EVALUATING PUBLIC DECISION MAKING:
The Squamish Flood Management Case

By

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The effectiveness of the flood management decision process in Squamish for producing socially optimal decisions is the subject of this thesis. Squamish is located on a coastal river floodplain which supports a variety of competing resources. Since different flood protection strategies produce different streams of costs and benefits, officials are faced with the problem of selecting a strategy which reduces flood damages while ensuring the greatest return from floodplain resources. Until the recent adoption of floodplain development regulations, officials have primarily relied on dykes for managing the flood hazard. Although the new regulations represent an improvement in flood management, no attempt was made to evaluate the effects on floodplain resources and there is a concern that should a flood exceed the level of the dykes those homes which are not floodproofed will be severely damaged. Should this occur, society will probably compensate the victims as well as to provide additional assistance for increasing the current level of flood protection.

This study examines these issues by reviewing the laws and policies governing flood management and by documenting the events and interactions of officials involved in making flood management decisions in Squamish.

Since the thesis examines the public decision making process, the evaluative criteria are derived from the social values inherent in our liberal democratic system. The criteria are as follows:
- the decision process should involve all affected interests;
- decisions should be based on adequate information;
- the decision process should be efficient.

Recommendations are made, based on a review of the literature on flood management and behavioural theory for resolving existing flood protection problems and for remedying the deficiencies identified from the foregoing analysis. The following summarizes the findings and recommendations:

1. The current flood protection plan has the following weaknesses:

   - Primary reliance is placed on a dyking system which is both incomplete and incapable of withstanding a catastrophic flood event.

   - The floodplain regulations provide only minimal protection from catastrophic floods as they do not apply to existing and new homes in established neighbourhoods.

   - Neither the dyking system nor the floodproofing regulations have been properly evaluated to determine their optimum level of protection.

   - A range of other strategies which could potentially reduce future flood damages have been overlooked.

   - There is still some uncertainty regarding the potential of the Cheekye River flood hazard.

To resolve these problems an inter-agency task force should be established to review the situation and recommend appropriate solutions. In particular, officials should consider the necessity of redesigning the dyking system and floodplain regulations in combination with a range of other strategies such as relocation, flood loss insurance, flood forecasting and river maintenance, to determine the optimum level of protection.
Officials should also consider the necessity of re-evaluating the Cheekye River hazard.

To ensure that task force plans are implemented, three recommendations are made. First, to ensure that adequate resources are available, all three levels of government should negotiate a cost-sharing arrangement. Second, the federal government should adopt a policy which stipulates that all federal programs, projects and financial assistance are subject to specific guidelines for flood management as determined by the Department of Environment and which reflect the direction of the foregoing recommendations. And third, the following recommendations for improving the current decision making process should be adopted.

2. The decision process has the following weaknesses:

- Those affected by flood management policies were not well represented during the decision process as there was no overall framework to coordinate and integrate all the concerned interests.

- Information used to select flood management strategies was deficient because no guidelines had ever been established to ensure that adequate information is generated to determine the best course of action.

- The decision process was inefficient due to unnecessary delays caused by inter-agency conflicts and because better decisions could have been reached had officials been more informed.

To resolve these deficiencies the Ministry of Environment should consider the following recommendations:

- To ensure adequate representation a decision process should be designed which ensures that all the interests including the public are provided with an opportunity to be informed of and to express their views on flood protection prior to decisions being made.
- To improve the adequacy of information, rules should be established for ensuring that all flood protection strategies are properly evaluated.

- To make the decision process more efficient the recommendations for improving the interactions of officials and for improving the information base should be implemented.
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CHAPTER 1

FLOOD MANAGEMENT DECISION MAKING:

The need for a new approach

1.1 RESEARCH FOCUS

This thesis examines flood management policies and decisions in Squamish, British Columbia, to determine if the process was able to produce socially optimal decisions. The study concludes with recommendations for dealing with immediate flood protection problems and for revising the decision process so that future decisions can achieve, to the extent possible, the greatest social benefit.

1.2 RESEARCH PROBLEM

With a population of approximately 9,000 persons, Squamish is situated on a coastal river valley floodplain that is highly vulnerable to flooding. Historically, the community has relied on a dyking strategy for flood protection. However, recent floods in 1980 and 1981 which caused in excess of $7 million damage, raised a concern regarding the adequacy of flood protection. As a result, officials decided to extend the dykes and control future floodplain development by requiring homes in new subdivisions to be floodproofed (i.e., raised above dyke level). While this is an improvement, the problem remains as some residents are not required to floodproof and if a flood breached
the existing dykes the damages would be catastrophic. Since the general public provides assistance for flood protection projects and will probably compensate future flood victims, the issue of distributing public goods and services in an economically optimal fashion is raised.

Moreover, because coastal floodplains have a multiplicity of competing uses and because different flood management strategies produce different patterns of land or resource uses, officials are faced with the more general issue of efficiently allocating land/resource uses. For example, the adoption of a dyking strategy and the subsequent development of the floodplain forecloses the opportunity of utilizing that area for agricultural development, fish and wildlife habitat or for outdoor recreation pursuits. Thus, decisions should be made so that those uses deemed by society to be the most important are protected and the greatest social benefit can be realized. In Squamish, officials did not take into account these competing resource/land use values in making flood management decisions. Hence, flood management decisions may not reflect a social optimum.

Traditionally, cost-benefit studies have been used for assisting officials in making flood management decisions. However, the application of cost-benefit analysis has suffered from recurring weaknesses which have undermined its satisfactory use for arriving at socially optimal decisions (James, 1968; Barlowe, 1972; Watt, 1973). In particular, the following three major deficiencies can be attributed to this problem.
First, certain intangible values which are relevant to the type and scale of protection adopted have either been ignored or improperly determined (James, 1968). Second, flood frequencies and flood magnitudes cannot be predicted with certainty, yet the costs and benefits of a project are often considered well established facts (James, 1968). And third, those responsible for flood management studies have historically perceived structural measures (e.g., dykes, dams and river diversions) as the only practical response to the flood hazard and consequently, a range of other strategies (e.g., floodproofing, zoning regulations and flood loss insurance) which produce different streams of costs and benefits have tended to be overlooked (White, 1964; 1975).

Clearly, if better or optimal decisions are to be achieved then officials need to discern more clearly the full range of options available as well as the full range of effects of each option. This can be achieved by improving the cost-benefit model and by adopting a decision process which moves beyond the mere application of economic criteria and into the political science arena where decisions are reached by reference to the socially acceptable standards of a good decision making process (Watt, 1973; Fox, 1976). Since ours is a democratic society, these social standards should reflect the normative ideals of democratic decision making theory. For the purposes of this study, this implies that those affected by a decision should have the opportunity to be informed of and express their views on proposed flood management plans; there should also be adequate
information from which to base an informed decision and the
decision process should be efficient so as not to be wasteful in
utilizing scarce public resources.

1.3 RESEARCH OBJECTIVES

In light of the foregoing, the objectives of this study are:

1. To develop criteria for evaluating the decision process
   for flood management based on the normative ideals of
   democratic theory.

2. To provide an historical account of the decision making
   process that led to the existing flood management
   program in Squamish.

3. To evaluate the adequacy of the decision making process
   for producing socially optimal decisions through the
   application of the normative criteria.

4. To utilize concepts from theories of political and
   administrative behaviour to explain why deficiencies
   in the case study arose.

5. To recommend immediate action for dealing with existing
   problems and to propose institutional changes so that
   future decisions can more closely reflect the normative
   ideals.

1.4 RESEARCH METHODS

The research followed five sequential stages which correspond
with the objectives above. Briefly, the evaluative criteria were
derived from the underlying principles of liberal democratic
theory (Fox, 1982, 1976, 1970; Mayo, 1960). The fundamental
basis of this approach is that socially optimal decisions can be
achieved through a process that is consistent with the normative
ideals of democratic decision making.

The information regarding the interactions of officials involved in making flood management decisions in Squamish, was obtained from numerous interviews with local, provincial and federal officials, the Squamish Times and the official minutes of Squamish Municipal Council meetings.

The evaluative criteria were then applied to the case study to determine the extent to which the decision process conformed to the normative ideals.

To understand why the case study varied from the normative ideals we identified possible explanations from theories of political and administrative behaviour from a review of the relevant literature (Aucoin, 1979; Downs, 1967; Fox, 1982; Kates, 1962; Lindblom, 1968; Olson, 1965; Russell, 1979; Sewell, 1971; Simon, 1957a, 1957b).

On the basis of these findings, the research concludes with recommendations to resolve existing flood protection problems and to improve the decision process so that future decisions can come closer to achieving the normative ideals.
CHAPTER 2
DESCRIPTION OF AREA

2.1 LOCATION

The area of study is defined by the boundaries of the District Municipality of Squamish and is known as the Lower Squamish Valley. This area is located 70 km. north of Vancouver at the head of Howe Sound on the British Columbian coastline (Figure 1). The valley follows the Squamish River from where it empties into Howe Sound to the Cheakamus River, a distance of approximately 17 km.

2.2 GEOGRAPHY AND LAND USE

The Lower Squamish Valley runs north-south amidst mile high coastal mountains which have confined settlement to the more easily developed Squamish River floodplain.

Today, there are 9,200 residents in the Municipality of Squamish.1 The major residential and commercial center of the municipality, the Village of Squamish, has a population of 3,368 people and is located on a delta near the mouth of the Squamish River, an area highly vulnerable to flooding. Other residential (e.g., Valleycliffe, Garibaldi Highlands and Brackendale),

Figure 1
REGIONAL LOCATION
1:525 000
commercial and industrial development (e.g., B.C. Rail and Industrial Park) is scattered throughout the valley in areas that are also subject to flooding (Figure 2 - 3).

Being on the coast, the area has a typical maritime climate with a dry, hot summer and a wet, mild winter. During the winter, the valley is subject to numerous rainstorms while the mountains, on the other hand, experience heavy snowfalls. The high rate of precipitation\(^2\) and variable winter temperatures are major contributing factors to flooding that can occur at any time from the late fall through to the early spring.

Within the Lower Squamish Valley, the Cheakamus and Mamquam Rivers are tributaries of the Squamish River. The combined watershed area of these rivers is approximately 3,636 km.\(^2\) A third smaller river, the Stawamus, drains an additional 39 km.\(^2\) but enters Howe Sound independently of the Squamish River.

The combination of rivers, feeder streams, the floodplain, and the coastal estuary provides valuable habitat for a variety of fish and wildlife species within the Lower Squamish Valley. The Squamish estuary is a popular breeding and feeding ground for migrating birds as well as an important source of nutrients for a variety of sea life (Government of Canada et.al., 1978). The rivers and feeder streams provide critical migrating channels and spawning grounds for anadromous fish. The vegetation cover along the banks of the rivers provide important nutrients for aquatic

---

2. Annual rate of precipitation is 202 cm. and snowfall at higher elevations has been known to exceed 255 cm.
Figure 2
LOCATION OF DYKES AND FLOODPLAIN DEVELOPMENT

- BC Railway
- Existing Dyke
- Fish Gate

Squamish River
Industrial Park
Highway 99
Valleycliffe Subdivision
Squamish
Judd Slough
Brackendale
Garibaldi Heights
Mamquam River
Figure 3
PHYSICAL HAZARDS
AND SETTLEMENT AREAS

Settlement Areas
Mud Slide Area
Maximum Danger
Mud Slide Area
Lesser Danger
Flood Prone Area *
Flood Prone Area **

* Derived from floodplain mapping
Inventory and Engineering Branch
Ministry of Environment

** Derived from Preliminary Geological
Hazards Mapping, Resource Analysis
Branch, Ministry of Environment
resources as well as serving as a protective canopy for wildlife.

The occurrence of these resources in close proximity to large population centers on the Lower Mainland gives it added value for outdoor recreation enthusiasts because areas which are closer are rapidly being destroyed by development. Presently, the primary attraction of the area is the salmon sport fishery and the unique opportunity to view large numbers of bald eagles.

2.3 THE FLOOD HAZARD

The most common flooding occurs in the late fall when warm and moist southerly inflow winds bring heavy rains to the valley and snow melt conditions to the mountains which, when combined, create sudden and abnormally high river discharges (fall flash flooding). These flood conditions are worsened when high waves, caused by severe coastal storms, and high tides combine to cause the water table of the floodplain to rise and prevents the normal drainage of run-off behind the dykes.

Although fall flooding is more common, the "spring freshet" flood poses a greater threat because it has the potential under the right conditions to become catastrophic. Such flooding is generally the result of several days of warm rainy weather. The melted mountain snow cover combines with the run-off from the rainfall to exceed the capacity of the watershed's drainage system. If the snow cover is abnormally deep and the warm, wet weather persists, the flood waters can exceed the design level of the dykes.
In addition to the foregoing flood hazards, the Cheekye River fan (Figure 3) has been designated as a potential flood hazard zone. This zone extends from the upper reaches of the Cheekye River to a residential area in Brackendale. The primary concern in this zone is that under heavy run-off conditions, the Cheekye River could shift course, loosen the unstable fan and cause massive flooding and mudslides. Currently, no strategy has been adopted to deal with this potential hazard.

2.4 HISTORY OF FLOODING

Streamflow data have been collected since 1916 on the Cheakamus and since 1955 on the Squamish. Current records indicate the following streamflow characteristics: 3

<table>
<thead>
<tr>
<th>RIVER SYSTEM</th>
<th>MEAN MONTHLY FLOW</th>
<th>MEAN ANNUAL FLOW</th>
<th>MINIMUM FLOW</th>
<th>MAXIMUM FLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheakamus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1914–1973 data</td>
<td>47 m/s 1660 cfs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mamquam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1937–1973 data</td>
<td>28 m/s 977 cfs</td>
<td>13 m/s 453 cfs</td>
<td>59 m/s 2072 cfs</td>
<td></td>
</tr>
<tr>
<td>Stawamus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973 data only</td>
<td>5 m/s 176 cfs</td>
<td>3.22 m/s 144 cfs</td>
<td>29 m/s 1010 cfs</td>
<td></td>
</tr>
<tr>
<td>Squamish</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1922–1973 data</td>
<td>241 m/s 8530 cfs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Water Survey of Canada (1973) Environment Canada, Inland Waters Directorate. Data were also collected from the Squamish during the brief period from 1922 – 1926.
1. In 1885 Norwegian settlers were forced to evacuate their homes because of severe flooding. There is no information regarding the time of year that flooding took place.

2. From 1921 to 1958, a total of seven major fall floods have occurred in the area (Marr, 1965). In many instances flood waters topped the existing dykes and forced residents to evacuate.

3. In the spring of 1972 and again in 1974, several areas of Squamish experienced minor damages from a "spring freshet" flood.

4. On December 27th 1980 areas throughout the Lower Squamish Valley suffered severe property damage from flooding. In the Valleycliffe area, flood waters broke through a dyke on the Stawamus River and caused damages to a schoolyard and several homes. In the Judd Slough area of Brackendale, a flood gate in the dyke was jammed open by log debris and flood waters flowed freely through an adjacent subdivision. Finally, a mobile home court near the confluence of the Squamish and Mamquam Rivers was flooded because the dyke had not been extended to protect this area. In total, 400 homes were flooded and 200 people were evacuated.

5. Most recently, on October 31st and November 1st 1981, two areas of Brackendale were flooded. In the Judd Slough area, homes located behind the dykes were flooded because the area lacked an adequate storm drainage system and two mobile home courts were flooded in the same undyked area of the floodplain as the previous year.

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4. Source: The Vancouver Sun, December 29th 1980. These figures include residents of the Lower and Upper Squamish Valleys.
2.5 HISTORY OF FLOOD MANAGEMENT

As previously indicated, settlement in Squamish has historically been confined to the relatively flat, Squamish River floodplain. To protect their homes and farmland from flooding the early settlers constructed a dyke. Eventually, others settled in the area protected by the dykes and gradually the farmland was transformed to a thriving new village.

Despite the occurrence of numerous floods throughout the early 1900's, little work was done to upgrade or expand the dykes. Finally, in 1949, it became apparent that additional flood protection was required to accommodate the rapidly expanding community. At the request of a local citizen's group, the provincial government conducted a series of feasibility studies which culminated in 1965 with the "Marr Report". This report concluded that it was economically feasible (benefits exceed the costs) to provide dyke protection for the entire Lower Squamish Valley.

By the mid 1970's, construction on the project was halted because provincial government funding was withheld pending the adoption by the municipality of measures to restrict further floodplain development. However, floodproofing regulations (Bylaw 277 - December, 1981) were not adopted until after floods struck major residential areas of the floodplain in 1980 and 1981, and caused in excess of $5 and $2 million respectively.

Today, approximately 95% of the valley is protected by a dyking system designed to accommodate a flood with a magnitude of
2,125 m$^3$/s (75,000 cfs) or an estimated flood recurrence interval of 200 years (Figure 3). The undyked portion of the valley is located in Brackendale on the north bank of the Mamquam River.

2.6 FLOOD MANAGEMENT ISSUES

As noted earlier, two flood types occur in the Squamish area. The more common "fall flash flood" type and the potentially more catastrophic "spring freshet" type. Because fall floods are more common and less severe than the "spring freshet", the existing dyking system has been somewhat successful in preventing flood damages. However, reliance on the dykes as the primary flood protection measure has actually contributed to an absolute increase in flood damages as residents have been encouraged to develop the floodplain under the false assumption that the dykes will prevent a future flood ("floodplain infilling").

The recent adoption of floodplain or floodproofing regulations will have some effect on controlling floodplain development and reducing future flood damages. However, the regulations do not appear adequate as they only apply to homes being constructed in new subdivisions. Other homes, with the exception of high density housing (e.g., condominiums), being constructed in established neighbourhoods are not required to floodproof. Thus, if a rare flood does occur and the dykes are breached, the effects on developed areas of the floodplain will be catastrophic.
The valley also suffers from the following flood protection problems: (1) there is no protection for the undyked portion of the Brackendale floodplain; (2) there is no provision for protection in a Brackendale subdivision against the Cheekye River flood hazard; (3) a variety of additional flood management strategies have not been considered for adoption (e.g., flood warning, flood loss insurance, public education, etc.); and finally, (4) there is no river maintenance program aimed at reducing potential flood hazards caused by log jams.

In addition to the foregoing issues, the construction of the dykes and subsequent development of the floodplain has serious implications for the use of other floodplain resources. For example, residential, commercial and industrial development virtually destroys fish and wildlife habitat. The construction and repair of dykes causes the deposition of deleterious substances in the water and results in the removal of riparian vegetation. The dykes also sever fish migratory channels in feeder streams and channelizes the river causing the gravel beds in spawning grounds to be scoured. Estuarine resources are thought to be vital to the viability of the sport and commercial fishing of the Georgia Strait and, therefore, have important implications for the social and economic well being of society as a whole (Government of Canada et.al., 1981).

5. For a comprehensive list of the full range of possible flood protection strategies, refer to F.G. White (1964) and Smith and Tobin (1979).
In light of the fact that Squamish relies almost entirely on the dyking system for flood protection, it is likely that residents will experience floods in the future. If this occurs, financial demands will again be made on society to compensate the flood victims and provide additional funding for increasing the amount of dyke protection. This, in turn, will further limit the potential for utilizing or protecting other floodplain resources as well as to cause flood management related costs to spiral.
This chapter describes the formal institutional arrangements and the legal jurisdictions and programs affecting flood management decisions. The stages of planning and implementing a flood control program are also outlined.

3.1 FORMAL INSTITUTIONAL FRAMEWORK

The new Canadian Constitution establishes the framework for the division of powers and responsibilities between federal and provincial jurisdictions over matters involving flood management. Briefly, because water is considered a natural resource, decisions affecting its use are generally considered a provincial responsibility. However, federal authorities have jurisdiction over water management decisions which affect federally controlled lands, inter-provincial or international waterways, navigable waterways (inland and ocean) and anadromous fish.

All other decisions which involve the management of water for flood protection purposes are the sole responsibility of provincial jurisdictions unless otherwise stated by agreement between the federal and provincial governments. Currently, agreements have been struck regarding the collection of stream flow data and the provision of federal financial and technical assistance for the Lower Fraser Valley Flood Management Project.
In British Columbia, flood management planning has been a shared responsibility between provincial and municipal jurisdictions. Traditionally, the municipal government has had responsibility for initiating and approving flood management programs. However, since most flood management projects require costly, technical expertise and large capital expenditures, provincial assistance in terms of feasibility and design studies, and project financing has been required. Recently, such assistance has been provided only if the municipality adopts floodplain zoning regulations. In this manner, municipal decision making can be strongly influenced by the provincial government.

Provincial authorities are also able to influence municipal flood management decisions in situations where fish and wildlife habitat is threatened.

Figure 4 provides a graphic illustration of the foregoing flood management decision making arrangements.

3.2 LEGAL JURISDICTIONS AND PROGRAMS

3.2.1 Federal Legislation

The primary federal legislation affecting municipal flood control projects is the Fisheries Act. Under this Act, a Federal Fisheries Officer of the Department of Fisheries and Oceans (D.F.O.) and/or a Provincial Conservation Officer of the Fish and Wildlife Branch, Ministry of Environment (M.O.E.), may prevent or halt any activities, below the normal high water mark
FIGURE 4

FORMAL FLOOD MANAGEMENT DECISION MAKING FRAMEWORK
of a stream, which are harmful to the normal passage or habitat of anadromous fish.

D.F.O. is responsible for approving flood control projects at the federal level. Flood control projects may be voluntarily referred for approval at the design stage or municipalities may wait to apply for the required "Gravel Removal Order" from the local Fisheries Officer prior to commencing construction. In either case, if the project does not meet the standards necessary to ensure the protection of the aquatic resource then the "Gravel Removal Order" may be withheld and the project delayed. Moreover, if, during the course of construction, the conditions of the Order are not being met, the Fisheries Officer may invoke the Fisheries Act to halt the project.

3.2.2 Federal Programs

The federal government administers the following flood management related programs and policies:

- collection of stream flow and water quality data
- Flood Damage Reduction Program
- Canada Mortgage and Housing Corporation (CMHC) floodproofing guidelines.

The collection of stream flow and water quality data is constitutionally a provincial responsibility that has been delegated, by agreement, to the federal government (Department of Environment (D.O.E.), Inland Waters Directorate). The data provide information for estimating the degree of protection
required for preventing the occurrence of a future flood event.

The Flood Damage Reduction Program, (D.O.E.) provides financing for flood control projects if the provincial and municipal governments have adopted measures to restrict new development from designated flood prone areas. As previously indicated, the Lower Fraser River Flood Control Project is the only project funded under this program.

Under the Federal Disaster Assistance Program, D.O.E. will share 50% of those flood damage costs which exceed the population total of the province. This means that with a population of 2.5 million in British Columbia, the first $2.5 million of flood costs are incurred by the province and any amounts exceeding this total are equally shared with the federal government. Currently, D.O.E. is attempting to negotiate an agreement with the province that would require municipalities to adopt floodplain development regulations in order to be eligible for federal flood relief.

Finally, CMHC has strict regulations which stipulate that approval for National Housing Act (NHA) mortgage insurance will not be granted for dwellings in designated flood prone areas unless specified floodproofing requirements are met.

3.2.3 Provincial Legislation

Four pieces of provincial legislation have an affect on the flood management policies of municipal governments, namely: The Municipal Enabling and Validating Act (1972); the Municipal Act (1979); the Strata Titles Act (1978); the Land Titles Act
(1978); and the Dyke Maintenance Act (1965). A fifth piece of legislation, the Federal Fisheries Act, as previously indicated, permits provincial Conservation Officers to have some degree of influence over municipal flood management activities when fish and wildlife habitat is threatened.

The Municipal Enabling and Validating Act stipulates that adoptions, amendments or repeals of regional/community plans or zoning bylaws must be registered and approved by the Minister of Municipal Affairs. In cases involving an area in a designated flood hazard zone, approval must also be obtained from the Minister of Environment. This act, however, only applies to communities in the Lower Fraser River Valley.

Under the Municipal Act, municipalities which have initiated an Official Community Plan must identify lands which are subject to natural hazards. There is no requirement that a protective strategy be adopted.

The Strata Titles Act and the Land Titles Act both require that the Approval Officer for bare land strata titles and new subdivision applications shall, in cases where the land is subject to flooding, obtain the consent of the Minister of Environment. As a condition of his consent, the Minister may require the insertion of certain floodproofing-type covenants in the Land Title.

And finally, the Dyke Maintenance Act empowers the Dyke Inspector (M.O.E.) to demand that the appropriate agency make repairs that are necessary for the proper operation of the dykes.
3.2.4 Provincial Programs

The Ministry of Environment, Water Management Branch, (M.O.E.) is responsible for administering the following provincial flood management programs:

- Floodplain Development Control Program
- Flood control and flood relief financing program.

The floodplain Development Control Program is similar to the federal government's Flood Damage Reduction Program. The primary aim of the program is to reduce flood damages by encouraging municipalities to control the extent of floodplain development. The planning program generally involves the identification of flood risk areas, floodplain mapping, designing and evaluating flood protection plans, reviewing community plans and floodplain zoning bylaws, and supervising the implementation of a plan (e.g., construction of a dyke). As previously discussed, M.O.E. does not have the authority to impose its flood management objectives and programs on the municipality. However, most municipalities voluntarily request M.O.E.'s services because they have the technical expertise and financial capability necessary to design and implement a flood management plan.

The flood control financing program has recently been used by M.O.E. to encourage municipalities to control floodplain development by stipulating that financial assistance is dependent on the adoption of floodplain zoning regulations.

The flood relief program, in contrast, lacks clearly defined eligibility criteria, such as floodproofing precautions,
and suffers from ad hoc administration.

3.2.5 Municipal Legislation

Municipal governments have the delegated authority to govern programs involving the management of floods. In Squamish, the only piece of legislation affecting flood management is Zoning Bylaw 277 (1981). The objective of this bylaw is to control the development of the floodplain so that future flood damages can be reduced. In short, the bylaw stipulates that no new development, with the exception of heavy industrial buildings, agricultural buildings, and dwellings in established subdivisions (except condominiums), can be constructed without the adoption of adequate floodproofing precautions, regardless of whether it is behind the dykes. Adequate floodproofing involves the raising of a building so that the main floor is above the level of the dykes.

3.2.6 Municipal Programs

In Squamish, the flood management program is primarily based on a dyking strategy. The recently adopted floodproofing regulations provide supplementary flood protection but only for newly constructed dwellings in areas of the floodplain that have not been previously developed. The only other strategy is an emergency evacuation program developed in response to concerns about a possible toxic substance spill from the B.C. Rail freight
yards and the local chemical plant.

Aside from their responsibility for administering the flood management program, the municipality is required to construct, maintain and repair all flood control works. If M.O.E. has designed the project, construction is generally conducted under the supervision of a M.O.E. engineer.

3.2.7 Private Institutions

In addition to the public institutional mechanisms for managing flood hazards, private institutions have the capability to influence flood management practices. However, in British Columbia, private institutions have had little involvement in flood management. Most banks will not provide mortgages for development in areas that have been declared a disaster zone by provincial or municipal authorities or if it is apparent that the bank could lose its investment from the occurrence of a natural hazard. The problem with this policy is that flood hazard zones are generally not considered disaster zones unless a flood is occurring at the time. Furthermore, most banks lack the expertise necessary to evaluate the nature of a potential disaster.

6. Information provided by the Regional Mortgage Manager, Bank of Montreal, Vancouver.
3.3 FORMAL PLANNING FRAMEWORK

In British Columbia, there is no clearly defined flood management planning program. The following outline simply provides a close approximation of the interactions of agencies involved in making flood management decisions. Generally, decisions proceed through the following stages:

1. The Conceptualization Stage;
2. The Evaluation Stage;
3. The Implementation Stage.

3.3.1 The Conceptualization Stage

This stage involves the identification of the problem (flood protection), and the goals and objectives necessary to resolve the problem (flood protection strategies). Once the problem has been identified, negotiations are initiated between provincial and municipal officials, and in certain cases, federal officials; to determine the type of strategies required to resolve the problem, the procedures to be followed for evaluating and implementing the project and the division of labour and financing necessary to implement the project.

3.3.2 Evaluation Stage

Once the project has been approved, M.O.E. assumes responsibility for evaluating its engineering and economic
feasibility. Generally, a cost-benefit study is conducted by M.O.E. staff or a consultant. The study calculates the benefits, in monetary terms, that would accrue from the prevention of damages with the introduction of a specific flood control plan and the monetary costs associated with constructing and maintaining the project. If the benefits exceed the costs, then the project is considered feasible.

Regardless of whether a cost-benefit study is conducted, the evaluation stage always involves the review of the project by agencies that may be potentially affected by a flood management plan. In short, agencies may recommend specific design changes so that their interests can be protected (e.g., the construction of fish gates to permit the passage of anadromous fish). When conflicts arise, bargaining is pursued between the affected agencies until an acceptable compromise is reached or a higher level of interaction is required. In the end, the type, design, location and timing of construction for the project may be significantly altered from the initial design proposal.

Finally, if a floodplain zoning bylaw is being adopted, the municipal government is required to obtain public input through a public participation program prior to adoption.

3.3.3 The Implementation Stage

The final stage in the planning process involves the implementation of the plan. If the plan involves the construction of a structural measure (e.g., dykes or dams), then the
municipality is responsible for acquiring, by easement, land purchase or expropriation, the necessary rights-of-way. The actual construction work may be conducted by municipal crews or a private contractor. If the provincial government has designed and financed a portion of the project, then M.O.E. engineers supervise the construction. In addition, other agencies such as D.F.O. may conduct on-site inspections during the construction phase to ensure that aquatic resources are not being threatened.

Upon implementation of the flood management plan, the municipality is responsible for enforcing the plan and ensuring that the protective measures are kept in good working order.
CHAPTER 4
CONCEPTUAL FRAMEWORK FOR ANALYSIS

4.1 NORMATIVE PRINCIPLES

At the outset of this study, I identified three major deficiencies of past cost-benefit studies which have contributed to the failure of flood management decisions to produce an optimal pattern of land use:

1. Difficulty in quantifying intangible values.
2. Uncertainty in predicting the occurrence of natural phenomena.
3. Limited perceptions of the management choices available.

In light of these deficiencies, I proposed that decision making in the public sector needs to move beyond the mere application of economic criteria and into the political science arena where decisions are reached by reference to common social standards (Watt, 1973).

I further suggested that in a democratic society, the social standards upon which to base public decision making should reflect the normative ideals of democratic decision making. Thus, assessments of government decision making should concentrate on the decision process rather than the decision outcome. Fox (1976) concurs with this approach because in his view a "good" process will produce a "good" outcome and, in fact, this is the manner by which we have traditionally appraised our public institutions.

The basic principles of democracy, according to Mayo
(1960), imply that decision makers are accountable for their actions through the will of the majority at election time and also that all members of society equally share the right to influence the decision process through socially acceptable channels at times other than during the election.

On the basis of these normative ideals, we may infer two social standards for assessing public institutions. First, those affected by a public decision should be accorded the opportunity to express their views to the policy makers. Second, in order for the interests of society to be fully represented, adequate information must be made freely available. A third standard of efficiency may be inferred from a basic social principle that the administration of public programs should not be wasteful of time and resources.

Adherence to the above normative ideals should remove a major obstacle for decision makers to reach socially acceptable or optimal decisions. The task of the following section is to further define these ideals so that they can be operationalized as assessment criteria. To facilitate our evaluation, a series of questions will be posed to determine the extent to which the case study reflected the normative ideals.

The chapter closes with a section devoted to identifying the principles of political/administrative behaviour and discussing the

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7. Mayo (1960) identified the following four principles of democracy: (1) control of policy makers through the electorate; (2) political equality through universal suffrage; (3) freedom of political expression by the electorate; and (4) rule by the will of the majority.
nature of collective action. This, in turn, will provide us with direction for proposing changes to the existing decision-making structures.

4.1.1 Representation of Interests

The democratic norms of our society suggest that public decisions should reflect the preference of the affected interests. Problems arise, however, when we attempt to define how these interests should be represented, who constitutes a legitimate interest in the policy issue being addressed and to what extent they should be afforded the opportunity to represent their views.

Firstly, in a large pluralistic democracy it is difficult to determine when a particular interest is being adequately represented. Moreover, if decision processes were designed so that affected interests at the federal and provincial level were directly involved, then decision processes would be cumbersome and decision outcomes difficult to reach. Thus, in order to avoid complex issues regarding how well decision makers represent federal and provincial constituents, we will assume that such interests are adequately represented by the relevant government agencies which, in turn, are accountable to society through elected officials.

This brings forth the problem of identifying legitimate interests and according them with sufficient opportunity to represent their views. Simply defined, a legitimate interest includes those persons or groups that will be directly or
indirectly affected by a particular collective action. Thus, Squamish area residents who are directly affected by a flood management plan include those persons who have a business interest on the floodplain, those who reside on the floodplain and those who pay local taxes but live outside the floodplain. In order to achieve full representation of these interests two conditions must be met. First, locally elected officials should be involved in deciding upon flood management policies. Second, residents should have an opportunity to be consulted on the conceptualization and evaluation of proposed plans prior to decisions being made. As a corollary to the second condition, residents should have the opportunity to obtain technical information regarding the proposed plans so that their input can be meaningful.

Those with an indirect interest are defined as individuals or groups who may not bear the impact of a particular decision directly but who nonetheless have a legitimate right to express their views. These include provincial and national taxpayers who have contributed their taxes towards financing the project or interest groups and resource agencies concerned with the use of floodplain resources. Adequate representation of these interests is achieved if provincial and federal agencies which represent these concerns are afforded the opportunity to partake in the conceptualization and evaluation of proposed plans.

If adequate representation is achieved, then there will be a greater opportunity for a broader range of preferences and social values to be expressed.
In light of the foregoing, the following questions will be used in the evaluation:

1. Were Squamish officials involved in the conceptualization and evaluation of flood management plans?
2. Were Squamish area residents afforded the opportunity to obtain information and express their views on proposed plans to their elected representatives prior to decisions being made?
3. Did provincial and federal representatives have the opportunity to take part in the conceptualization and evaluation of proposed plans?

4.1.2 Information Adequacy

Representation of all the affected interests is of limited value unless adequate information is available for the interests to make informed judgements on the issues and problems being addressed.

As mentioned earlier, the use of economic evaluation tools has had practical difficulties which prevented public decision makers from achieving an optimal outcome. The major premise of this thesis is that these problems can be largely overcome through the adoption of a decision process which encourages input from the affected interests and through the adoption of a clearly defined set of guidelines for conducting cost-benefit tests which specifically addresses the deficiencies outlined earlier.

In light of the foregoing and based on a review of the literature on cost-benefit techniques (James, 1967; Sewell, 1961; White, 1960; 1964), information adequacy can be achieved through
the adoption of the following procedures:

1. Determine the full range of potential strategies.

2. Determine the categories of information required to evaluate the costs and benefits, including intangible values, associated with each strategy so that the concerns of all the interests can be addressed.

3. Determine the optimal level of protection from a combination of all strategies at various levels of protection.

To understand the basic operational elements of these procedures it is necessary to provide a more detailed description for each stage.

4.1.2.1 Range of Choice

Research conducted at the University of Chicago by Gilbert F. White and his associates during the 1960's, indicated that increasing flood costs were due to the adoption of large-scale, structural measures (e.g., dams, dykes and river diversions). White argued that such measures led floodplain investors to believe that they would be protected from future flooding. When the rare flood which exceeded the level of protection did occur, the increased development resulted in damages being far greater than they would have been without the protective measure.

To resolve this problem, White (1965) and others (Burton, 1965, 1970; Sewell, 1969; Smith and Tobin, 1974; Ward, 1978) argue that existing structural measures must be accompanied by a range of other measures designed to control future land use on
the floodplain as well as to complement existing measures. Thus, a flood management program might include a dyking system, flood loss insurance, emergency evacuation and flood warning schemes, relocation, floodproofing and floodplain development regulations.

The identification of a broader range of options is also crucial for addressing the requirements or needs of a broader range of interests as different strategies produce different patterns of land or resource use effects.

4.1.2.2 Range of Costs and Benefits

In order to fully comprehend the effects of each strategy, we must identify the range of affected interests, and the range of costs and benefits including intangible values, that each interest would require to assess the effects on his particular area of concern. For example, an environmental group would be concerned about the biophysical effects of a strategy on the aquatic resources, national and provincial taxpayers might be strictly concerned with the distribution of economic effects and local residents might be primarily concerned with the social effects of a strategy, particularly those related to public health and a sense of security.

Thus, if we are to satisfy the concerns of all the interests then the following general categories of information and the distribution of their effects will need to be considered in the cost-benefit evaluation:

1. The economic effects
2. The social effects
3. The biophysical effects

4.1.2.3 Selecting the Optimum

The final stage involves the selection of a combination of strategies to achieve optimal flood protection. This involves two tasks: (1) the estimation of a number of levels of protection for each measure, and (2) the selection of an optimal combination of these measures.

The various levels of protection for each measure are determined by estimating the cost of providing incremental levels or benefits of protection as determined from a reduction in anticipated flood frequencies or average annual damages as illustrated on Table 2.

Since flood frequencies are generally determined from limited hydrological records, the estimated benefits of providing a certain level of protection are uncertain. This factor, therefore, must be explicitly accounted for in the cost-benefit calculation.

Once the various levels of protection have been determined for each strategy, then the strategies must be combined to provide maximum protection at minimum total cost. To achieve this, it is necessary to evaluate many alternative combinations of types and scales of measures and compare their associated costs and benefits. The optimal combination is derived by comparing minimum total costs with the associated design frequencies, minimizing
<table>
<thead>
<tr>
<th>Dyke Elevation (Meters)</th>
<th>Chance of Overtopping (% Per/yr.)</th>
<th>Annual Cost of Dykes</th>
<th>Incremental Costs</th>
<th>Average Annual Damages (Benefits)</th>
<th>Incremental Benefits</th>
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**Table 2**

Estimated Scales of Adjustment for a Dyking Strategy.
costs while maximizing the reduction in flood frequencies.

As illustrated in Table 2, given the associated costs and benefits, and the estimated flood frequency, the optimal design level for a dyke would be 2.44 meters. At this level, marginal benefits equal marginal costs. Beyond this level, increments of protection are not economically feasible for this measure because the additional costs exceed the anticipated benefits.

In view of the foregoing, the following questions will be used for evaluating the criteria of information adequacy:

1. Were alternative combinations of kinds of measures and scales of adjustment for each measure evaluated?

2. Were the following categories of the costs and benefits and the distribution of their effects, including intangible values, supplied for evaluating the proposed flood protection measures?
   - economic effects
   - social effects
   - biophysical effects

3. Did the process account for and seek to minimize the problems associated with making decisions based on uncertainty?
4.1.3 Efficiency of Decision Process

The efficient provision of public goods and services is difficult to assess because they are not generally guided by market forces. For our purposes, efficiency is defined as a ratio of inputs to outputs or benefits/costs. The greater the ratio by reducing costs and increasing or at least maintaining the same level of benefits the more efficient the system.

There may be situations, however, where increased costs lead to a better outcome, defined as superior flood protection, but the benefit/cost ratio is actually reduced. There may also be situations where a better outcome is not so easily defined. In both instances, if we can reasonably assume that the increased expenditures led to a significantly better outcome by providing decision makers with more certainty in estimating the effects of pursuing a particular course of action, then the system could be judged as more efficient.

In light of the foregoing, the following evaluative questions are posed:

1. Could the same outcome be achieved with less time, public funds and staff resources?

2. Could officials have achieved a significantly better outcome in terms of making more informed judgements by expending more time, public funds and staff resources?

The foregoing discussion describes an ideal decision making process. In reality, however, ideals are seldom achieved because the complexity of human behaviour makes it difficult to predict how a proposed decision making arrangement will function (Fox, 1982). Nonetheless, it is important that policy and
decision makers continue to explore new ways to bring institutional decision making closer to reflecting the social values of society. To do this, we need to gain an understanding of the behavioural factors that influence individuals and institutional performance.

4.2 BEHAVIOURAL FACTORS

Public Choice Theory provides one approach for simplifying human behaviour and assessing the performance of public institutions. The basic assumptions of this model are that:

(1) The individual decision maker will pursue a course of action that will maximize his own well-being, and (2) when making decisions he will behave in a rational manner (Russell, 1979). Thus, public officials will seek to maximize their power, income, security and social and professional status (Downs, 1967). In turn, this generally leads to increases in program budgets, staffs and agency power.

Clearly, the utility of this model is that it expressly avoids an overly complex analysis by not examining the inter-relationships among cognitive, personality and cultural factors. However, if we are to assess institutional performance and design new decision making arrangements, then our analysis must refer to

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the following additional behavioural factors (Fox, 1982):

1. Human rationality is "bounded" by various practical limitations.
2. Human behaviour is guided by perception, attitude and ideology.

4.2.1 Bounded Rationality

Rationality may be bounded by the following limitations (March and Simon, 1958; Dror, 1968; Downs, 1967):

1. The limited amount of time available for the decision maker to consider a problem and choose the most effective course of action.
2. The limited capacity of the individual to handle information, review all possible solutions and make the best possible choice.
3. The multiplicity of demands on public agencies generally restricts officials from focusing their full attention on every possible project.
4. Improved or additional information from which to base "good" decisions can usually only be attained through the expenditure of additional scarce public resources (e.g., time, capital and labour).
5. Regardless of what level of information is obtained, it is impossible to predict with absolute certainty the occurrence of natural phenomena or future events.

Simon (1957) states that the decision maker will compensate for these limitations by "satisficing" or choosing the alternative that is "good enough". When "satisficing", decision makers tend to be "risk averse" by choosing traditional courses of action (Lindblom, 1968). Thus, flood managers who lack sufficient information to evaluate all the potential effects of
a flood control strategy, including the prediction of a future flood event, will generally respond to the problem of flooding by choosing traditional solutions (e.g., dykes and dams).

Lindblom (1968) refers to this conservative behaviour as "muddling through". This means that public officials will muddle through a succession of incremental changes, oriented towards resolving an immediate problem ("disjointed incrementalism"), rather than to make policies aimed at attaining a long term solution. In other words, the individual seeks a satisfying rather than an optimal solution. Although Lindblom's theory has merit for describing the behaviour of public officials, its use in a prescriptive sense would result in inept institutions.

4.2.2 Perceptions, Attitudes and Idealogies

Behavioural theorists (Fox, 1982; Sewell, 1971; Kates, 1970; White, 1966) state that the behaviour of decision makers is governed by the circumstances surrounding the decision situation, his perception of his role and the range of possible choices, the attitudes that he has formed out of his experiences and the ideals that he feels should be pursued.

In flood management, this implies that the nature of our past experiences with floods, the circumstances surrounding the decision situation and our professional and personal background, and social affiliations will all affect the manner in which we respond to the flood hazard.
Kates (1970) states that our perceptions of the flood hazard are primarily determined by our experiences with past flood events. He argues that the recency, magnitude, duration and frequency of these events are the most important factors affecting our responses. Hence, the individual who has experienced a recent, catastrophic flood will likely choose a different flood management strategy than the person who has never experienced a flood of such proportions.

Fox (1982) states that the general public's perception and values of a particular problem or issue can have a significant influence on the way a public official will perceive and react to the situation. For example, an official who is required to choose a management strategy at the time of a flood, will likely choose differently than he would at another time, because of the increased expression of public concerns and viewpoints regarding the most appropriate direction for flood management policies. At other times, the public may simply be disinterested in such an issue and consequently, officials won't need to be as concerned about potential negative reactions.

Finally, we also tend to form our attitudes and ideals in response to our social environments (Sewell, 1971). That is, our professional and personal backgrounds and affiliations will affect our perceptions of problem situations and the potential range of solutions to those problems. Thus, an engineer will respond differently to a flood problem than the person with little education or one trained as a biologist or social scientist (Fox, 1982). Moreover, those individuals who belong to similar social
groups, such as professional associations or family and cultural groupings, can generally be expected to respond to a decision situation in a similar fashion. This is particularly true for flood management as a small, homogenous group of individuals (engineers) have primarily been responsible for flood protection and have historically relied on large-scale, structural solutions (e.g., dykes and dams).

Kates (1970) argues that the consequence of the foregoing factors is that the individuals scope for searching for new and improved solutions to old problems is limited to traditional pathways. Hence, changes in public policies take a long time to be considered and adopted.

4.3 THE NATURE OF COLLECTIVE ACTION

The foregoing discussion has focussed primarily on the factors that affect the behaviour of individual decision makers. However, individuals never make public policy decisions without interacting with other parties who are affected by that policy. In order to explain the performance of institutions and design new decision making structures, we must gain an understanding of the nature of how decision makers interact and reach collective agreements.

The principle that individuals will act to maximize their own self-interest implies that in most collective decision making situations there will be a diversity of opinion among the participants on what should be done. Downs (1967) states that
even in situations of apparent cooperation, decision makers will likely have some conflicts of interest if they are maximizing their own well-being. If collective action is to occur, then some means must be found for resolving their conflicts (Fox, 1982).

Lindblom (1968) states that the task of conflict resolution can be achieved by one of two mutual adjustment techniques; negotiation, and the creation and discharge of obligations. The process of negotiation and bargaining involves a penetrating review of the problem by each participant which may result in their perceptions and initial stand being changed (Fox, 1982). The creation and discharge of obligations motivates individuals to cooperate through the principle of reciprocity. That is, an individual may agree to support another individual if that person reciprocates by supporting the first individual on another issue.

However, the process of conflict resolution will likely not occur unless individual decision makers from various representative agencies perceive that it is possible and necessary to do so (Dahl and Lindblom, 1953). Thus, institutional decision making frameworks should be designed so that decision makers are required to interact. In doing so, organizational performance is enhanced because it encourages the expression of a broader range of preferences and helps introduce new information and innovative methods for achieving a collective goal.

Ostrom (1973) supports this premise and proposes that institutional authorities and jurisdictions should be fragmented and overlapped so that they can limit and control one another.
This, he argues, is the only way to achieve a truly democratic decision-making process.

Both Ostrom and Sproule-Jones (1974) argue further that the decision-making process should be extended to include greater participation from the public. They state that unless the public is afforded the opportunity to express their preference to representative agencies, then the decision makers will be taking action without reference to the preferences or values of those affected by that action. Hence, decision-making processes will be less than democratically ideal. Moreover, by enabling a wider degree of participation, more alternative solutions can be taken into consideration prior to a course of action being selected.

4.4 EVALUATIVE FRAMEWORK SUMMARIZED

Earlier I argued that the use of economic criteria to guide public decision makers needs to be supplemented by reference to common social standards so that we can produce socially optimal decisions. The underlying theme of this approach is that socially optimal decisions can only be achieved through a process that reflects the social values of the affected interests. Since we live in a democratic society I chose evaluative criteria that were inferred from the basic principles of our liberal democratic system. The criteria are as follows:

1. The affected interest should be represented.

2. Information should be adequate for making an informed decision.
3. The decision process should be efficient.

To understand the case study and to assist in understanding what needs to be done to design an improved decision making process, I examined factors that determine the behaviour of decision makers. These factors were derived from political-administrative theories and include the following:

1. Decision makers are rational.
2. Rationality is said to be "bounded".
3. Decision makers strive to maximize their own self-interest.
4. Preferences are guided by the decision maker's perceptions, attitudes and experience.
5. Decision outcomes are based on collective decision making behaviour.

The foregoing provides the framework from which to base my case study assessment and to improve the decision process.
This chapter outlines, in chronological order, the events and decisions that led to the existing flood management strategy in the Lower Squamish Valley.

As is the case with most historical research, many details are difficult to confirm. Often facts become distorted in the minds of the actors over time and documentation is difficult to obtain from government officials. Thus, there may be certain aspects of the ensuing chronology where events do not coincide with the perceptions of those who were involved in the decision process. Nonetheless, the author is confident that the chronology reflects a fair account of the events.

To assist the reader in understanding the significance of certain events, they are presented as if they occurred within the following planning framework: (1) The Conceptualization Stage; (2) The Evaluation Stage, and (3) The Implementation Stage. It should be noted, however, that no such framework exists for devising flood management plans in Squamish. In addition, in order to reduce confusion over the constantly evolving names of government agencies, the names of all agencies throughout the period of study have been revised to reflect the current name.
5.1 THE CONCEPTUALIZATION STAGE

5.1.1 The Need for Flood Protection

The first settlers to the Squamish Valley responded to the flood hazard by hiring Chinese labourers to construct a dyke on the present site of the Village of Squamish so that they could convert the rich soils of the floodplain into farmland. Eventually, the protected area attracted other settlers and the productive farmland was transformed into a thriving new village.

Despite numerous floods throughout the early 1900's, residents did little else to improve the degree of flood protection beyond covering their own losses. In fact, it wasn't until the post-war population boom (1949) that the need for further protection became a public issue. Since there was no municipal council at the time, citizens formed the Squamish Valley Development Committee (S.V.D.C.) and approached the provincial government for assistance to upgrade and extend the existing village dykes throughout the entire Lower Squamish Valley. The primary argument for initiating a project of this magnitude was to provide protection for existing development in unprotected areas and to encourage future expansion and development throughout the valley.

The province responded by freezing all development on Crown and Pacific Great Eastern Railroad land and conducting the following feasibility studies:


These studies primarily concentrated on evaluating the need for improved and increased dyke protection as proposed by S.V.D.C. To this writer's knowledge, the dyking strategy was the only solution that was considered. In short, officials simply assumed that should it prove necessary, a dyke should be constructed to deal with the problem of flooding.

However, it wasn't until the "Marr Report" in 1965 that the actual design and economic feasibility of the project were evaluated. Prior to this, no direct action was taken by the government beyond an on-again, off-again effort to control development on Crown owned floodplain land and the construction of some erosion control work to protect bridges, highways and agricultural land.

5.2 THE EVALUATION STAGE

5.2.1 The Marr Report

In 1965, just shortly after Squamish became incorporated as a municipality, B.E. Marr of the Water Management Branch (M.O.E.) conducted the first and only comprehensive design and economic feasibility study of the proposed Lower Squamish Valley dyking
The study determined the costs of the project solely on the basis of the capital investment required to improve the existing dykes as well as to construct and maintain a new dyke at the 50 year flood recurrence level.

It is important to point out, that the level of the dykes was determined from limited hydrological information. Marr (1965) acknowledged this fact and illustrated the short duration of recorded river discharges in the following Table 3:

<table>
<thead>
<tr>
<th>TABLE 3</th>
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<tbody>
<tr>
<td>HYDROMETRIC RECORDS</td>
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<tr>
<td>Cheakamus River at Garibaldi ..... Discharge 1916-1951 and 1954-1965</td>
</tr>
<tr>
<td>Squamish River near Brackendale .... Discharge 1922-1926 and 1955-1965 (above Cheakamus Junction)</td>
</tr>
<tr>
<td>Mamquam River near Squamish ...... Stage 1960-1965</td>
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<tr>
<td>Cheakamus River near Brackendale ... Discharge 1957-1965 (above Cheekye River)</td>
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9. On the basis of more recent data, the estimated level of the dykes has been revised from the 50 to the 200 year flood recurrence interval.
The benefits were determined by estimating the reduction in "average annual damages" that might be expected from the construction of the dyke. Average annual damages were determined by estimating the amount of damages incurred at two foot intervals above the main floor of an average nonbasement "equivalent" house. The value of an equivalent house was based on an estimated average of all tax assessed homes in the area. The report acknowledged the fact that these estimates did not represent the true market value of potential damages to Squamish homes or businesses. However, it failed to indicate if these estimates were above or below the suspected market value.

Final estimates of the total benefits were calculated by adding the following factors:

- "average annual damages" prevented;

- the damage to the land prevented (10% of average annual damages);

- the loss of cleared land and cost of improvements due to erosion prevented;

- the amount of present flood control expenditures no longer required.

The study then converted the costs and benefits to a "present value" at 5% over a 50 year period to arrive at a benefit-cost ratio of 1.83.

On the basis of these calculations, officials declared that the proposed project was economically feasible. Despite the fact that the study suffered from deficiencies, some of which were acknowledged by Marr, no one has questioned the accuracy of this conclusion.
5.2.2 Negotiating the Financial Arrangements

Once the study was completed, negotiations to arrange for project financing were initiated. From the start, it was understood that the municipality and the province would share the initial costs of the project equally. However, the federal government (D.O.E.) made it clear that financial assistance would only be provided if the proposed level of the dyke was changed from the 50 to the 100 year flood recurrence interval.

D.O.E.'s decision to adopt this level of protection was based solely on the fact that it was the standard used by the U.S. Army Corps of Engineers. Whereas, the 50 year level adopted by provincial officials reflected the amount that the municipality and province were willing to pay. 10

To resolve this conflict, both senior governments initiated a series of negotiations which culminated in the fall of 1967 after the Mamquam River flooded. Being concerned about the flooding and frustrated by the apparent bureaucratic impasse, the municipality decided to force the issue by publicly announcing plans that the Mamquam dyke would be constructed immediately with the cost being shared by all three governments. On January 23rd 1968, the council sent the following telegram to D.O.E.:

10. Information obtained from correspondence entitled, "Present Status of Dyking and Flood Control in Squamish and Bella Coola" (December 10th 1976) - File #404, Inland Waters Directorate, Department of Environment.
"Municipality proceeding immediately with emergency river control work on Mamquam River. Provincial and municipal governments each contributing $25,000. Kindly confirm federal contribution of $25,000."

D.O.E. responded by declining to participate in the financing of the project on the basis that a satisfactory agreement had not been struck. The provincial government, on the other hand, agreed to finance 50% of the project.

5.3 THE IMPLEMENTATION STAGE

5.3.1 Some Unresolved Design Issues

Despite the fact that the project was well underway by 1968, there still remained some unresolved design issues. In particular, D.F.O. was not afforded the opportunity to express its concerns regarding the design and location of fish gates or the potential impacts of construction work on the aquatic habitat prior to the project being approved for implementation. In fact, prior to 1974 a "Gravel Removal Order" was not required for construction activities in fish bearing waters. Consequently, D.F.O.'s involvement was limited to ad hoc inspections by fisheries officers.

In one instance (March, 1969), the local officer demanded

that construction activities in the Judd Slough area cease. The municipal council responded by requesting the local member of parliament, Jack Davis, to intervene on their behalf and obtain approval for the project. Davis was apparently successful, as approval was shortly thereafter granted.\textsuperscript{12}

Despite the obvious deficiencies in the planning process, no apparent changes were made throughout the duration of the construction period to 1972.

5.3.2 The Project Halts: A New Strategy is Devised.

In 1972, areas throughout the province were struck by major spring flooding. As a result, provincial authorities found it necessary to direct public funds for flood management to those areas that appeared to have the greatest need. In the shuffle, funding to complete the Squamish project was withdrawn.\textsuperscript{13} At about the same time, M.O.E. officials began to realize that the escalating costs for flood relief and flood protection were related to the fact that structural measures were primarily responsible for increasing flood damage costs because they encouraged floodplain development. Accordingly, M.O.E. devised a new strategy to regulate future development on the floodplain.

\begin{itemize}
  \item \textsuperscript{12} Information obtained from former Fisheries Officer, Arthur Reynolds, and the official minutes of the Municipal Council meetings (March, 1969).
  \item \textsuperscript{13} Information obtained from interview with M.O.E. engineers.
\end{itemize}
As a first step to implementing this new approach, the Ministry of Municipal Affairs adopted the Municipal Enabling and Validating Act (1972). This new act stipulated that all new bylaws and community plans in areas of the Lower Fraser Valley which are subject to flooding must be approved by both the Minister of Municipal Affairs and the Minister of Environment.

This change in flood management had little impact on changing the view of Squamish officials on flood control and floodplain development. Throughout the early 1970's, the municipality continued to request funds from M.O.E. to complete the dyke as well as to encourage the development of residential subdivisions on the floodplain.

5.3.3 Tougher Floodplain Legislation but Development Marches Forth.

Severe flooding throughout the province in the spring of 1974 again led the government to introduce additional legislation (Bill 121 - Land Registry Act)\textsuperscript{14} to control floodplain development. This legislation required all subdivision development in flood prone areas to be approved by both the Minister of Municipal Affairs and the Minister of Environment.

\textsuperscript{14} The Land Registry Act has since become the Land Titles Act (1978).
The effect of this legislation meant that the following projects on the floodplain might be jeopardized:

1. A proposed Industrial Park in an area subject to flood depths of 3 meters.

2. A proposed hospital and two housing projects (Tantalus Project and Brackendale Co-op) already underway in an area of Brackendale subject to slides and flooding from the Cheekye River fan.

3. Increased residential development in both the Judd Slough (Brackendale) and Valleycliffe areas which are subject to severe flooding from the Squamish and Stawamus Rivers respectively.

It is of interest to note that all of these projects were endorsed and subsidized to one degree or another by various provincial government agencies. In particular, the housing projects were promoted by the Dunhill Housing Corporation, a Crown corporation which has since become the Housing Division of the Ministry of Lands, Parks and Housing. Thus, while one arm of the government was seeking to reduce future flood damages by restricting floodplain development, another arm of the government actively encouraged such development. This apparent inconsistency in government objectives can be attributed largely to the lack of an inter-agency referral system regarding land use development and control.

As well, decisions made at the political level also served to create inconsistencies in the government's objective of controlling future floodplain development. For example, when the municipal council confronted the Minister of Environment regarding the future of the aforementioned projects and the
continuation of financing to complete the Brackendale dyke, the Minister decided that due to the "unique" geography and historical patterns of development in the region, the floodplain development restrictions would be relaxed and the dyking project would be re-activated.  

Thus, despite the original intent of the new legislation, lack of inter-agency communication and decisions being made at the political level essentially neutralized efforts to control development on the floodplain. Eventually, however, the hospital and the Tantalus and Brackendale Co-op housing projects were halted as a result of M.O.E.'s increasing concern that the proposed projects were subject to severe danger from the Cheekye fan hazard.

5.3.4 Improving the Decision Process: Protecting Other Floodplain Resources.

In 1974, D.F.O. enacted the "Gravel Removal Order" as a supplement to the Fisheries Act. As outlined earlier, this order required that proponents obtain D.F.O. consent for construction activities in fish bearing waters. After adoption, D.F.O. officials and the municipal council again became embroiled over a number of issues regarding the approval of dyke designs and

construction work.

At one point in January 1975, a meeting was held between municipal, M.O.E. and D.F.O. officials regarding D.F.O.'s refusal to approve dyke and flood gate designs in the Judd Slough area. Approval for the construction of the dyke was granted provided the following conditions were met:

"1. Flood gates are left open all the time except during flood conditions.

2. Details of gate design shall be submitted to the Vancouver office (referring to D.F.O.) for review and approval before construction.

3. Dyking construction must be undertaken in a manner which will not result in the deposition of sediment or other deleterious substances into the slough".

This agreement resulted in increased inter-agency participation in flood management decision making. For the first time, D.F.O. was provided the opportunity to express its concerns about a proposed flood control project prior to being implemented.

Shortly afterwards, construction work on the Brackendale Dyke was again halted as M.O.E. refused further funding until the municipality adopted floodplain zoning regulations.

In the following year (1976), the decision process was further improved when the Land Management Branch initiated a

16. The term flood gate, is also referred to as a fish gate.

similar referral system with M.O.E. This system required the Lands Branch to refer all applications for Crown land use in floodable areas to M.O.E. for review and approval.

In early 1977, D.F.O. again exerted its authority in an effort to gain more input into flood management decisions. This time, a controversy had arisen over D.F.O.'s refusal to approve a developer's plans to repair some dykes damaged by minor flooding in the Valleycliffe area. The municipality acted as a mediator in the dispute because there was a concern that unless the developer repaired the dykes immediately the area would be flooded a second time. Negotiations concluded with the developer proceeding with the repairs and the municipal council adopting the following resolution:

"...that the Federal Fisheries Department be notified by the administration of all intended subdivision plans which are being developed near the course of a creek or river so that proper fish management regulations and policy can be continued."

5.3.5 Improving the Flood Management Plan: M.O.E. Pulls the Purse Strings.

In the spring of 1977, negotiations were conducted between


19. Note: It is not certain if the referral system was extended to all provincial agencies at this time. Currently, the use of the referral system is widespread.

the municipality and M.O.E. regarding the conditions under which further financial assistance would be provided to complete the Brackendale dyke. M.O.E. reiterated its original position that further funding was entirely contingent upon the adoption of floodplain zoning regulations. M.O.E. further recommended that these regulations be adopted as part of a comprehensive Community Plan.

The Municipality rejected M.O.E.'s proposal and accused the provincial government of attempting to undermine the traditional authority of the municipality over land use decisions. Two years later (1979), however, Squamish officials agreed to develop an Official Community Plan that would include regulations for floodplain development.

The plan was written by consultants between 1979 and late 1981 with extensive input from the public, the Ministry of Municipal Affairs, M.O.E. and Squamish officials. During that time, however, the dykes remained incomplete and floodplain development proceeded unabated.

5.3.6 The Flood of 1980:
Fish First - People Second.

On December 28th and 29th 1980, Squamish was struck by a fall flood with a peak flow of 2,480 m³/s (87,583 cfs) which forced the evacuation of approximately 400 residents in the Lower and Upper Squamish Valley areas. Although the flood waters peaked at a magnitude in excess of the design level of the dykes
1,122 m$^3$/s (75,000 cfs) only the following areas experienced flooding:

1. Homes in the Valleycliffe subdivision were flooded when the Stawamus River broke through dykes that were constructed by the developer (Guildford Industries). Residents reported that the river broke through a section of the dyke that was constructed to divert the river to permit the development of a park and schoolyard and that the dyke did not have the appropriate face rock to prevent erosion.

2. The undyked area of Brackendale was inundated with flood waters which caused damages to two mobile home courts and several homes.

3. On a bend on the Upper Mamquam River flood waters ripped open the dyke and damaged a section of the adjacent golf course.

4. The fish gate at the north entrance to the Judd Slough was jammed open by debris causing flooding to the adjacent subdivision.

Following the flood, the provincial and federal governments shared the cost of flood relief and the province incurred the expense of repairing the damaged dykes. However, the financing was not provided without a great deal of threatening from politicians regarding future flood relief to residents living in hazardous areas. The Minister of Environment (Stephen Rogers) stated that:

"...people living in areas which have been flooded more than once need not expect to get reimbursed again if they stay in the flood area." 21

And, Senator Ray Perrault of the federal government expressed a concern about continually providing flood relief to a community that lacked proper floodproofing regulations. Clearly, these comments were directly aimed at pressuring the municipal council into expediting the adoption of a floodplain zoning bylaw.

Citizens reacted by forming the North Squamish Ratepayers Association and threatening to withhold 1981 property taxes if their demands for the completion of a "well designed dyking system" were not met. Citizens also accused D.F.O. of putting "fish before people" because of the fish gate jamming incident at Judd Slough and because in the past D.F.O. had prevented efforts such as clearing log jams, dredging the river and constructing dykes to control the river.

In an effort to placate the angry citizenry, the municipal council conducted several public meetings to discuss dyke repairs,

23. Personal comment made to researcher by the editor of the Squamish Times.
24. This research discovered that an initial agreement between D.F.O. and the municipality clearly stipulated that maintenance of the fish gates was a municipal responsibility (Source: Municipal Council Official Minutes).
flood relief payments and completion of the dykes. The council advised the public during these meetings that further funding to complete the dykes would not be granted by M.O.E. until the floodplain regulations were adopted.

Throughout the remainder of the year, M.O.E. conducted an engineering study of the proposed project and the municipality proceeded with the necessary steps to adopt the floodplain regulations. In September, 1981, M.O.E. forwarded the proposed plan to the Regional Technical Planning Committee (T.P.C.) for review and approval by resource agencies affected by the project. This marked one of the first instances where a flood management plan was referred to all affected agencies prior to being implemented.

5.3.7 The Flood of 1981:
Political Pressure Mounts.

On October 31st and November 1st 1981, flooding again struck Squamish. This time, residents of the Spiral and Wagon Wheel Trailer Courts located in the undyked area of Brackendale, as well as homes behind the dykes in the Judd Slough area, were flooded. Flooding behind the dykes was caused because the area lacked the necessary drainage and pumping system to remove excess

25. The T.P.C. is an inter-ministerial task force which provides advice to municipalities and regional districts regarding specific projects and land use proposals.
run-off during flood conditions.

Immediately following the flood, angry residents demanded to know if flood relief was forthcoming and why the municipal and provincial governments had not taken the appropriate steps to provide flood protection for the community. Both governments replied that flood relief would be granted but that residents who had been previously flooded would have to cover the first $1,000 of flood damages. They also stated that financing had not been made available to complete the dykes because the council had not adopted the floodplain regulations. However, the council complained that unforeseen circumstances had prevented the final "reading" required to officially adopt the regulations.

In an effort to pressure both governments into action, the N.S.R.A. staged a media event to draw public attention to the problem by blockading Highway 99.

5.3.8 The Last Barrier: Floodplain Zoning Bylaw 277

Shortly after the highway blockade, the council held a special meeting to enact Zoning Bylaw 277 (December 1st 1981). In doing so, the council effectively eliminated the last barrier to obtaining provincial funds to complete the dyke (refer to Chapters 3.2.5 for a description of bylaw).

Once the bylaw was enacted, the council immediately requested the provincial government to fulfill its portion of the agreement. The province responded, however, by claiming that there were insufficient funds to cover the cost of the project.
Throughout the remainder of 1981, the media and local citizens continued to criticize both the provincial and municipal governments for not providing adequate flood protection. Finally, before the year ended, the council announced that it would contribute $250,000 towards the completion of the dykes and with or without provincial support, it would commence work immediately. Shortly afterwards on January 2nd 1982, the provincial government announced that it would contribute the remaining $750,000. These contributions would not be sufficient, however, to complete the dyke or to install an internal drainage system.

In the following year, local officials purchased a number of second-hand pumps to resolve internal drainage problems and more work was conducted on the dyking system.

In early 1983, M.O.E. contributed an additional $1 million to complete the major portion of the dyking system. Today, only a small area of the floodplain remains unprotected by dykes.
CHAPTER 6
CASE STUDY ASSESSMENT

This chapter evaluates the case study in terms of the normative ideals set out in Chapter 4. A series of questions is posed for each criterion to indicate the degree to which the case study adhered to the normative ideal. After each assessment I provide an explanation for the identified deficiency based on empirical evidence and behavioural theory. As there may be instances where I am unable to empirically explain a particular deficiency, I will rely on what the behavioural theory suggests would be a likely explanation.

6.1 REPRESENTATION OF INTERESTS

1. Were Squamish officials involved in the conceptualization and evaluation of flood management plans?

Squamish officials were not always involved in the conceptualization and evaluation of flood management plans. In fact, case study evidence indicates that representatives from Squamish were only involved at the stage in which the dyking project was first conceptualized and at the stage where the floodproofing regulations were designed.

Regarding the dyking project, citizens formed the Squamish Valley Development Committee in 1949 which officially approached the provincial government for financial and technical assistance to upgrade and extend the existing dyking system. Subsequent to
this, provincial authorities did not obtain additional input from Squamish representatives to review or evaluate the proposed plan.

Regarding the floodproofing regulations, the evidence indicates that provincial authorities were primarily responsible for conceptualizing this new approach. Recall that widespread flooding throughout the province in 1972 led M.O.E. to revise its traditional approach of constructing dykes to control the river, to encouraging municipalities to adopt regulations to restrict development on the floodplain. This policy change did not involve input from municipal officials. On the contrary, M.O.E. attempted to coerce the municipality to adopt the new strategy by withholding additional financial assistance to complete the dykes.

However, once the municipality decided to adopt the new policy, provincial and municipal representatives entered negotiations to revise certain features of the regulations. In this sense, it can be argued that Squamish officials were involved during the design stage of the floodproofing regulations.

2. Were Squamish area residents afforded the opportunity to obtain information and express their views on proposed plans to their elected representatives prior to decisions being made?

Formal opportunities were not always available for residents to obtain information and express their views on proposed plans to elected officials prior to decisions being made. Recall that 16 years had elapsed from when residents first expressed their views on dyke protection (1949), to when the actual decision was made
to implement the project (1965). Throughout this time period, officials did not seek to advise the public of the status of the proposed project or to incorporate public opinion into the objectives and design of the project. Yet, during that period it is likely that new residents with different views on flood protection were not even aware that the project was being considered.

The recent adoption of the floodproofing regulations, in contrast, involved a formal public participation program, as required under the Municipal Act.

3. Did provincial and federal representatives have the opportunity to take part in the conceptualization and evaluation of proposed plans?

Although M.O.E. officials were extensively involved during the conceptualization and evaluation of both the dyking project and the floodproofing regulations, other provincial and federal agencies were often excluded or not sufficiently involved during these stages of the decision process.

For example, at the outset of the dyking project, certain affected agencies were not afforded the opportunity to discuss the need for flood protection, to propose alternative solutions or to advise M.O.E. and Squamish officials of the potential effects of the proposed plan. Consequently, it wasn't until the project was well underway that agencies like D.O.E. and D.F.O. were able to request, or in D.F.O.'s case, demand that certain design features be altered. In other words, those agencies that did have
input were involved only in a negative reactive sense after decisions were made to proceed with a specific type of strategy.

The process followed for adopting the floodproofing regulations was substantially improved in terms of involving other agencies. Recall that agencies belonging to the local T.P.C. were afforded the opportunity to review the proposed regulations prior to being adopted. As before, however, their input had minimal impact as they were responding to a plan that had already been decided upon by M.O.E. officials.

In conclusion, affected interests, particularly federal and provincial representatives, were not always provided with sufficient opportunity to interact during the conceptualization and evaluation stage of the decision process.

Two reasons may be cited for this deficiency; firstly, the decision process lacked an overall planning framework from which to coordinate the activities of the affected interests; and secondly, those responsible for flood management did not perceive the value of gaining a broader perspective by involving other interests in designing flood management plans.

On the first point, our decision theory argues that unless officials perceive it to be "necessary or possible" it is unlikely that they will interact and engage in a meaningful dialogue to resolve their conflicting interests (Dahl and Lindblom, 1968). Moreover, inter-agency and public consultation might be perceived by powerful agencies as contrary to their own self-interest as the resolution of conflicts would likely entail
a degree of compromise. Since there was no policy requiring agencies to coordinate their services, officials tended to pursue their own narrowly defined agency goals with little reference to the impacts on other interests. Whenever conflicts arose, as occurred on numerous occasions with D.F.O., officials would be forced to seek a solution. Beyond that, opportunities for affected interests to interact with those responsible for flood management was minimal.

Regarding the second point, our decision theory states that the manner in which we perceive and respond to a problem situation is related to our past experiences, and our professional and social affiliations (Fox, 1982). In the case study, those responsible for designing flood management plans belonged to a small, homogenous group of individuals (M.O.E. engineering staff) who, because of their professional affiliations, likely did not perceive the importance of gaining a broader perspective by inviting input from other interests. However, had M.O.E.'s staff included professionals with different backgrounds, as it does not (e.g., planning staff), then perhaps a wider perspective on such issues would have been explored.

6.2 ADEQUACY OF INFORMATION

Information adequacy is a relative concept which evolves over time as technology and science advance. Since the case study reviews evaluation procedures which took place almost 20 years ago it is important to determine whether procedures followed were
considered adequate by the standards of the day. A review of the literature on cost-benefit techniques for evaluating flood management projects indicates that during the 1960's researchers were proposing widespread changes to the traditional approach of evaluating a single alternative on the basis of economic criteria. For example, G.F. White (1960, 1964) proposed that a range of alternatives should be evaluated in an optimization procedure. As well, the importance of evaluating intangible values and indirect effects was discussed by Sewell in 1961 ("Guide to Benefit/Cost Analysis") and by James in 1968 ("Economic Analysis of Alternative Flood Control Measures"). James (1968) also pointed out that there were severe problems with predicting the occurrence of flood frequencies and flood depths and then making estimates of the costs and benefits with certainty.

In light of the literature, I have concluded that although the "state of the art" was undergoing changes, officials responsible for the "Marr Report" in 1965 could have apprised themselves with the latest techniques of cost-benefit analysis. On the other hand, reliance on traditional methodologies during periods of change may be viewed as a reasonable response to an uncertain or unknown situation. From this perspective, the "Marr Report" probably generated adequate information from which to base a flood management decision. For our purposes, however, greater insights can be achieved by evaluating the report in terms of today's accepted standards.
1. Were alternative combinations of kinds of measures and scales of adjustment for each measure evaluated?

At no time was a range of alternative solutions or various scales of adjustment evaluated by those responsible for flood management in Squamish. At the outset, officials decided that the solution to the flood hazard would be to construct a dyke and more recently to adopt floodproofing regulations, neither of which were evaluated at various scales of adjustment or considered in conjunction with a range of alternatives to determine the optimal level of protection.

In fact, the scales for both were selected on the basis of predetermined standards (i.e., the 1 in 50 year dyke level represented the extent to which officials were willing to pay for flood protection and the 1 in 200 year floodproofing level corresponded with the revised estimate of the protective level of the dykes and also represented a provincial standard).

2. Were the following categories of the costs and benefits and the distribution of their effects, including intangible values, supplied for evaluating the proposed flood protection measures?

- economic effects
- social effects
- biophysical effects

The dyking project was the only measure subjected to a formal evaluation process (Marr Report, 1965). This study concentrated strictly on evaluating the tangible economic effects that would accrue to local residents by introducing a flood control project and reducing flood damages on the floodplain.
Other, tangible and intangible effects related to biophysical and social values, were not considered.

3. Did the process account for and seek to minimize the problems associated with making decisions based on uncertainty?

The only reference to the problem of uncertainty was made by the "Marr Report" (1965) which merely suggested that predictions of flood frequencies were likely inaccurate because they were based on limited hydrological data. Beyond this, no effort was made to compensate for this inadequacy.

It may be concluded, therefore, that the ideal of "adequate information" was not achieved. Information used to evaluate the dyking project was deficient, no formal evaluation study was conducted for determining the feasibility of the floodproofing regulations and the issue of uncertainty was inadequately addressed.

The primary reason for the information deficiency was that guidelines or criteria had never been established for evaluating and selecting proposed flood management plans. Consequently, information used to evaluate the dyking project was deficient and no information was generated to evaluate subsequent flood management plans.

Regarding the methods used to evaluate the dyking project, if, as our theory suggests (Lindblom, 1968), individuals tend to be "risk averse" by choosing traditional courses of action, it is
not surprising that M.O.E. engineers did not apply the latest "state of the art" techniques when conducting the cost-benefit analysis. Lindblom (1968) also defines such behaviour as "muddling through", which means that individuals generally seek solutions which resolve immediate problems as opposed to resolving long term problems. Hence, traditional solutions were viewed as being adequate.

Moreover, since the decision process was dominated by M.O.E. engineers, who were not required by law or policy to obtain input from other affected interests, it is likely that a range of other flood control measures and their distributional effects were not even perceived.

Regarding the issue of uncertainty, our theory suggests that had officials experienced a recent, catastrophic flood event then they likely would have taken more appropriate measures, beyond acknowledging the deficiencies in hydrological information, to deal with the problem.

My theoretical framework also suggests that the study suffered from the foregoing deficiencies because the evaluator was unable to devote the amount of time and resources necessary to conduct a more adequate evaluation study (March and Simon, 1958; Down, 1967; Dror, 1968). My empirical evidence supports this premise, as M.O.E. officials complained that such studies are often hampered by time and funding constraints. M.O.E. officials also stated that it was unnecessary to conduct subsequent studies to the Marr Report or to evaluate the flood-proofing plan because it was obvious that the benefits of
implementing the projects exceeded the costs. 26

Although M.O.E. officials dominated the design and evaluation stages of the process, Squamish officials, nonetheless, played a significant role in selecting a final flood management plan. Two reasons may be cited for their actions in not considering alternative strategies. First, large-scale, capital intensive solutions, such as dykes, rely heavily on senior government financial assistance, whereas small-scale, nonstructural solutions, such as floodplain regulations, involve a greater social and monetary commitment from local residents. If individuals are behaving to maximize their own self-interest, then residents would naturally select the dyking strategy. Second, those who first initiated the dyking project in 1949 (S.V.D.C.) made it quite clear that the major reason for adopting the dykes was to promote industrial and residential growth on the floodplain. Thus, even if alternatives such as controlling floodplain development had been perceived at the time, the community, as it eventually did, would likely have rejected them.

26. Information obtained from M.O.E. Engineering staff (J. Wester and H. Nesbit-Porter).
6.3 EFFICIENCY OF DECISION PROCESS

1. Could the same outcome be achieved with less time, public funds and staff resources?

Given the time involved with completing the dyking project, 18 years (1965 - 1983), and adopting the floodproofing regulations, 10 years (1972 - 1982), as well as the fact that delays were primarily created by inter-agency conflicts, we may conclude that had the various affected agencies been required by law or policy to interact and coordinate their respective services then the amount of time and public funds wasted from agencies working at cross purposes might have been reduced.

2. Could officials have achieved a significantly better outcome in terms of making more informed judgements by expending more time, public funds and staff resources?

In view of the deficiencies in the information used to evaluate the dyking strategy (i.e., alternatives were not considered, optimization procedures were not used and the full range of costs and benefits were not evaluated) and the fact that no information was generated to evaluate the floodproofing regulations, it is likely that additional expenditures to improve the data base would have assisted officials in making more informed judgements about alternative courses of action.

In view of the foregoing, we may conclude that the decision process was inefficient because it was unnecessarily extended by inter-agency conflicts and a significantly better outcome might have been reached had additional resources been expended to
improve the quality of information used to guide officials' decisions.

The case study indicates that there were three primary reasons for the decision process being inefficient. First, the process lacked an overriding framework requiring agencies to interact and coordinate their conflicting services and goals to reach a collective action. For example, M.O.E. officials delayed the completion of the dykes throughout the 1970's in an effort to force municipal officials to adopt floodproofing regulations. Construction delays were also caused by D.F.O. officials attempting to force design changes aimed at protecting aquatic resources. Delays in adopting the floodproofing regulations were, at least partially, related to the fact that while M.O.E. was pressuring the municipality to control floodplain development, another provincial agency, the Dunhill Housing Corporation, was assisting the municipality to develop areas of Crown land on the floodplain for housing.

Second, construction delays were created on several occasions because provincial fiscal budgetary restraints forced M.O.E. officials to withdraw financial assistance from the project.

Third, M.O.E. officials did not believe that the expenditures involved in conducting new studies would result in improved decisions. Recall, that M.O.E. officials stated that additional studies were unnecessary because it was obvious that the benefits of proposed projects exceeded the costs.
This concludes the evaluation of flood management decision making in Squamish. The final chapter will recommend changes aimed at resolving the foregoing deficiencies.
Prior to proceeding with the recommendations, I wish to emphasize that the ideals discussed in this research are more easily stated than achieved. I also recognize that many deficiencies exist because flood management is an evolving field that is steadily improving as we gain knowledge about the effects of our actions and the factors that influence our decisions. Thus, this analysis is not meant as a critique of past professional judgements. Rather, it represents the history of a public decision and provides a milepost to gauge our progress.

My recommendations address two issues; first, are the actions that are required immediately to resolve existing flood protection problems; and second, are the changes and improvements required to move future flood management decision making closer to achieving the normative ideals.

7.1 RESOLVING EXISTING FLOOD MANAGEMENT PROBLEMS

Currently, the municipality has adopted floodproofing regulations to control floodplain development, the dyking project is virtually completed and pumps have been installed to improve internal drainage problems. Despite these changes, the following flood management problems still remain (see Flood Management Issues - Chapter 2.6):
- Primary reliance is placed on a dyking system which is both incomplete and incapable of withstanding a catastrophic flood event.

- The floodplain regulations provide only minimal protection from catastrophic floods as they do not apply to existing and new homes in established neighbourhoods.

- Neither the dyking system nor the floodproofing regulations have been properly evaluated to determine their optimum level of protection.

- A range of other strategies which could potentially reduce future flood damages have been overlooked.

- There is still some uncertainty regarding the potential of the Cheekye River flood hazard.

- There is no provision for preventing the formation of log jams which are capable of causing sudden and catastrophic flooding to downstream residents.

To resolve the foregoing problems a Task Force, consisting of federal, provincial and municipal government agencies, should be established immediately to review the existing situation and to establish a framework to evaluate future courses of action. It is recommended that the Task Force consider the following measures:

1. To reduce the potential for residual damages from a flood that exceeds the existing level of the dykes a range of alternative strategies should be considered for adoption. In particular, it is recommended that the Task Force explore the feasibility of adopting the following measures:

A. A public information program with the following components:

- the nature of the Squamish flood regime and the potential consequences, given the existing flood management plan, of locating on the floodplain;
- suggestions and cost estimates for constructing a floodproofed home or to floodproof an existing dwelling;

- advice for householders on how to reduce the cost of flood damages caused by flooding;

- information regarding where to obtain flood warning bulletins, emergency assistance, and how to escape a catastrophic flood event;

B. A program of government grants or low interest loans to assist established residents to floodproof their home.

C. A program of government subsidized flood loss insurance so that future flood damage costs can be distributed in a more socially equitable fashion.

D. An improved system of flood forecasting and warning to provide residents with sufficient time to prepare for a flood (i.e., floodproofing household goods and selecting an escape route).

E. A river maintenance program to remove potential hazards caused by log jams.

2. Since officials never conducted an evaluation to determine the optimal design of the floodproofing regulations, it is recommended that the Task Force review the necessity of redesigning the regulations.

3. Since there is some uncertainty regarding the benefits of completing the entire dyking system, it is recommended that future construction not take place until a range of alternative courses of action, (e.g., relocation and floodproofing) are evaluated to determine if there are less expensive ways of achieving the same outcome.
4. Since there is some uncertainty regarding the Cheekye River hazard, the Task Force should review the necessity of re-evaluating the nature of the hazard.

5. Since the foregoing measures will require additional public resources, and since all three levels of government will benefit from a reduction in future flood damages, all three levels of government should share in the costs. To determine the extent of sharing, negotiations should be initiated immediately.

Prior to proceeding with the recommendations for resolving the normative weaknesses in the flood management decision process, it should be noted that neither the foregoing recommendations nor the problems facing Squamish flood managers are particularly unusual. The importance of revising flood management strategies to control land use as opposed to controlling the dynamic forces of a river has been recognized at least for the past twenty years. This raises the question as to why officials have been so reluctant to adopt these changes.

The Squamish situation indicates that changes were not adopted by officials because there was no incentive for them to do so. It was also apparent that both the municipal and provincial governments were sensitive to local public demands
which generally favoured large-scale, capital intensive measures for flood protection over restrictions of land use on the floodplain.

Two recommendations are made to rectify this situation. The first, which is outlined in the section to follow, involves the adoption of a new decision making structure and process which ensures that decision makers are well informed and encourages a broader range of interests from all levels of government and the public to express their views on flood protection. Recall that flood management decisions have historically been made by a small group of individuals who either had a vested interest in pursuing certain courses of action or, because of their backgrounds, had a narrow perspective on what courses of action to pursue.

The second involves a recommendation that the federal government, which is assumed to be not as politically sensitive to small-scale local issues, take a stronger role for ensuring that proper flood management policies are initiated at the local level.

This can be achieved through the adoption of a policy which stipulates that all projects and programs, regardless of their relationship to flood protection, which are initiated by federal government agencies or Crown Corporations and for which federal funds are provided or federal land required, be subjected to specific guidelines for flood protection as determined by the Department of Environment. These guidelines should take into account the foregoing recommendations.
7.2 RESOLVING THE NORMATIVE DEFICIENCIES

Weaknesses in the flood management decision making process indicate that radical changes are required in the manner in which flood management planning is conducted in Squamish and throughout the province. The following recommendations are based on theories of political and administrative behaviour, and are aimed at strengthening the identified weaknesses so that the normative ideals of democratic decision making can be achieved. It should be noted, however, that the recommendations are based on theoretical ideals which require further research prior to being implemented.

7.2.1 Increasing Representation

In Chapter 6 we argued that the lack of adequate representation was primarily related to the fact that guidelines had not been established for designing a flood management plan or involving other agencies and the public in the decision process. Consequently, interactions amongst concerned interests tended to occur in a haphazard fashion after decisions had been made.

According to our theoretical framework, the decision powers of public agencies should be fragmented so that they can limit and control one another. In our case study, decision powers were fragmented but there was no coordinating policy or law requiring officials to interact and cooperate with one another. Without this, Dahl and Lindblom (1968) argue that officials will
generally not interact.

In light of these factors, the following recommendations should be considered for adoption:

1. M.O.E. should assume the primary responsibility for designing a decision process that assures participation of all groups impacted by flood management decisions.

2. To ensure that a broad range of viewpoints are accounted for in designing the decision process, input should be obtained at the outset from an advisory task force consisting of the public and concerned agencies.

3. To ensure that the proposed decision process is effective, it should consist of at least three key features. First, terms of reference should be established which outline how flood management decisions will be made as well as the roles and responsibilities of the decision makers. Second, rules should be established which ensure that all agencies are given the opportunity to be informed of and to express their views on proposed plans prior to decisions being made. And third, members of the public should be provided with an equal opportunity to be informed of and to express their views on proposed plans prior to decisions being made.

7.2.2 Improving Information

Our assessment indicates that the primary reason for inadequate information was that guidelines for evaluating and selecting flood management plans had never been established and since flood management officials were not required to interact with other agencies, the views and ideals of those involved tended to dictate the nature of the information and evaluative techniques that were used in selecting a plan. Deficiencies in information were also related to agency budget and time
constraints.

Earlier, I argued that by making provisions for the expression of a wider range of preferences during the decision process, a broader range of alternatives and values as well as improved or innovative evaluation methods can be used to assist officials in making more informed judgements.

To resolve the problem of inadequate information, M.O.E. officials should consider the adoption of the following recommendations:

1. To ensure that decisions are based on good or adequate information, guidelines should be established which outline the type of analysis and when it should be used, to evaluate proposed flood management projects.

2. To ensure that the classic deficiencies of cost-benefit analysis, as outlined earlier, are minimized, guidelines for conducting the analysis should be established. Reference should be made to existing guidelines set out by E.L.U.C., with specific reference to the following factors: a wide range of alternatives at different scales of adjustment should be evaluated; affected interests should be consulted in identifying the categories of information that should be considered in the evaluation; and the issue of measuring intangibles and dealing with uncertainty should be specifically addressed.

3. To ensure that adequate resources are available to conduct a thorough analysis of flood management problems, some means of cost-sharing should be established amongst the three levels of government.

7.2.3 Improving Efficiency

The decision process was inefficient primarily because the
relevant agencies were not required to coordinate their conflicting program objectives and because there were no guidelines which stipulated the type of information that should be utilized for evaluating flood management plans. Consequently, the process of negotiating compromises amongst conflicting interests occurred in such a fashion so as to unnecessarily delay the decision process and the information used to base decisions was either inadequate or nonexistent.

According to our theory, because individuals tend to behave as self-interested maximizers, officials not required to interact will do so only if it is deemed to be in their best interest. However, as indicated by our case study, such behaviour tends to encourage other interests to disrupt the decision process as a means of expressing their preferences and instituting changes. Lindblom (1968) suggests that such problems can be resolved through the process of negotiation. According to Fox (1982) this should involve a penetrating review of the problem by each participant which, in turn, may change their perceptions and initial stand. Thus, if agencies are required to interact and coordinate their services through the institution of a decision process as earlier proposed, then there will be less opportunity for officials to adopt, inadvertently or otherwise, independent courses of action that are counter-productive to achieving a collective goal.

Furthermore, as previously proposed, by adopting guidelines for intergovernmental cost-sharing and for assisting officials in determining when a study should be conducted and the types of
information and techniques that should be used to conduct an evaluation, the quality of information used to make informed decisions should greatly improve.

In conclusion, there is no easy solution to improving the manner in which we choose flood management strategies. Nevertheless, the recommendations that have been proposed should improve the current approach to flood management for British Columbia and Squamish so that future flood damages can be reduced and future decisions can produce a socially optimal pattern of resource/land uses.
BIBLIOGRAPHY


