlements en vigueur concernant la construction ou toutes autres matières, la superficie d'un lot situé à l'intérieur du territoire sujet à inondation, en tout ou en partie, doit être au minimum de deux mille (2,000) mètres carrés si l'un des services d'aqueduc ou d'égout est existant et de trois mille (3,000) mètres carrés lorsque ni les services d'aqueduc et d'égout n'existent.

ARTICLE 8- Les dispositions de l'article 7 ne s'appliquent pas aux lots subdivisés avant l'entrée en vigueur du présent règlement.

ARTICLE 9- A l'intérieur du territoire sujet à inondation désigné à l'article 6, la construction de tout bâtiment et la réalisation de tout ouvrage doivent respecter les prescriptions suivantes:

a) Aucune cave ni sous-sol ne sont autorisés;

1) A une partie du lot 358 aux plan et livre de renvoi officiels de la paroisse cadastrale de St-Vincent-de-Paul, montrée en grisé sur le plan portant le numéro 3949 préparé par le Service d'Urbanisme de la Ville de Laval en date du 13 décembre 1979, à la condition que la superficie du terrain à bâtir soit d'au moins 939 mètres carrés. (Règl. L-4723, en vigueur 80-04-11).

"2) A des parties du lot 13 aux plan et livre de renvoi officiels de la paroisse cadastrale de St-François-de-Sales, montrées en grisé sur le plan portant le numéro 4342 préparé par le Service d'urbanisme de la Ville de Laval en date du 17 juillet 1981."
(Règl. L-5235, en vigueur 82-02-10).

2 of 2

DISPOSITIONS PARTICULIÈRES APPLICABLES AU TERRITOIRE SUJET A INONDATION

ARTICLE 5- Les plans préparés par le Ministère des Richesses Naturelles du Québec et le Ministère d'Etat à l'Environnement du Canada, portant les signatures des Honorables Yves Bénubé du Québec et Len Marchand du Canada en date du 11 mai 1978, à l'échelle 1 :10 000 et portant les numéros
31 H 12 - 100-0101, 31 H 12 - 100-0102, 31 H 12 - 100-0103,
31 H 12 - 100-0202, 31 H 12 - 100-0203, 31 H 12 - 100-0302,
31 H 12 - 100-0303, 31 H 12 - 100-0304, 31 H 12 - 100-0403 et
31 H 12 - 100-0404 font partie intégrante du présent règlement.

ARTICLE 6- La zone d'inondation de la crue centenaire identifiée sur les plans mentionnés à l'article précédent désigne le territoire sujet à inondation aux fins d'application du présent règlement.

ARTICLE 7- Outre les dispositions des règlements en vigueur concernant la construction ou toutes autres matières, la superficie d'un lot situé à l'intérieur du territoire sujet à inondation, en tout ou en partie, doit être au minimum de deux mille (2,000) mètres carrés si l'un des services d'aqueduc ou d'égout est existant et de trois mille (3,000) mètres carrés lorsque ni les services d'aqueduc et d'égout n'existent.

ARTICLE 8- Les dispositions de l'article 7 ne s'appliquent pas aux lots subdivisés avant l'entrée en vigueur du présent règlement.

ARTICLE 9- A l'intérieur du territoire sujet à inondation désigné à l'article 6, la construction de tout bâtiment et la réalisation de tout ouvrage doivent respecter les prescriptions suivantes:

a) Aucune cave ni sous-sol ne sont autorisés;

b) toute structure ou partie de structure située sous la cote d'inondation doit être conçue et construite de façon étanche, conformément aux exigences de la section 9.11 du Code du Bâtiment du Québec;

c) aucune ouverture n'est autorisée sous la cote d'inondation;

d) aucun vide sanitaire n'est autorisé sous la cote d'inondation;

e) aucune partie d'aucun plancher ne doit se situer à moins de soixante-quinze (75) centimètres au-dessus de la cote d'inondation.

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REGLEMENT NUMERO L-4442

ARTICLE 10- ~~Le présent règlement entrera en vigueur suivant les dispositions de la loi.~~

Toute infraction à l'une quelconque des dispositions du présent règlement rend le contrevenant passible d'une amende minimum de cent-cinquante dollars (150,00 $) et n'excédant pas trois cents dollars (300,00 $) et les frais et, à défaut de paiement de l'amende et des frais dans le délai fixé, d'un emprisonnement n'excédant pas deux (2) mois, ledit emprisonnement devant cesser dès le paiement de l'amende et des frais.

Toute infraction continue de l'une quelconque des dispositions du présent règlement constitue jour par jour une infraction séparée.

Au surplus et sans préjudice aux deux premiers alinéas du présent article, la Ville de Laval conserve tout autre recours pouvant lui appartenir pour défaut d'accomplissement de l'une ou l'autre des obligations imposées par le présent règlement. (Règl. L-4784, en vigueur 81-03-04).

ARTICLE 11- **Le présent règlement entrera en vigueur suivant les dispositions de la loi. (Règl. L-4784, en vigueur 81-03-04).**

ADOPTE

(signé) _____
M. Lucien Paiement, Maire.

(signé) _____
M. Jean-Marc Quevillon, Président du Conseil.

(signé) _____
M. Ronald Bourcier, Greffier, ou
M. Robert Labelle, Greffier adjoint.

4. DISPOSITIONS APPLICABLES A TOUTES LES ZONES (Suite)

4.23 Normes applicables aux zones inondables

4.23.1 Identification des zones inondables

Des zones inondables sont identifiées aux plans de zonage formant partie intégrale du présent règlement. Pour chacune des zones, une cote est donnée, fixant le niveau des hautes eaux de récurrence décennale.

4.23.2 Usages prohibés

Dans toutes les zones inondables, les usages suivants sont prohibés, nonobstant toute autre disposition du présent règlement:

- cimetières d'autos
- cours de rebuts
- dépotoirs à ciel ouvert

4.23.3 Lots riverains

Nonobstant toute autre disposition du présent règlement, tout lot riverain de la Rivière des Mille-Iles et du Lac des Deux-Montagnes devra avoir: une superficie minimale de vingt mille (20,000') pieds carrés si aucun service d'égout et d'aqueduc n'est en place et de quinze mille (15,000') pieds carrés si le lot est desservi par l'un ou l'autre des deux services. Dans les deux cas, le frontage minimal devra être de cent vingt-cinq (125') pieds.

4.23.4 Normes de construction

Les dispositions du règlement de construction à l'égard des bâtisses situées dans les zones d'inondation devront être respectées.

4. DISPOSITIONS APPLICABLES A TOUTES LES ZONES (Suite)

4.5 Normes applicables aux zones inondables

4.5.1 Identification des zones inondables

Des zones inondables sont identifiées aux plans de zonage formant partie intégrale du présent règlement. ~~Pour chacune des zones, une cote est donnée, fixant le niveau des hautes eaux de récurrence décennale.~~

4.5.2 Usages prohibés

Dans toutes les zones inondables, les usages suivants sont prohibés, nonobstant toute autre disposition du présent règlement:

- cimetières d'autos
- cours de rebuts
- dépotoirs à ciel ouvert

4.5.3 ~~Lots riverains~~

~~Nonobstant toute autre disposition du présent règlement, tout lot riverain de la rivière des Mille-Iles devra avoir une superficie minimale de 15,000 pieds carrés et un frontage minimum de 125 pieds~~.

4.5.4 Normes de construction

Les dispositions du règlement de construction à l'égard des bâtisses situées dans les zones d'inondation devront être respectées.

Ste-Christine

St. Eustache

Reglement 848
Construction

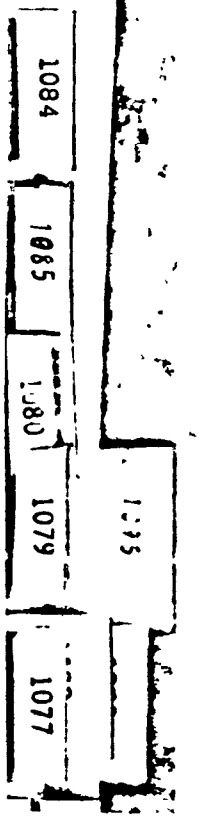
1 Le premier paragraphe de l'article 10.20 est abrogé et remplacé par le suivant:

"Aucun bâtiment destiné à l'habitation ne doit avoir une façade principale de moins de 28 pieds de largeur."

2 L'article 10.22.1 est abrogé et remplacé par le suivant:

Aucun plancher de cave ou de sous-sol ne pourra être construit à plus de deux (2') pieds sous le niveau des hautes eaux tel que défini à l'article 4.5.1 du règlement de zonage et devra être muni d'une pompe submersible, tout rez-de-chaussée devra être à au moins deux (2') pieds plus haut que ce niveau des hautes eaux. Il est défendu de déverser les eaux ainsi pompées dans l'égout domestique.

Aucune partie d'un bâtiment qui est situé plus bas que la cote des hautes eaux pour la zone inondable tel que défini par le règlement de zonage ne peut servir d'habitation.



Rivière des Mille-Iles

Ville de Boisbriand

Cotes en mètres en front de la ville de Boisbriand

	Numéro Section	10 ans m	crue 1974 m	100 ans m	P..
	1	22,21	22,66	23,00	75.46
AVENUE ENTRE MONTÉE SAINTE ET AUTO.	2	22,21	22,66	23,00	75.46
ÎLE MORRIS	3	22,22	22,66	23,00	75.46
EST ÎLE DCHAI	4	22,24 75.95	22,66	23,00	75.46
OUEST ÎLE DE MAI. CHEMIN PRINCIPAL	5	22,45 73.65	23,00 75.46	23.48 23,35	76.05 E 76.64
	6	22,46	23,01	23,37	76.67
FER FILIOU	7	22,48	23,02	23,38	76.71
FER CHARRON	8	22,57	23,11	23,43 23,48	76.87 E 77.03
FER ROBERT V. MILLE-ILES	9	22,60	23,14	23,51	77.13
	10	22,62	23,16	23,53	77.20
FER. LEMAY	11	22,63	23,18	23,55	77.26
65IÈME AVENUE	12	22,64	23,19	23,56	77.30

MINISTÈRE DE L'ENVIRONNEMENT EAUX DE SURFACE

EN DATE DE JANVIER 1982.

4.5.2.10 Logements dans les sous-sols

Les logements dans les sous-sols sont permis dans les zones d'application.

4.5.2.11 Territoire inondable

Dans les zones d'application, la construction de bâtiments et la réalisation de tout ouvrage est soumise aux dispositions suivantes:

4.5.2.11.1 Toute nouvelle rue doit être construite au-dessus de la cote d'inondation centenaire, telle qu'indiquée au plan de zonage:

4.5.2.11.2 Le sommet des puits et les éléments épurateurs des installations septiques sont interdits sous la cote centenaire.

4.5.2.11.3 Tout nouveau réseau d'égouts doit être conçu de façon à éviter le refoulement en période de crue.

4.5.2.11.4 Aucune ouverture, fenêtre, soupirail, porte d'accès n'est permise sous la cote d'inondation centenaire.

4.5.2.11.5 Aucun plancher de rez-de-chaussée n'est permis à un niveau inférieur à trente centimètres (30) au-dessus de la cote centenaire.

4.5.2.11.6 Aucun plancher de cave ou sous-sol n'est permis à un niveau inférieur à la cote d'inondation centenaire.

4.5.2.11.7 Aucun plancher de vide sanitaire n'est permis à un niveau inférieur à un (1) mètre au-dessous de la cote centenaire.

4.5.2.11.8 Toute la surface externe de la partie verticale des fondations située sous la cote d'inondation doit être couverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de seize millimètres (16).

4.5.2.11.9 Le plancher de la fondation doit être construit avec un contre-dalle de base (dalle de propreté) dont la surface est recouverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de seize millimètres (16).

4.5.2.11.10 Le béton utilisé pour l'ensemble de la fondation doit avoir une résistance en compression de vingt mégapascal (20 mpa) à sept jours et de vingt- cinq mégapascal (25 mpa) à vingt-huit (28) jours; les fondations en bloc de béton sont prohibées.

4.5.2.11.11 Les fondations et la dalle de béton doivent avoir l'armature nécessaire pour résister à la pression hydrostatique que provoquerait une crue dite centenaire.

4.5.2.11.12 Le drain principal d'évacuation doit être muni d'un clapet anti-retour.

4.5.2.11.13 Chaque construction devrait être équipée d'une pompe d'une capacité minimale d'évacuation de neuf mille litres (9 000) par heure.

4.5.2.12.2 Normes de Protection de l'Environnement

Toutes les exploitations agricoles doivent être en conformité avec les normes et règlements de l'autorité provinciale concernée notamment la Loi sur la qualité de l'Environnement (L.R.Q. 1977, Chapitre Q2) du ministère de l'Environnement.

De plus tous les travaux de détournement, de modification ou de remplissage d'un cours d'eau ou d'un marais sont interdits à moins d'être accompagnés d'une autorisation de l'autorité provinciale concernée.

4.5.2.12.3 Normes de lotissement

Dans les zones Agriculture (A), le frontage minimal du terrain doit être de soixante (60) mètres et la profondeur de quarante-cinq (45) mètres. La superficie minimale doit être de quatre (4) hectares, sauf les terrains adjacents à un chemin public existant lors de l'entrée en vigueur du présent règlement, où la superficie minimale est réduite à trois mille mètres (3 000) carrés, le frontage minimal à dix-sept (17) mètres et la profondeur minimale à trente (30) mètres.

4.5.2.13 Dispositions particulières pour les constructions en bordure d'un lac ou d'un cours d'eau

4.5.2.13.1 Marge minimale entre tout bâtiment et la ligne naturelle des hautes eaux d'un lac au un cours d'eau

Aucune construction avec fondation, ne peut être édifiée, à l'exception des garages pour yachts et quais, en deçà de dix (10) mètres de la ligne naturelle des hautes eaux d'un lac ou d'un cours d'eau.

Les garages pour yachts ayant accès à un lac ou un cours d'eau ne doivent pas quant à eux être situés à plus d'un mètre cinquante centimètres (1,50) de la ligne naturelle des hautes eaux en direction des terrains.

4.5.2.13.2 Constructions autorisées sur la rive d'un lac ou d'un cours d'eau

Sur la rive d'un lac ou d'un cours d'eau d'une largeur minimale de dix mètres (10), seuls sont autorisés les garages pour yachts, les constructions sans fondation et les quais. Les garages pour yachts doivent cependant être construits sur pilotis, sur pieux ou sur plate-formes flottantes et ne doivent pas gêner la libre circulation de l'eau. Seuls les quais flottants ou sur caissons ou pilotis et qui ne transforment pas la nature de la rive du lac ou du cours d'eau, sont autorisés.

4.5.2.13.3 Recouvrement végétal de la rive naturelle d'un lac ou d'un cours d'eau

La rive naturelle d'un lac ou d'un cours d'eau d'une largeur minimale de dix (10) mètres doit être conservée boisée ou recouverte d'arbustes naturels sur une longueur d'un moins soixante pour cent (60%) de la ligne du lot borné par le lac ou le cours d'eau.

Les aménagements et ouvrages sur la rive d'un lac ou d'un cours d'eau doivent être conçus et réalisés de façon à respecter l'état et l'aspect naturel des lieux et de façon à ne pas nuire à l'écoulement naturel des eaux, ni créer de foyer de pollution.

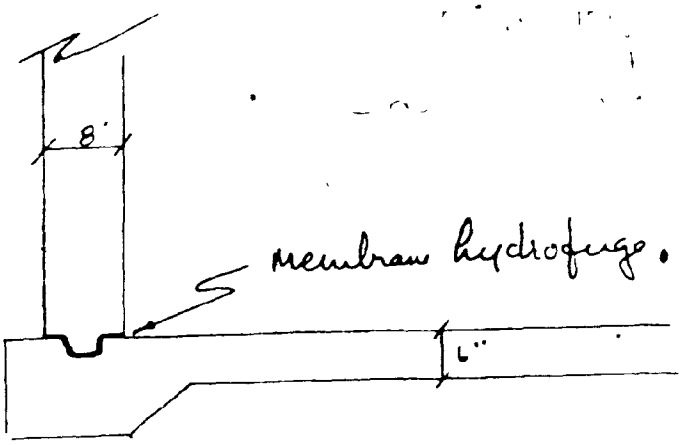
4.5.2.13.4 Protection de l'environnement

Tous les travaux relatifs à l'excavation, dragage, remblayage, détournement, modification ou remplissage d'un lac, d'un cours d'eau ou d'un marais sont interdits à moins d'être accompagnés d'une autorisation de l'autorité provinciale concernée.

4.5.2.14 Parcs de maisons mobiles

4.5.2.14.1 Champ d'application

Toute maison mobile servant de résidence permanente doit être située et aménagée à l'intérieur d'une zone réservée à cette fin, (Résidence R-4).



d'un édifice doivent
t d'égout et d'aqueduc,
ampes d'accès et des
ronnante.

t pas être à plus de
variation dans
lu terrassement des
it pas être plus
re (4) pieds.

5.3.7 s'appliquent
'intérieur des
entifiés au plan
... de la lettre "1" qui suit le numéro du secteur.

5.3.7.1 Toute voie de communication ou route doit être construite au-dessus de la cote d'inondation centenaire.

5.3.7.2 La construction de puits ou d'installations septiques est interdite.

5.3.7.3 Tout réseau d'égouts doit être conçu de façon à éviter le refoulement en période de crue.

5.3.7.4 Aucune ouverture, fenêtre, soupirail, porte d'accès, n'est permise sur le territoire situé sous la cote d'inondation centenaire.

5.3.7.5 Le plancher de rez-de-chaussée doit être au moins 1,25 pieds plus élevé que la cote d'inondation centenaire.

5.3.7.6 Toute la surface externe de la partie verticale des fondations située sous la cote d'inondation doit être couverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de seize millimètres (16).

5.3.7.7 Le plancher de la fondation doit être construit avec un contre-dalle de base (dalle de propreté) dont la surface est recouverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de seize millimètres (16).

5.3.7.8 Le béton utilisé pour l'ensemble de la fondation doit avoir une résistance en compression de vingt mille sept cents kilopascals (20 700) à sept jours et de vingt-sept mille six cents (27 600) kilopascals à vingt-huit (28) jours; les fondations en bloc de béton sont prohibées.

5.3.6 Plancher principal

Le plancher principal et le terrassement d'un édifice doivent se conformer aux critères de raccordement d'égout et d'aqueduc, des pentes maximales et minimales, des rampes d'accès et des relations du terrain à la propriété environnante.

En général, le plancher principal ne doit pas être à plus de quatre (4) pieds du niveau de la rue. La variation dans les élévations du plancher principal et du terrassement des propriétés voisines sur la même rue ne doit pas être plus que la pente de la rue, plus ou moins quatre (4) pieds.

5.3.7 Territoire inondable

Les dispositions des articles 5.3.7.1 à 5.3.7 s'appliquent à la construction de bâtiments situés à l'intérieur des secteurs inondables. Ces secteurs sont identifiés au plan de zonage par la lettre "i" qui suit le numéro du secteur.

5.3.7.1 Toute voie de communication ou route doit être construite au-dessus de la cote d'inondation centenaire.

5.3.7.2 La construction de puits ou d'installations septiques est interdite.

5.3.7.3 Tout réseau d'égouts doit être conçu de façon à éviter le refoulement en période de crue.

5.3.7.4 Aucune ouverture, fenêtre, soupirail, porte d'accès, n'est permise sur le territoire situé sous la cote d'inondation centenaire.

5.3.7.5 Le plancher de rez-de-chaussée doit être au moins 1,25 pieds plus élevé que la cote d'inondation centenaire.

5.3.7.6 Toute la surface externe de la partie verticale des fondations située sous la cote d'inondation doit être couverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de seize millimètres (16).

5.3.7.7 Le plancher de la fondation doit être construit avec un contre-dalle de base (dalle de propreté) dont la surface est recouverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de seize millimètres (16).

5.3.7.8 Le béton utilisé pour l'ensemble de la fondation doit avoir une résistance en compression de vingt mille sept cents kilopascals (20 700) à sept jours et de vingt-sept mille six cents (27 600) kilopascals à vingt-huit (28) jours; les fondations en bloc de béton sont prohibées.

5.3.7.9 Les fondations de béton doivent avoir l'armature nécessaire pour résister à la pression hydrostatique que provoquerait une crue dite centenaire.

5.3.7.10 Le drain principal d'évacuation doit être muni d'un clapet anti-retour.

5.3.7.11 Chaque construction doit être équipée d'une pompe d'une capacité minimale d'évacuation de neuf mille litres (9 000) par heure.

Pour fins du présent article, la cote d'inondation centenaire pour la Ville de Rosemere est fixée à 73.75 pieds.

5.3.7.12 Dispositifs particuliers

Tout propriétaire d'immeuble doit installer une soupape de retenue sur les branchements horizontaux recevant les eaux usées de tout les appareils situés au rez-de-chaussée. Il doit de plus installer une vanne d'arrêt sur le branchement collecteur recevant les eaux usées de tous les appareils installés dans le sous-sol et la cave.

La cave ou le sous-sol de tout bâtiment doit avoir une fosse dans laquelle se trouve une pompe submersible pouvant faire évacuer l'eau pouvant s'infiltrer dans la cave ou le sous-sol.

5.3.8 Tous les branchements horizontaux recevant les eaux usées de tous les appareils dans les caves et les sous-sols des maisons et immeubles doivent être munis d'une soupape de retenue approuvés par le Bureau Provincial d'inspection de plomberie.

5.3.9 Tout propriétaire désirant faire un raccordement à l'égout sanitaire ou pluvial et à l'aqueduc doit obtenir un certificat de l'inspecteur en bâtiment.

5.4. ENTRETIEN DES BATIMENTS

5.4.1 Tout bâtiment doit être tenu dans un bon état.

5.4.1.1 La peinture et les teintures doivent être uniformes. Toute teinture ou peinture écaillée doit être remplacée.

5.4.1.2 Tout matériel pourri ou désagrégé qui a perdu son apparence et ses propriétés initiales doit être remplacé.

5.4.1.3 Les corniches, les gouttières, les fenêtres et les portes doivent être plus particulièrement surveillées et réparées.

5.4.2. Tout propriétaire qui néglige l'entretien et n'effectue pas les rénovations ou réparations nécessaires contrevient au présent règlement et est passible des sanctions prévues au chapitre 1.4 du présent règlement

4.1 REPARTITION EN ZONES ET SECTEURS

4.1.1 Répartition en zones

Pour les fins de la règlementation des usages, la municipalité est répartie en zones ci-après énumérées, apparaissant au plan de zonage et identifiées par les lettres d'appellation ci-indiquées.

Chaque zone est qualifiée des utilisations dominantes. Ces vocations n'indiquent pas nécessairement que seuls ces groupes d'usages sont permis dans ce secteur.

ZONES	VOCATIONS
HU	Habitation faible densité
HM	Habitation moyenne densité
HF	Habitation forte densité
HX	Habitation indéterminée
C	Commerce
Q	Commerce et habitation intégrés
I	Industrie
A	Agriculture
P	Communautaire

4.1.2 Répartition en secteurs de votation

Pour les fins de votation, les zones sont subdivisées en secteurs identifiés par un ou des chiffres placés à la suite des lettres d'appellation de zone et délimitées sur un plan dit "plan de zonage". Ce plan de zonage ainsi que les symboles et autres indications y figurant, authentifiés sous la signature du Maire et du Greffier, font partie intégrante de ce règlement à toutes fins que de droit.

4.1.3 Règles d'interprétation du plan de zonage

La délimitation, sur le plan de zonage, des secteurs ou des zones, est faite à l'aide de tracés identifiés dans la légende du plan et dont la localisation est déterminée par les règles suivantes:

4.1.3.1 Les limites des secteurs coincident avec les lignes suivantes:

-l'axe ou le prolongement de l'axe des rues et voies piétonnières existantes, homologuées ou proposées;
-l'axe des cours d'eau;
-l'axe des emprises des utilités publiques.

4.2.6 Le groupe communautaire

Sont de ce groupe, les usages publics et semi-publics.

4.2.6.1 Communautaire 1

Sont de cet usage:

4.2.6.1.1 Les parcs et les terrains de jeux publics.

4.2.6.1.2 Les espaces libres prévues à l'article 6.3.1

4.2.6.1.3 Les espaces réservés à la transmission et distribution des services d'utilités publiques

4.2.6.1.4 Les propriétés municipales

4.2.6.2 Communautaire 2

Sont de cet usage, ceux qui impliquent, comme principales activités, l'éducation, les loisirs et les activités culturelles de nature communautaire au palier de l'unité de voisinage.

Sont de cet usage:

4.2.6.2.1 Bibliothèques municipales

4.2.6.2.2 Centres communautaires

4.2.6.2.3 Centres de loisirs

4.2.6.2.4 Ecoles élémentaires

4.2.6.2.5 Musées

4.2.6.2.6 Parcs et terrains de jeux publics.

4.2.6.2.7 Garderies

4.2.6.3 Communautaire 3

Sont de cet usage, ceux qui impliquent, comme principales activités, l'éducation, les loisirs et les activités culturelles de nature communautaire desservant l'ensemble de la communauté.

Sont de cet usage:

4.2.6.3.1 Foyers

4.2.6.3.2 Hôpitaux

4.2.6.3.3 Hospices

4.2.6.3.4 Institutions religieuses en général

4.2.6.3.5 Maisons de retraite, de convalescence, de repos

4.2.6.3.6 Monastères

4.2.6.3.7 Noviciats

4.2.6.3.8 Orphelinats

4.2.6.3.9 Sanatoriums

4.2.6.3.10 Séminaires

4.2.6.3.11 Universités

4.2.6.3.12 Maisons d'enseignement

4.2.6.3.13 Edifices du culte

4.2.6.3.14 Résidences de professeurs

4.2.6.4 Communautaire 4

Sont de cet usage, ceux de nature semi-publique, qui desservent, l'ensemble de la communauté.

Sont de cet usage:

4.2.6.4.1 Marinas

4.2.6.4.2 Clubs nautiques avec leurs installations auxiliaires et leurs services connexes

4.2.6.4.3 Cimetières

4.2.6.4.4 Golfs publics et privés.

(361)
(15-03-80)

4.5.2.8 Secteur indéterminé (HX)

Dans les zones d'application, les propriétaires déjà établis peuvent continuer leur occupation et usage, même agrandir, rénover ou restaurer à l'intérieur des limites de leur terrain, sujet à toutes les dispositions du présent règlement.

La hauteur maximale est alors limitée à trois (3) étages et les marges minimales doivent correspondre à.

- marge de recul: vingt-cinq (25) pieds
- marge latérale: six pieds et demi (6.5)
- total des deux latérales. quinze (15) pieds
- marge arrière: vingt-cinq (25) pieds

Cependant aucune nouvelle construction ne peut être implantée sur des terrains vacants à l'intérieur de ce secteur à moins qu'un plan de lotissement ne soit soumis et approuvé par le Conseil conformément aux l'articles 3.1.1 et 3.1.2.

4.5.2.9 Marges latérales applicables dans certaines zones

Dans les zones d'application, la marge latérale minimale peut être réduite à quatre (4) pieds lorsque ce mur latéral ne comporte ni fenêtre, ni ouverture. Dans ce cas, le total des deux (2) marges latérales minimales est de treize (13) pieds.

4.5.2.10 Marge arrière applicable dans certaines zones

Dans les zones d'application, la marge arrière minimale peut être réduite à quinze (15) pieds.

4.5.2.11 Logements dans les sous-sols

Les logements dans les sous-sols sont permis dans les zones d'application. Ils doivent toutefois avoir un hauteur minimale de sept pieds et demi (7½) exempts de toute obstruction du plancher au plafond.

4.5.2.12 Territoire inondable

Dans les zones d'application, la construction de bâtiments et la réalisation de tout ouvrage est soumise aux dispositions suivantes:

4.5.2 12.1 Toute voie de communication doit être construite au-dessus de la cote d'inondation centenaire telle qu'indiquée au plan de zonage que l'on retrouve à l'annexe "A1".

4.5 2.12.2 La construction de puits ou d'installations septiques est interdite.

4.5.2.12.3 Tout réseau d'égouts doit être conçu de façon à éviter le refoulement en période de crue.

4.5.2.12 4 Aucune ouverture, fenêtre, soupirail, porte d'accès n'est permise sur le territoire situé sous la cote d'inondation centenaire telle qu'indiquée au plan de zonage.

4.5.2.12.5 Aucun plancher de rez-de-chaussé ne doit être permis à un niveau inférieur à la cote d'inondation centenaire. 22 5m3

4.5.2.12.6 Toute la surface externe de la partie verticale des fondations située sous la cote d'inondation doit être couverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de un seizième (1/16) de pouce.

4.5.2.12.7 Le plancher de la fondation doit être construit avec une contre-dalle de base (dalle de propreté) dont la surface est recouverte d'une membrane hydrofuge à base d'asphalte caoutchouté d'une épaisseur minimale de un seizième (1/16) de pouce.

4.5.2.12.8 Le béton utilisé pour l'ensemble de la fondation doit avoir une résistance en compression de trois mille (3,000) (psi) à sept (7) jours et de quatre mille (4,000) (psi) à vingt-huit (28) jours; les fondations en bloc de béton sont prohibées.

4.5.2.12.9 Les fondations de béton doivent avoir l'armature nécessaire pour résister à la pression hydrostatique que provoquerait une crue dite centenaire.

4.5.2.12.10 Le drain principal d'évacuation doit être muni d'un clapet anti-retour.

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4.5.2.12.11 **Chaque construction devrait être équipée d'une pompe d'une capacité minimale d'évacuation de deux mille (2,000) gallons impériaux par heure.**

4.5.3 Usages particuliers

Les usages suivants sont prohibés dans toutes les zones et, ceci nonobstant toute interprétation de tres clauses du présent règlement, sauf lorsque leur référence est spécifiquement mentionnée dans la grille des usages et normes à l'article "Usages spécifiquement permis", en regard d'un secteur donné. En plus de respecter toutes les dispositions prévus pour les articles du règlement s'appliquant aux zones dans les quelles ils sont situés, ces usages particuliers doivent se soumettre aux dispositions de la présente section, lesquels prévalent sur tout autre dispositions du présent règlement en cas de contradiction.

Les usages particuliers sont

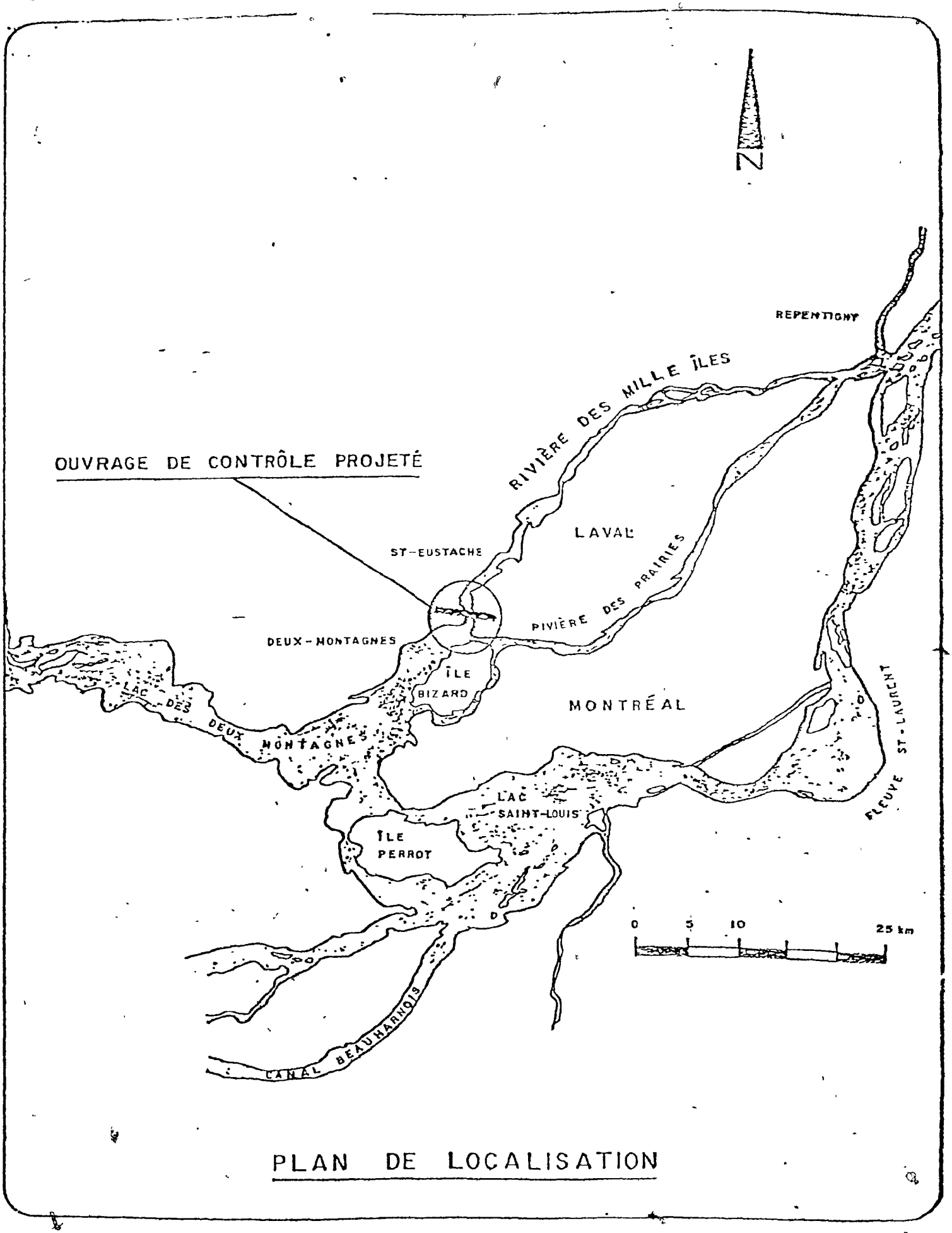
- les industries extractives
- les terrains de camping
- les maisons mobiles

4.5.3.1 Normes et critères d'aménagement et d'exploitation des terrains de camping

Aucun terrain de camping et/ou caravaning ne peut être aménagé, transformé, agrandi et/ou exploité à moins de se conformer aux normes et critères d'aménagement et d'exploitation des dispositions interprétatives de la Loi de l'Hotellerie et de ses règlements relatifs aux terrains ainsi qu'aux règlements du Service de Protection de l'Environnement et à moins d'avoir obtenu un permis du Ministère du Tourisme de la Chasse et de la Pêche à cet effet, et un certificat de la Corporation Municipale.

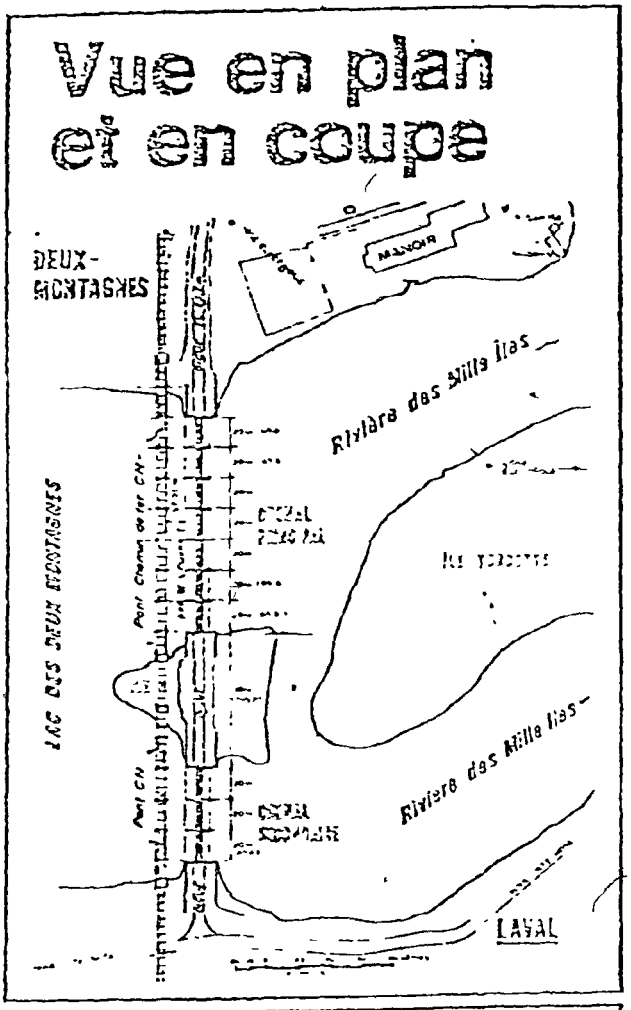
Appendix VI

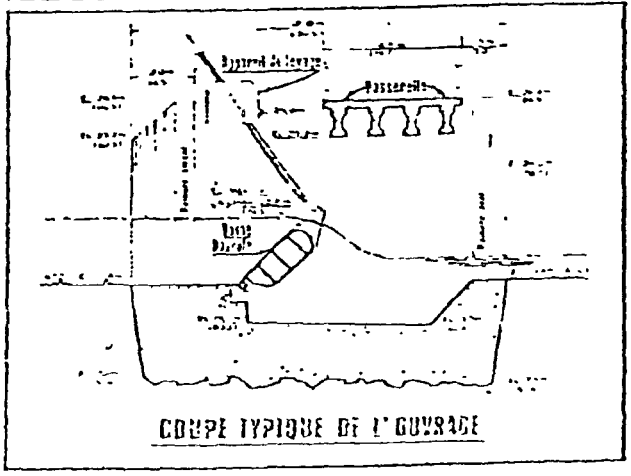
The Mille Iles River dam: alternative C3

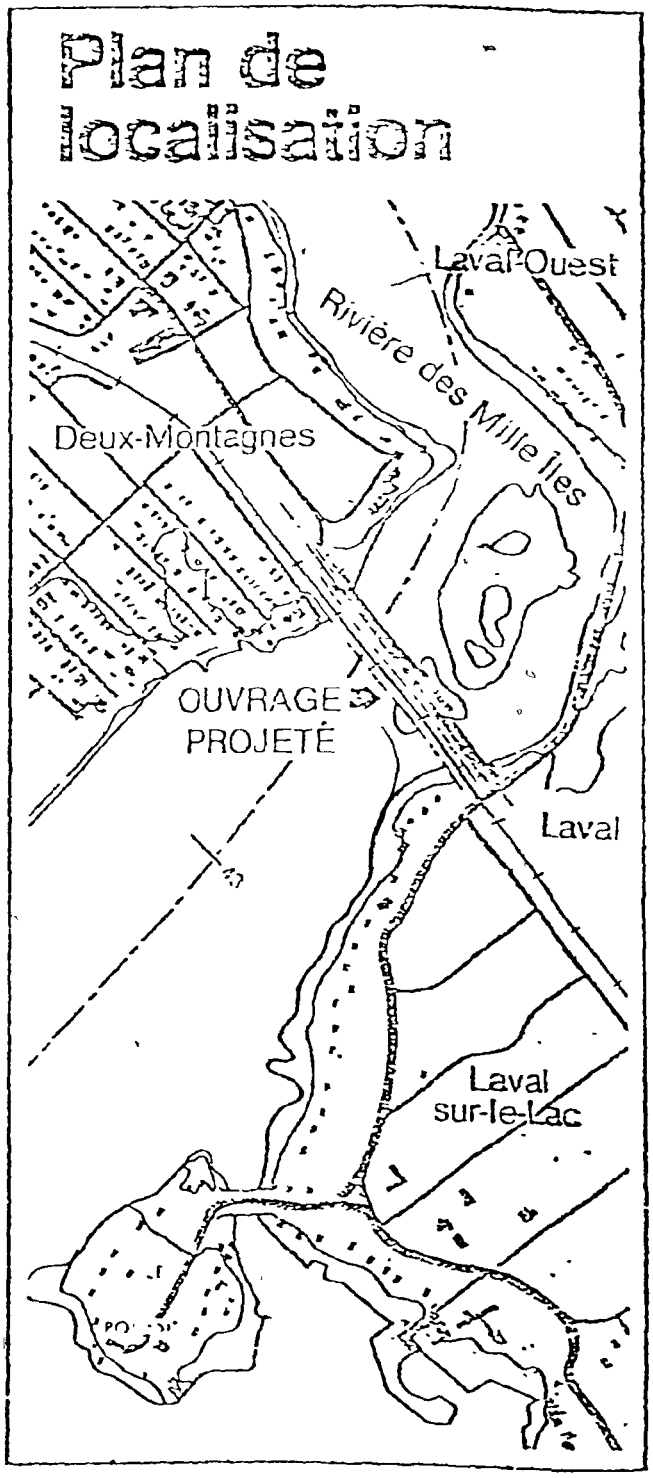


PLAN DE LOCALISATION

Source: Shawinigan 1981







Source: Shawinigan 1981

Glossary

Avifauna:

Ring-billed gull- Larus delawarensis
Herring gull- Larus argentus
Great black headed gull- Larus marinus
Great blue heron- Ardea herodias
Black crowned night heron- Nucticoray nycticorax
Green heron- Burotes virescens
American bittern- Botaurus lenqtiqinosus
Least bittern- Ixobrychus exilisis

vegetation:
(source: Golet 1976)

Pickerelweed- Pontederia cordata
Arrowhead- Sagittaria latifolia
Water plantain- Alisma triviale
Water arum- Calla palustris
Golden club- Orontium aquaticum
Purple loosesstrife- Lythrum salicaria
Water lily- Nymphaea odorata
Wild celery- Vallisneria americana
Duckweed- Lemna minor
Reed canary grass- Phalaris arundinacea
Blue joint- Calamagrostis canadensis
Woolgrass- Scirpus cyperinus
Cattail- Typha sp.
Mannagrass- Glyceria sp.
Soft rush- Juncus effusus
Sedges- Carex sp.
Flowering rush- Butomus umbellatus
Joe-pye weed- Eupatorium maculatum
Red maple- Acer rubrum
Silver maple- Acer saccharinum

Speckled alder- Alnus rugosa
Willow- Salix sp.
Red osier- Cornus stolonifera
High bush blueberry- Vaccinium corymbosum
Buttonbush- Cephalanthus occidentalis
Swamp rose- Rosa palustris
Viburnum- Viburnum sp.
Sweet gale- Myrica gale
Sheep laurel- Kalmia augustifolia
Bog laurel- Kalmia polifolia
Sugar maple- Acer saccharum
Ash- Fraxinus sp.
Sensitive fern- Onoclea sensibilis
Oak- Quercus
Beech- Fagus sp.