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Technical Report No. 14

Environmental Protection Regulation: Water Pollution, and the Pulp and Paper Industry

Peter A. Victor
Terrence N. Burrell
with
Jim Evans
Charles Figueiredo

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TECHNICAL REPORT NO. 14

ENVIRONMENTAL PROTECTION REGULATION: WATER POLLUTION, AND THE PULP AND PAPER INDUSTRY

by

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The findings of this Technical Report are the personal responsibility of the author, and, as such, have not been endorsed by members of the Economic Council of Canada.

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FOREWORD

This study is one of a series commissioned by the Economic Council's Regulation Reference which deals with various aspects of environmental regulation. These studies do not profess to cover the whole field of environmental regulation but they do focus on several important areas of concern.

The following is a list (alphabetically by author) of environmental studies to be published in this series:

*** Bankes, Nigel and Andrew R. Thompson, Monitoring for Impact Assessment and Management: An Analysis of the Legal and Administrative Framework.

* Dewees, Donald N., Evaluation of Policies for Regulating Environmental Pollution.

*** Dorcey, Anthony H.J., Michael W. McPhee and Sam Sydneysmith, Salmon Protection and the B.C. Coastal Forest Industry: Environmental Regulation as a Bargaining Process.

* Felske, Brian E. and Associates Ltd. and Robert Gibson, Sulphur Dioxide Regulation and the Canadian Non-ferrous Metals Industry.

** Hunt, Constance D. and Alastair R. Lucas, Environmental Regulation - Its Impact on Major Oil and Gas Projects: Oil Sands and Arctic

* Nelson, J.G., J.C. Day and Sabine Jessen, Environmental Regulation of the Nanticoke Industrial Complex

* Nemetz, Peter, John Sturdy, Dean Uyeno, Patricia Vertinsky, Ilan Vertinsky and Aidan Vining, Regulation of Toxic Chemicals in the Environment

* Rohlich, Gerard A. and Richard Howe, The Toxic Substances Control Act: Overview and Evaluation

Swaigen, John Z., Compensation of Pollution Victims in Canada

*** Thompson, Andrew R. Environmental Regulation in Canada: An Assessment of the Regulatory Process

* Victor, Peter A. and Terrence N. Burrell, Environmental Protection Regulation, Water Pollution, and the Pulp and Paper Industry

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (CONT'D) PAGE

LIST OF TABLES (CONT'D) PAGE

LIST OF FIGURES

Résumé

Il ne fait aucun doute que notre société doit s'imposer une certaine forme de réglementation en vue de protéger son environnement et de défendre les intérêts, d'ailleurs souvent concurrentiels, de ceux qui l'utilisent. Personne n'a la propriété ni de l'air ni de l'eau, et les droits de les utiliser pour éliminer les déchets ou pour toute autre fin ne peuvent s'échanger sur le marché.

Au Canada, pour ce qui touche à la pollution industrielle, les gouvernements ont en général assuré la protection de l'environnement en établissant d'abord une certaine forme de normes légalement applicables pour le déversement des déchets et en négociant des modalités d'observance de ces normes avec les compagnies. A défaut d'entente, le gouvernement recourt habituellement à des poursuites judiciaires. A ces mesures s'ajoutent encore diverses formes d'allégements fiscaux et d'aide financière qui visent à réduire la part des coûts de la lutte contre la pollution que supporte l'industrie.

Le présent document fait partie d'un groupe d'études qui ont été commandées par le Conseil économique du Canada sur la réglementation et la protection de l'environnement. Il traite des règlements relatifs à la pollution de l'eau dans l'industrie des pâtes et papiers. Les auteurs y examinent le rôle du gouvernement fédéral dans la réglementation de cette industrie tant du point de vue des procédures officielles que du degré de réalisation des objectifs de lutte contre la pollution. Sur le plan provincial, ils n'étudient en détail que le cas de l'Ontario, bien que beaucoup de leurs constatations s'appliquent

aussi à d'autres provinces où l'industrie des pâtes et papiers est importante.

L'étude traite aussi de l'incidence économique globale, sur l'industrie, des dépenses pour la lutte contre la pollution, et souligne en outre l'inquiétude que suscite la possibilité d'effets sur les prix et l'emploi.

Dans une étude de cas de deux usines, les auteurs examinent plus à fond les leçons à tirer au sujet de l'intervention par voie de réglementation et des façons de l'améliorer. Ils calculent certaines fonctions des coûts de la dépollution dans le cas de ces usines, et analysent les réactions possibles aux incitations économiques visant à contrôler la pollution (par exemple, les frais de déversement d'effluents).

Voici quelles sont les principales conclusions de l'étude sur la réglementation fédérale et ontarienne de l'industrie des pâtes et papiers en vue de la réalisation des objectifs de lutte contre la pollution :

1. Les objectifs de la lutte contre la pollution ne s'inspirent pas de la volonté d'équilibrer les avantages et les coûts.

2. Des programmes de conformité aux règlements sont négociés et les coûts de la dépollution entrent en ligne de compte.

3. Le public n'a que très peu participé, dans le passé, au processus de réglementation, mais les choses ont commencé à changer depuis quelque temps.

4. L'accent a porté principalement sur la réglementation de la demande biochimique en oxygène et sur le rejet de matières en suspension; d'autre part, on se préoccupe maintenant davantage des déchets toxiques.

5. Les organismes de réglementation ont toujours été déçus dans leurs attentes pour ce qui est de la conformité aux normes et règlements.

6. Les programmes de subventions et les allègements fiscaux particuliers vont à l'encontre du principe selon lequel "c'est au pollueur de payer".

7. Les frais administratifs à la charge de l'État et de l'industrie sont déjà si faibles qu'on ne voit guère comment les réduire.

8. Il n'y a que peu de chevauchement entre les attributions fédérales et provinciales en matière de réglementation.

9. Les estimations de ce qu'il en a coûté à l'industrie des pâtes et papiers pour contrôler le déversement des eaux usées au cours de la dernière décennie varient beaucoup selon la source de l'estimation. Les investissements effectués pour la lutte contre la pollution de l'eau ont représenté environ 10 % de l'ensemble des dépenses en immobilisations et en réparation, par l'industrie, au cours des années 70.

10. Il existe peu de données sytématiques pouvant servir à démontrer les effets nocifs du rejet des eaux usées dans les lacs et les rivières de l'Ontario par les usines de pâtes et papiers.

11. Peu de compagnies ont été poursuivies pour cause de pollution de l'eau, et les amendes, lorsqu'elles ont été appliquées, étaient loin d'atteindre ce qu'il en coûtait pour contrôler les déversements.

12. Le processus de réglementation est actuellement en voie de modification.

Ces conclusions sont à la base de recommandations sur la façon d'améliorer la réglementation des rejets d'eaux usées provenant des usines de pâtes et papiers. Ces recommandations s'appliquent surtout à l'Ontario mais, dans la mesure où elles visent les faiblesses du processus de réglementation qui existent dans d'autres domaines de compétence et à l'égard d'autres industries, elles ont une plus grande portée. En bref, ces recommandations sont les suivantes :

1. Il importe d'entreprendre une étude publique des objectifs envisagés quant à la qualité des eaux de réception.

2. Il faudrait prendre des mesures pour accroître la participation du public à l'établissement de programmes de conformité propres à chaque usine (c'est-à-dire des programmes pouvant permettre de réduire les déversements par étapes).

3. Les buts, les coûts et l'efficacité des programmes de surveillance régulière de la qualité des eaux devraient être réexaminés.

4. Les programmes informatiques permettant de colliger et tenir à jour les données sur les déversements de déchets

devraient être évalués et appliqués s'ils sont jugés valables.

5. Il faudrait imposer une amende à ceux qui tardent à se conformer aux normes de contrôle de la pollution, afin de s'assurer que les programmes particuliers de dépollution à chaque usine soient observés. (L'amende serait automatiquement prélevée sur chaque unité rejetée dépassant la quantité permise par le programme de conformité applicable à l'usine).

6. Toute décision d'exempter une compagnie de satisfaire aux normes de lutte contre la pollution devrait être considérée comme relevant de la politique économique et sociale, et comparée avec d'autres décisions qui pourraient être plus appropriées.

SUMMARY

In our society the need for some form of regulation to protect the environment and to defend the interests of its competing users is beyond question. Air and water in particular are not owned and rights to their use for waste disposal or any other purpose cannot be traded in the market place.

Typically, governments in Canada have approached environmental protection regulation for industry by setting some form of legally enforceable discharge standards and negotiating compliance schedules with companies. Generally, as a last resort, enforcement is sought through court action. These measures are supplemented by various forms of tax relief and financial assistance which are used to reduce the share of pollution abatement costs borne by industry.

This study, which is one of several commissioned by the Economic Council of Canada on environmental protection regulation, concentrates on the regulation of water pollution from the pulp and paper industry. It examines the federal role in regulating the industry both in terms of the formal procedures involved and the extent to which abatement objectives have been achieved. At the provincial level only Ontario is considered in any detail, though many of the findings apply to the other provinces in which the pulp and paper industry is prominent.

The study also considers the overall economic impacts of pollution abatement expenditures on the industry. Attention is paid to the concern over possible price and employment effects.

The lessons that can be learned about regulation and how it might be improved are further examined in two mill specific case studies. Abatement cost

functions are estimated for these mills and possible responses to economic incentives for pollution control (i.e. effluent charges) are analysed.

The principal conclusions on how the pulp and paper industry is regulated to achieve water pollution control objectives, federally and in Ontario, are:

1. Abatement objectives are not based on attempts to balance benefits and costs.

2. Compliance programs are negotiated and abatement costs enter as a consideration.

3. Public involvement in the regulatory process has been minimal in the past though recently this has begun to change.

4. Most emphasis has been placed on regulating biochemical oxygen demand and discharges of suspended solids; toxic wastes are now receiving more attention.

5. The expectations of the regulatory authorities for compliance have been continually frustrated.

6. Subsidy programs and special tax allowances compromise the "polluter pays principle".

7. The administrative costs borne by government and the industry are already so modest that there is little or no opportunity for reducing them.

8. Jurisdictional overlaps between the federal and provincial regulatory authorities are minimal.

9. Estimates of costs to the industry of controlling waste water discharges during the past decade vary greatly depending on the source of the estimate. Capital expenditures for water pollution abatement were about 10% of total capital and repair expenditures by the industry in the 1970's.

10. Little systematic information is available to demonstrate the damaging effects of waste water discharges from the pulp and paper industry on Ontario's lakes and rivers.

11. Few companies have been prosecuted for causing water pollution, and fines, when enforced, have been far below the costs of controlling discharges.

12. Some changes in the regulatory process are underway.

These conclusions provide the basis for recommendations on how the regulation of waste water discharges from the pulp and paper industry could be improved. The recommendations apply principally to Ontario but, to the extent that they address shortcomings in the regulatory process that exist in other jurisdictions and with respect to other industries, they have a broader relevance. Stated in brief, the recommendations are:

1. A public review of water quality objectives for receiving waters should be undertaken.

2. Steps should be taken to increase public involvement in setting mill specific compliance programs (i.e. programs which may permit staged reductions in discharges).

3. The purposes, costs and adequacy of routine water quality monitoring programs should be reviewed.

4. Data-processing programs for maintaining an up-to-date, retrievable record of waste discharges should be evaluated and implemented if found to be worthwhile.

5. A pollution control delay penalty should be introduced for ensuring compliance with mill specific pollution abatement schedules. (Such a penalty would be an automatic charge per unit of discharge in excess of the amount allowed in the mill's compliance program).

6. Any decision to exempt a company from meeting abatement requirements should be seen as an instrument of social and economic policy and compared with others that might be more appropriate.

CHAPTER 1

AN OVERVIEW OF THE ISSUES

1.1 The Problem

The pulp and paper industry has long been one of Canada's most important industries. Data for the year 1977 show that it is the leading manufacturing industry in Canada in terms of value added and employment, and the third highest in value of shipments. It is also Canada's most important export industry. Table 1.1 summarizes these data and shows the contribution the industry makes to the economies of Atlantic Canada, Quebec, Ontario, the Prairies and British Columbia. The pulp and paper industry has the first or second highest value of shipments, value added and employment for all manufacturing industries in the Atlantic region, Quebec and British Columbia. It is ranked no lower than sixth according to any of these measures in Ontario and the Prairies.

In addition to the industry's national and provincial economic importance, there are numerous communities across the country whose very existence depends on the continued operation of individual mills. Consequently in these communities the economic health of the pulp and paper industry takes on a social significance beyond the economic significance revealed in the aggregate data of Table 1.1.

Despite the fact that the pulp and paper industry has earned quite considerable profits in the past 2 years, there is growing concern over the declining competitiveness of the industry.[1] Over the past decade the rate of return on capital in the pulp and paper industry has generally been lower than in most other manufacturing industries in Canada.[2] Meanwhile the industry's share of the North American and world markets has steadily

Table 1.1

THE ECONOMIC CONTRIBUTION OF THE CANADIAN PULP AND PAPER INDUSTRY (1977)

Regions \ Manufacturing Data	Shipments ($ 000)	% of Region or Prov.	Rank in Region or Prov.	Value Added ($ 000)	% of Region or Prov.	Rank in Region or Prov.	Number of Employees	% of Region or Prov.	Rank in Region or Prov.
ATLANTIC	717,891	14	1	282,638	15	1	8,235	10	2
QUEBEC	2,202,565	8	2	1,027,976	8	1	31,668	6	1
ONTARIO	1,603,037	3	6	688,718	3	5	21,604	3	5
PRAIRIES[1]	139,417	1	3	59,452	2	4	1,318	1	6
BRITISH COLUMBIA	1,632,539	16	2	825,157	18	2	17,842	13	2
CANADA	6,636,533	6	3	3,069,757	7	1	84,533	5	1

[1] Ranking based on 1976 Manufacturing Industry Data

Sources:

(1) Statistics Canada, Pulp and Paper Mills: 1977, (36-204)

(2) Statistics Canada, Manufacturing Industries of Canada: National and Provincial Areas (31-203)

declined.[3] In the Eastern provinces in particular, much of the plant and equipment is old and out of date, and there is some question as to the industry's willingness and capability to undertake the expenditures necessary for an adequate rate of modernization. It is for this reason that the Federal government and the governments of Quebec and Ontario have announced programs designed to provide financial assistance to the industry.[4]

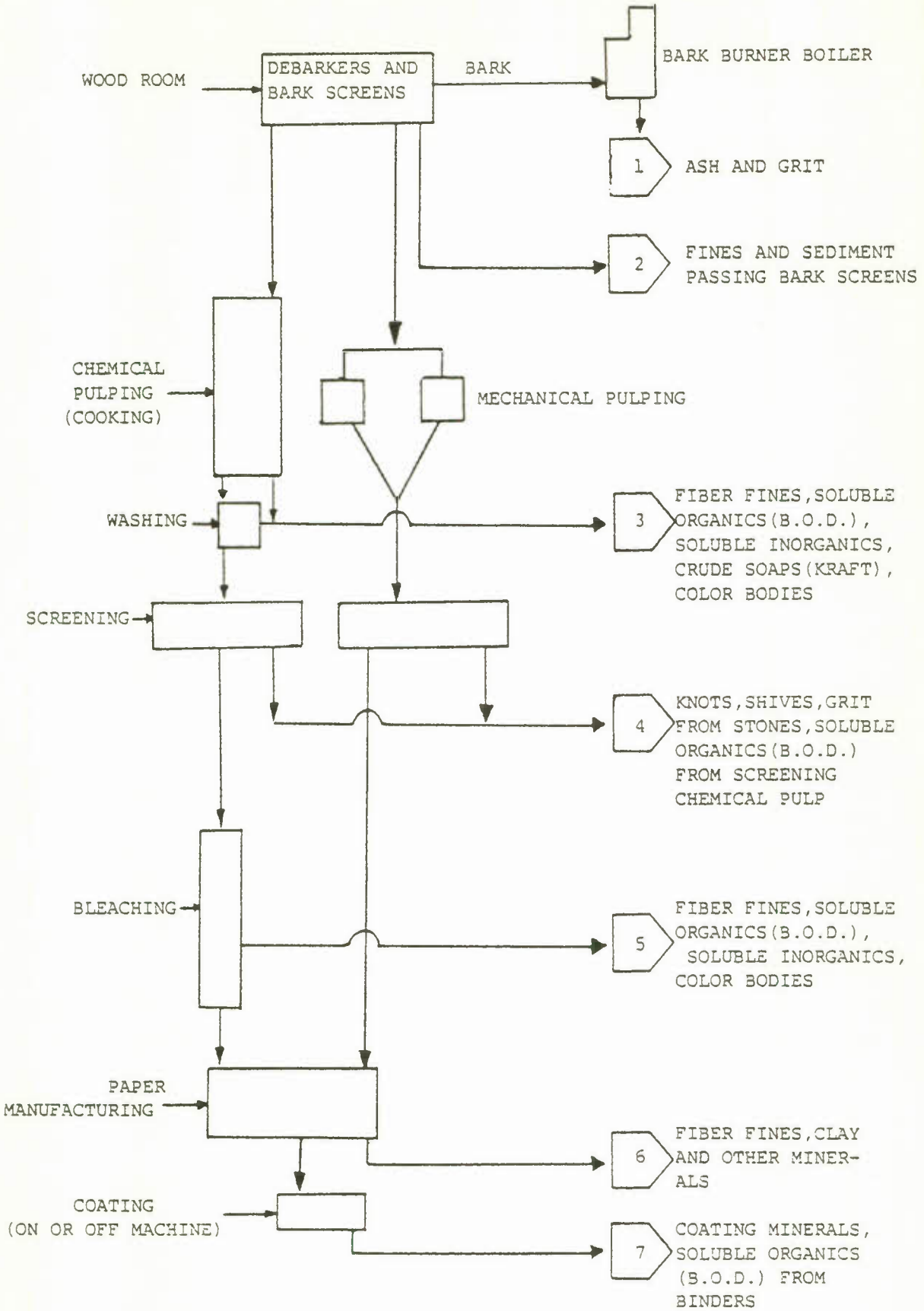
The economic side of the pulp and paper industry in Canada has a counterpart in the technology it employs. The production processes commonly used in the industry involve enormous quantities of water: for transporting wood within the mill, as an input in the cooking and grinding processes, and for carrying the separated fibres through the bleaching, refining and sheet forming phases of manufacture.[5] Ultimately, after various forms of treatment, the water is returned to the environment carrying large quantities of wastes, usually in a very dilute form.

The principal production processes and their associated waterborne wastes are summarized in Figure 1.1. Variations in mill size, technology, and vintage have a pronounced effect on the quantities of these wastes so that generalizations about water pollution from the industry may be misleading. Differences in mill locations add a further complication since the environmental impact of the discharge of a given quantity of waste varies considerably with the size and condition of the receiving waters.

Nevertheless the overall significance of the pulp and paper industry as a source of water effluents is beyond dispute. In Ontario, for example, the industry is responsible for about 80 percent of the soluble organic material and 60 percent of the suspended solids discharged directly by all industries into Ontario's lakes and rivers.[6] The effects of these and other major types of wastes coming from this industry are summarized in Table 1.2 together with the parameters commonly used for monitoring waste-

Figure 1.1

SOURCES OF WATER POLLUTION FROM THE PULP AND PAPER INDUSTRY



Source: R.M. Billings and G.G. DeHaas, "Pollution Control in the Pulp and Paper Industry", in H.F. Lunds, Industrial Pollution Control Handbook, New York, 1971.

TABLE 1.2(A)

TYPICAL CONTRIBUTIONS OF PULP AND PAPER MILL SOURCES TO THE VALUES OF SELECTED WATER QUALITY PARAMETERS OF UNTREATED MILL EFFLUENT (H=HIGH, M=MEDIUM, L=LOW)

MILL SOURCE	EFFLUENT COMPONENT	SELECTED WATER QUALITY PARAMETERS						
		BOD	COD	SS*	CS**	DS***	PH	TOXICITY
WR	1					M	M	L
	2	H		H				H
	3	H			H			H
GWP	1					M	M	H
	4	L			H			H
	5	L			H			H
GWB	6		M					M
KP	7					H	L	H
	8					H	L	H
	9		H	M		M	M	M
	10		M	M			M	L
	11			H				H
	12							H
	13		L					M
	14	L		M				L
	15				L	L		L
	16	M				H		L
	17							M
SP	18		H	H		L	M	M
	19		H	L		H	H	M
	20		H	L		H	L	M
	21	H				H	L	M
	1						M	M
	16	H				H		L
	17							M
	11			M				M
	14	M		H				L
CPB	22		L				H	H
	23					M		
	24					M		M/H
	25							H
	1							L
PC	17	M		M				M
	26	M			M			M
	13		L					
	27	H		M		M		L
	28				H			M
	29			M				L
	30				H			M

*SS:SETTLEABLE SOLIDS, **CS:COLLOIDAL SOLIDS, ***DS:DISSOLVED SOLIDS

KEY TO TABLE 1.2(A)

1. Resin Acids
2. Bark Chips
3. Silt and Bark Fines
4. Cellulose Fines
5. Wood Fines
6. Zinc Hydrosulphite
7. Resin Acid Soaps
8. Fatty Acid Soaps
9. Inorganic Sulphides and Sulphates
10. Organic Sulphides
11. Lignin Residues and Derivatives
12. Methyl Mercaptan
13. Alcohols
14. Fibres
15. Heavy Metal Ions
16. Wood Sugars and Carbohydrates
17. Phenol and Derivatives (Ketones)
18. (Na) Sulphite
19. (Ca) Sulphite
20. (Mg) Sulphite
21. (NH_4) Sulphite
22. Chlorine and Chloroamines
23. Organic Dyes and Color Surfactants
24. Slimicides and biocides
25. Chlorinated lignins
26. Fibre particles
27. Protein and Starch Adhesives
28. Titanium Dioxide
29. Calcium Carbonate
30. Clay and Talc

WR:WOODROOM
GWP:GROUNDWOOD PULP
GWB:GROUNDWOOD BLEACH
KP:KRAFT PULP
SP:SULPHITE PULP
CPB:CHEMICAL PULP BLEACH
PC:PAPERMAKING AND COATING

KEY TO TABLE 1.2 (A) (continued)

BOD	Biochemical Oxygen demand measures the weight of Dissolved Oxygen utilized by microorganisms as they consume or degrade carbon - and nitrogen - containing compounds in organic matter. It is normally measured over a 5 day incubation period and is called BOD_5.
COD	Chemical Oxygen demand measures the Oxygen demand of non-biodegradeable compounds, such as inorganic reducing compounds.
SETTLEABLE SOLIDS	Measures the quantity of insoluble material which tends to precipitate out of suspension in a fluid medium.
COLLOIDAL SOLIDS	Measures the quantity of insoluble material in suspension in a fluid medium.
Ph	Measures the degree of acidity or alkalinity of a fluid medium.
TOXICITY	Measures the lethal and sublethan effects of contaminants on aquatic life (fish).

TABLE 1.2(B)

SOME POSSIBLE EFFECTS OF TYPICAL PULP AND PAPER EFFLUENT COMPONENTS ON RECEIVING WATERS AND ASSOCIATED BIOTA

EFFLUENT COMPONENT	COMMUNITY AFFECTED																												
	FISH													BENTHIC (AND PHYSIO-CHEMICAL)							HUMAN							
	SUB-LETHAL							LETHAL						SHORT TERM			LONG TERM*				AESTHETIC/ USE LOSS					P**		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A*	B*	C*
1	X	X	X					X								X						X							
2	X	X	X	X			X					X		X	X	X	X	X	X	X	X					X			X
3	X	X	X	X								X					X												
4	X	X	X	X								X					X									X			X
5	X	X	X	X								X					X									X			X
6				X	X	X						X				X	X		X							X			X
7								X						X	X	X						X			X				
8								X						X	X	X						X			X				
9							X							X			X	X	X	X	X								
10						X	X						X				X	X	X		X								
11																			X	X	X								
12									X												X		X	X	X			X	
13						X																	X	X	X				
14	X	X	X	X			X					X		X	X	X	X	X	X	X	X					X			X
15				X	X	X						X							X							X			
16																	X	X			X								
17						X																	X	X	X		X		
18		X			X	X											X	X			X								
19		X			X	X											X	X			X								
20		X			X	X											X	X			X								
21		X			X	X											X	X			X								
22								X		X	X																		
23																										X			
24							X												X	X									
25																			X	X	X							X	
26	X	X	X	X								X					X									X			X
27																	X									X			
28	X	X		X										X	X	X										X			
29																			X	X	X								
30	X	X		X										X	X	X										X			

* SLUDGE RELATED

**PATHOGENS

KEY TO TABLE 1.2(B)

A	respiratory abnormalities
B	impaired swimming (mobility)
C	reduced O_2 uptake
D	disruption of feeding behavior
E	disruption of migratory and spawning repertoires
F	reduction of growth rate
G	bleeding and susceptibility to infection
H	denaturing of gill protein
I	paralysis of gill muscles
J	denaturing of mucous membrane protein
K	denaturing of respiratory epithelia
L	gill laceration
M	degenerative hyperactivity and loss of orientation
N	lowering of photosynthetic activity
O	reduction of reaeration rate
P	surface concentration of toxicity (foaming)
Q	de-oxygenation (transitory)
R	de-oxygenation (long term)
S	benthic concentration of toxicity
T	degeneration of benthic community
U	elimination of micro-organismic variety
V	foaming
W	fish tainting
X	water odor
Y	water taste
Z	turbidity and streaking
A*	color
B*	chemical toxins
C*	pathogens

FOR EFFLUENT COMPONENTS SEE KEY TO TABLE 1.2(A)

SOURCES FOR TABLES 1.2 (A) AND 1.2 (B)

1. POLLUTION CONTROL IN THE PULP AND PAPER INDUSTRY
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   AMERICAN CHEMICAL SOCIETY 1969

5. FRESHWATER POLLUTION, CANADIAN STYLE
   P.A. LARKIN
   McGILL-QUEEN'S UNIVERSITY PRESS 1974

water discharges and their impacts on receiving waters. The table lists the range of waterborne wastes from the pulp and paper industry and the diversity of their actual and potential impacts. (Various air pollutants and solid wastes are also produced by the industry but are not considered in this study.)

The magnitude of these wastewater discharges has attracted the attention of government, the media, academics and environmental groups, all of whom have expressed concern about the impact of the pulp and paper industry on Canada's lakes, rivers, and seas. However, the size of the industry and its use of large amounts of water do not by themselves explain the need for a comprehensive program of environmental regulation.

In Canada the private sector is relied upon to make important decisions regarding the allocation of resources among alternative uses. Thus, while governments have policies designed to influence the overall level of employment and the conditions of employment, no restrictions are placed on the amount of labour or other productive inputs that a company can employ. As a rule it is left to the market to determine who and how many people are employed in each company and at what wage (providing minimum wage laws are satisfied). At the same time those employed have the right to organize in order to protect their interests as employees and to bargain collectively with employers.

With respect to the industry's use of water for carrying off its waste products, the situation is quite different. No price is paid for this service even though the cost of providing it is not free in the sense that a receiving water used for effluent disposal may be impaired for providing other services. These services may include recreational use, potable water supply, and the support of viable ecosystems. Companies can usually disregard the economic and other costs they may impose on others by pollution the receiving waters, since those affected may have little or

no right to compensation. In all but the rare circumstances where civil actions might be brought, such as where riparian rights are being infringed or a legal nuisance exists, the victims have no other recourse but through the political process. Even this avenue is open only to those with sufficient time and resources; conditions only infrequently satisfied in the case of widely dispersed victims of environmental pollution. It should not be surprising, therefore, that companies in all industries are inclined to make extensive use of receiving waters for waste disposal since the cost to them for doing so is zero.

These circumstances, where use of the environment for waste disposal is free but imposes costs on others, create a prima facae case for government regulation to control industrial and other waste disposal activities: to provide all those who wish to use the environment for carrying off waste products with an appropriate set of incentives to protect the environment and the interests of its other actual and potential users.

1.2 Government Response

The burgeoning of public interest in environmental matters during the late 1960's and early 1970's led to a variety of responses from government. An important milestone in Canada was the national conference of the Canadian Council of Resource Ministers on 'Pollution and our Environment' held in 1966. In the years following the conference, new federal and provincial departments were created, charged with responsibilities for protecting the environment. Often these new departments were groupings of existing offices, so it should not be thought that this activity was entirely new. What distinguished this period was the emphasis given to environmental protection by government, reflecting the discovery by the public of an issue which had, in fact, been around for a very long time.

A related aspect of the government response to environmental concerns was the enactment of new legislation for pollution control. Again there was a considerable body of law already extant but it was given a renewed focus through consolidation, amendment and the promulgation of new regulations.

One feature of the efforts by government to protect the environment that merits clarification is the use, often in combination, of the terms "regulations", "standards", "objectives", "guidelines", "criteria" and "requirements". These terms are frequently used interchangably even though their meanings are not the same.

Canadian environmental protection legislation typically empowers a government (federal or provincial) to make 'regulations'. These regulations may specify 'standards', expressed in terms of waste discharges or ambient concentrations. Contravention of these standards is an offence under the

appropriate Act. Examples of standards include those established under the federal Fisheries Act which apply to wastewater discharges from new, expanded or altered pulp and paper mills.

"Objectives" or "guidelines" are targets which have not been made legally binding. They may apply to ambient environmental quality, such as Ontario's Provincial Water Quality Objectives, or to specific discharges, such as those in Ontario for wastewater loadings from pulp and paper mills. Failure to meet an objective or guideline may indicate that an offence has been committed, but is not itself an offence.

Standards, objectives and guidelines are often established by reference to a "criterion". Such criteria relate levels of ambient environmental quality to potential uses, (eg., Ontario's Drinking Water Quality Criteria). They are normally established with reference to experimental and epediemiological data, though a considerable amount of judgment and uncertainty may be involved.

Sometimes the term "requirement" is used in reference to both a standard and an objective. This can be confusing since standards have the force of legal sanction while objectives do not. For example, the periodic federal Status Reports on Abatement of Water Pollution from the Canadian Pulp and Paper Industry refer to "requirements". These are standards when applied to new, expanded or altered mills, and objectives when applied to existing ones.

The federal Department of the Environment (Environment Canada) was established as a separate entity in 1970-71. Among its six branches is the Environmental Protection Service which is responsible for conducting the federal government's pollution control activities. These include drawing up regulations, gathering water quality statistics and dealing with emergencies such as oil spills.

The responsibility to protect fish, stemming directly from the British North America Act of 1867, has been the principal basis for the federal government's active role in regulating activities that might cause water pollution.[7] The Fisheries Act of 1867 was revised in 1971 to give the federal government the means to control specific industrial effluents by defining certain substances as being deleterious to fish.[8] For example, the discharge of these substances from new pulp and paper mills must not exceed levels defined in regulations promulgated in 1971.[9] These regulations reflect Environment Canada's view, arrived at in consultation with industry and provincial officials, of the "best practicable technology" for the industry. The regulations, which apply uniformly across Canada, are intended as minima to protect fish, and are specified by substance for each basic process within a mill. By aggregating across processes a total permissible discharge of each regulated substance is arrived at for any new or expanded mill.

It is important to note that pulp and paper mills existing in 1971 are not covered by these regulations. Instead, less stringent guidelines were established and are used as objectives in arriving at compliance schedules negotiated between Environment Canada's regional branches and individual companies. (These mills can still be prosecuted under section 33(2) of the Fisheries Act for discharging deleterious substances.)

To supplement this regulatory activity the federal government allows the capital cost of pollution abatement facilities to be depreciated over two years for tax purposes, and grants rebates of the federal sales tax on the purchase of pollution control equipment. This is the same treatment that expenditures on production equipment receive. Also, in 1979 the federal government announced, with Quebec and Ontario, joint programs of assistance for the pulp and paper industry to provide funding for capital expenditures for modernization and pollution abatement.

This brief account of the federal government's approach to regulating wastewater disposal, by the pulp and paper industry in particular, does not do justice to the legislation or the complexity and subtlety of the institutional arrangements. Whereas there exists reasonably compre-

hensive accounts of the legislation,[10] far less has been written about the way in which the Environmental Protection Service actually discharges its regulatory responsibilities. An important issue in this regard is its liaison with the provincial authorities and the extent to which the federal and provincial regulatory activities are mutually reinforcing rather than conflicting or unnecessarily overlapping. This matter is taken up in Chapters 3 and 6 which also look more closely at the federal/provincial programs of financial assistance for the industry.

It is more difficult to generalize about provincial approaches to environmental regulation of the pulp and paper industry (or any other industry) owing to their diversity. Among the reasons for this diversity are variations in the capacity of each province to deal with the pollution problems that come within its jurisdiction, the differences in the problems themselves and the arrangements worked out with the federal authorities. The federal role has been least prominent in Quebec and Ontario, more so in British Columbia and the Prairies, and in the Maritimes considerable reliance is placed on Environment Canada's regional offices in all aspects of the regulatory process.

One important feature which distinguishes the provincial approaches to pollution control from the federal one is the emphasis placed by the provinces on the assimilative capacity of the receiving waters. Typically, objectives are established with the aim of ensuring water quality suitable for various uses. The capacity of individual lakes and rivers to assimilate wastes is assessed so that specific discharge limits for each mill can be determined. These limits are then incorporated in provincial regulatory instruments and mill compliance programs. For mills discharging wastes into inland waters, these provincial limits are usually more stringent than those derived from the federal regulations and guidelines. This is because the federal requirements are only intended as minimum standards to protect fish, whereas the provinces are responsible for ensuring adequate water quality for a wider range of uses.[11]

In Chapter 3, the major pieces of federal and provincial environmental protection legislation directly relevant to the pulp and paper industry are summarized in terms of their general approach, ministerial powers, public participation, and other aspects. However, such summaries are only a preliminary step in coming to an understanding of the regulatory processes themselves. In addition an account of the parties involved is required: the branches of the civil service, the companies, the industry associations (the Canadian Pulp and Paper Association - C.P.P.A.) and public interest groups, as well as an analysis of the information used in the regulatory process, its flow among the various parties, and a careful account of how objectives are set and the related compliance actions decided upon. This Study considers Ontario's approach to regulating the pulp and paper industry in some detail and also examines the federal regulatory process across Canada, though in somewhat less depth.

1.3 The Industry's Record in Controlling Wastewater Discharges

From 1969 to 1978 the industry's output rose by 18%. In the same period the discharge of total suspended solids fell by 47% and that of biochemical oxygen demand (BOD) by 27%. As of 1974, 23 mills were in compliance with the federal government's toxicity requirement. This rose to 39 by 1978. Further details of these changes are given in Table 1.3 which reveals a considerable degree of variation at the regional level.

It is an open question as to how much of this reduction in wastewater discharges has been due to the regulatory efforts of the federal and provincial governments. The gradual replacement by the industry of old facilities and equipment which took place independently of regulation, also played a part in reducing waste discharges. This is especially the case for suspended solids removal since the retained fibre has some commercial value to the companies, a value which has been increasing as wood costs have risen.

These comments notwithstanding, at this highly aggregated level the industry's record is one of modest but definite improvement. Furthermore, these improvements do not seem to have been won cheaply. Estimates by the C.P.P.A. indicate that the industry spent over 800 million dollars (in 1980 dollars), on water pollution abatement from 1970-1979. These estimates are examined in more detail in the next chapter. In the case of Ontario they are compared with estimates derived from data obtained from tax records. Although closer examination reveals discrepancies in the estimates (of which the C.P.P.A. is aware) they show beyond question that the industry has committed substantial funds to controlling its wastewater discharges.

Table 1.3

Summary of Data on Production and Wastewater Discharges for the Pulp and Paper Industry

Region	Production (Average Daily Tonnes)[1] 1969	Production (Average Daily Tonnes)[1] 1978	Suspended Solids (Tonnes/Day) 1969	Suspended Solids (Tonnes/Day) 1978	BOD (Tonnes/Day) 1969	BOD (Tonnes/Day) 1978	Mills in Compliance with Federal Toxicity Requirements[2] 1974	Mills in Compliance with Federal Toxicity Requirements[2] 1978
Atlantic	7,326	9,040	315	198	733	515	5(18)	6(19)
Quebec	19,329	21,864	1,024	525	1,526	1,377	4(44)	6(50)
Ontario	12,088	13,720	508	233	979	768	1(29)	9(29)
Prairies[3]	1,652	2,800	28	36	58	76	3(6)	6(7)
Pacific	13,905	16,498	55	396	945	395	10(26)	12(24)
Canada	54,300	63,922	2,923	1,388	4,235	3,629	23(123)	39(129)

Sources: Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry 1974, 1976, Environment Canada Report EPS 3-WP-75-6, December 1975 and Report EPS-3-WP-77-9, September 1977; 1978 data from unpublished Environment Canada Sources.

1. 1 tonne = approximately 2,200 lbs.

2. Values in brackets show the total number of mills not connected to municipal sewage treatment systems.

3. Referred to as the Northwest region by Environment Canada, it includes Manitoba, Saskatchewan and Alberta.

1.4 Assessing the Adequacy of Environmental Regulation and its Impact on the Pulp and Paper Industry.

A number of questions must be examined when the adequacy and impact of environmental regulation is assessed; for example.

- do the water quality standards and objectives (i.e., for receiving water and effluent) represent a balance between the costs and benefits of achieving them?

- are the regulatory processes effective for achieving the water quality standards and objectives?

- are the results of the regulatory process
  - . efficient, in the sense that benefits are obtained at least cost?
  - . equitable, in the sense that the distribution of the benefits and costs among the various groups affected satisfies some explicit notion of fairness?

With the exception of the last question dealing with equity, neo-classical welfare economics provides a framework which precisely defines the meaning of these questions. It also supplies the operational concepts of cost-benefit analysis for valuing and comparing the costs and benefits of regulation.[12]

Two approaches to addressing these questions can be distinguished. The first would focus on the results of the regulatory effort. It would consider, in a comprehensive way, the costs and benefits of regulation to determine the degree to which the net benefits from regulation are being maximized. However, the information demanded by the framework cannot be easily obtained, especially for an entire industry. In the course of this study a considerable amount of information has been assembled, especially for Ontario, but it falls far short of the requirement

for a comprehensive cost-benefit analysis of environmental protection regulation and the pulp and paper industry.

A second approach to assessing the adequacy of environmental regulation would focus on the process of regulation, by considering the extent to which costs and benefits are taken into account in the deliberations and actions of the regulatory authorities. While it may not be possible to assess from the outside, as it were, the broad range of costs and benefits of regulation in the manner required by the first approach, it may be possible to determine whether and in what way the regulators themselves become cognizant of these factors. To the extent that costs and benefits are not properly considered in the regulatory process it may be concluded that it would be only by chance that the process satisfies the evaluative criteria implied in the questions posed above. Moreover, an assessment of how the costs and benefits of regulation might more satisfactorily be accounted for provides a basis for making policy recommendations.

Since recommendations are an intended output from this study, as is an overall assessment of the impact of environmental regulation on the pulp and paper industry, both of these approaches to studying the regulation of industry have been pursued in this study, though in a partial and incomplete fashion.

1.5 Scope and Limitations of the Study

Much has already been said to this point on the scope and limitations of the study. A further indication is provided by a summary of the following chapters.

Chapters 2 - 4 address a wide range of issues from a national perspective. The statistical background is provided in Chapter 2. It offers information on wastewater discharges, on expenditures for water pollution abatement, and on the record of the pulp and paper industry in complying with federal abatement requirements.. Chapter 3 examines the federal approach to environmental regulation. Consideration is given to the extent to which benefits and costs enter into the regulatory process. Chapter 4 looks at the overall economic impacts of pollution abatement expenditures in industry. It reviews several reasons for concern over these impacts such as possible price and employment effects. Comments are made on attempts by others to measure these impacts and on the significance of the results obtained. In this regard it is agreed that a distinction should be made between estimates of the impacts on the "average" mill, which may be modest, and the much more significant impacts which may be felt by marginal mills. Chapter 4 closes with some comments on the industry's prospects for the 1980's and its ability to afford further, substantial expenditures on pollution abatement.

Chapters 5 and 6 examine the statistical record of the pulp and paper industry in Ontario, and the regulatory process used in that province. In addition, the principal distinguishing features of the regulatory processes in Quebec and British Columbia are described for comparison with Ontario.

Chapter 7 takes the analysis to an even greater degree of detail. Two mill specific case studies are described which show how various analytical tools may be useful for a more systematic assessment of the costs and benefits of abatement as part of the regulatory process.

The final chapter is concerned with recommendations. Those that are presented deal with the major components of the regulatory process: ambient water quality objectives, mill specific compliance programs, monitoring, enforcement and financial assistance. Although the discussion concentrates primarily on Ontario, much of what is said, especially about a greater use of economic incentives for pollution abatement, applies to the pulp and paper industry in all parts of Canada. It should be emphasized that the implementation of any of the recommendations would require further analysis, refinement and planning. It is the purpose of the study to prompt this further work; the study makes no pretension to having completed it.

FOOTNOTES

CHAPTER 1

1. Government of Canada, Department of Industry, Trade & Commerce, Review of the Canadian Forest Products Industry, Forest Products Group, November 1978; Ontario Ministry of Natural Resources, The Ontario Pulp and Paper Industry - Status and Outlook, April 1978.

2. Review of the Canadian Forest Products Industry, pg. 147-152.

3. The Ontario Pulp and Paper Industry - Status and Outlook.

4. These programs are discussed in later chapters.

Footnotes, Chapter 1 cont'd.

5. Useful accounts of the technology of pulping and papermaking and associated waste products are given in A.J. Bruley Training Manual on the Basic Technology of the Pulp and Paper Industry and its Waste Reduction Practices, Water Pollution Control Directorate; Environmental Protection Service Report No. EPS 6-WP-74-3, April 1975, and also in R.M. Billings and G.G. DeHaas, "Pollution Control in the Pulp and Paper Industry", in H.F. Lund Industrial Pollution Control Handbook, McGraw Hill, 1971.

6. Based on data for 1978 provided by the Ontario Ministry of the Environment.

7. The British North America Act, 1867 establishes the division of powers between the federal and provincial governments. However, environmental concerns are not specifically mentioned and complete agreement on jurisdiction has not been reached. (See Estrin and Swaigen op cit for further discussion.)

8. L. Edgeworth and F.G. Hurtubise, "Canada's Approach to Environmental Pollution Control for the Pulp and Paper Industry", paper delivered to the Fifteenth E.U.C.E.P.A. Conference, Rome, Italy, May 1973.

9. Pulp and Paper Regulations, Environment Canada, Regulations, Codes and Protocols Report, EPSI-WP-72-1.

10. Other relevant legislation includes the Navigable Water Protection Act, the Canada Water Act and the Migratory Birds Convention Act. For an account of these and their relevance to the pulp and paper industry see D. Estrin and J. Swaigen, Environment on Trial, Canadian Environmental Law Research Foundation, 1978. This book also discusses the Chlor-Alkali Mercury Regulations under the Fisheries Act which regulates mercury discharges from chlor-alkali plants that make chlorine and caustic soda for the pulp and paper industry.

Footnotes, Chapter 1, cont'd.

11. This also accounts in part for the reason why the standards set by the U.S. Environmental Protection Agency for the pulp and paper industry are more stringent than the standards and guidelines of the federal government.

12. See, for example, E.J. Mishan, Cost-Benefit Analysis, 2nd edition, Allen and Unwin (London) 1975.

CHAPTER 2

WASTEWATER DISCHARGES FROM THE PULP AND PAPER INDUSTRY IN CANADA: CONTROL AND REGULATION

This chapter presents information for the pulp and paper industry on: wastewater discharges, expenditures on pollution abatement, the extent of compliance with the Federal requirements, projected rates of compliance, and projections of discharges assuming full compliance. The information is given at the regional level and covers the entire country. Only those mills which discharge their wastes directly into receiving waters, i.e. not via minicipal treatment systems, are included. More disaggregated information is presented for Ontario, covering also the quality of receiving waters and the administrative costs of the provincial Ministry of the Environment in regulating the pulp and paper industry.

This information is useful for making a preliminary assessment of the regulatory effort and for providing the background necessary for making recommendations to improve the regulatory system.

2.1 Wastewater Discharges from the Pulp and Paper Industry 1969-1978

Tables 2.1 - 2.4 show that, with some important regional differences, production of pulp and paper has increased over the 1969-1978 period. The tables also show that the discharge of wastewater effluents has declined. Table 2.1 deals with production, 2.2 deals with suspended solid discharges, 2.3 deals with biochemical oxygen demand (BOD) discharges, and 2.4 with compliance with toxicity requirements.[1]

Taking each region in turn:

ATLANTIC - This region accounted for about 14% of national pulp and paper output in 1978. Production peaked in 1973/74 and has declined since then at about 2% per annum. Discharges of suspended solids and BOD have declined throughout the period at an increasingly rapid rate. The discharge of these wastes per ton of product has also declined markedly. From 1974 to 1978 only 1 more mill came into compliance with the toxicity requirements, with two-thirds of the mills remaining in non-compliance.

QUEBEC - Quebec's share of the national pulp and paper output is around 35%. Production climbed over the past 10 years, with the rate of increase jumping sharply after 1976. Taking the period as a whole, discharges of suspended solids and BOD declined, the former by considerably more than the latter. However, from 1973/74 - 1975/76 suspended solids discharges increased. BOD discharges increased from 1975/76 - 1978. The number of mills in Quebec meeting the federal toxicity requirements rose by 2 between 1974 and 1978, but remains close to only 10% of the total mills in the province.

ONTARIO - Production rose over the 1969-1978 period at an increasing annual rate. Ontario's share of the national output has remained at just over 20%. Suspended solids discharges fell rapidly from 1969 to 1973/74 and then quite slowly to 1978. BOD discharges also declined throughout the period, though considerably more slowly than did suspended solids in the first five years. Between 1973/74 and 1975/76 the number of mills in compliance with the federal toxicity requirements rose from 1 to 9 with no change to 1978. This represents about one-third of the mills in the province.

Table 2.1

PULP AND PAPER INDUSTRY PRODUCTION 1969-1978

REGION	Average Daily Tonnes				Average Annual % Change[3]		
	1969	1973/74[2]	1975/76[2]	1978	69-73/74	73/74-75/76	75/76-78
Atlantic	7,326	9,849	9,412	9,040	6.1	(2.2)	(2.0)
Quebec	19,329	19,875	20,158	21,864	0.6	0.7	4.1
Ontario	12,088	12,383	12,711	13,720	0.5	1.3	3.9
Prairies[1]	1,652	2,088	2,558	2,800	4.8	4.1	1.8
B.C.	13,905	16,712	15,963	16,498	3.7	(2.3)	1.7
TOTAL	54,300	60,907	60,802	63,922	2.3	(0.1)	2.5

[1] includes Alberta, Saskatchewan and Manitoba

[2] average of 2 years

[3] calculated 69-74, 74-76, 76-78

Source: Environment Canada Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry, 1974, 1976. Data for 1978 provided by Environment Canada.

Table 2.2

DISCHARGE OF SUSPENDED SOLIDS

FROM THE PULP AND PAPER INDUSTRY 1969-1978

	Average Daily Tonnes				Average Annual % Change[3]		
REGION	1969	1973/74[2]	1975/76[2]	1978	69-73/74	73/74-75/76	75/76-78
Atlantic	315	327	292	198	(2.2)	(5.5)	(17.7)
Quebec	1,024	657	685	525	(8.5)	2.1	(12.5)
Ontario	508	251	242	233	(13.2)	(1.8)	(1.9)
Prairies[1]	46	44	48	36	(0.9)	4.5	(13.4)
B.C.	765	459	351	396	(9.7)	(12.6)	6.2
TOTAL	2,658	1,737	1,618	1,388	(8.2)	(3.5)	(7.4)

[1] includes Alberta, Saskatchewan and Manitoba

[2] average of 2 years

[3] calculated 69-74, 74-76, 76-78

Source: Environment Canada Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry, 1974, 1976. Data for 1978 provided by Environment Canada.

Table 2.3

BOD DISCHARGES FROM THE PULP AND PAPER INDUSTRY 1969-1978

REGION	Average Daily Tonnes				Average Annual % Change[3]		
	1969	1973/74[2]	1975/76[2]	1978	69-73/74	73/74-75/76	75/76-78
Atlantic	733	689	649	515	(1.2)	(3.0)	(10.9)
Quebec	1,526	1,336	1,250	1,377	(2.6)	(3.3)	5.0
Ontario	979	823	801	768	(3.4)	(1.4)	(2.1)
Prairies[1]	58	73	82	76	4.7	6.0	(3.7)
B.C.	945	955	511	395	0.2	(26.9)	(12.1)
TOTAL	4,235	3,876	3,344	3,132	(1.8)	(7.1)	(3.2)

[1] includes Alberta, Saskatchewan and Manitoba

[2] average of 2 years

[3] calculated 69-74, 74-76, 76-78

Source: Environment Canada Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry, 1974, 1976. Data for 1978 provided by Environment Canada.

Table 2.4

NUMBER OF PULP AND PAPER MILLS IN COMPLIANCE WITH FEDERAL TOXICITY REQUIREMENT 1974-1978

	1974		1976		1978	
REGION	Total Mills	Mills in Compliance	Total Mills	Mills in Compliance	Total Mills	Mills in Compliance
Atlantic	18	5	19	5	19	6
Quebec	44	4	50	7	50	6[1]
Ontario	29	1	29	9	29	9
Prairies	6	3	7	5	7	6
B.C.	26	10	24	10	24	12
TOTAL	123	23	129	36	129	39

[1] Reduced from 7 in 1976 because the effluent from 2 mills now treated in shared facilities.

Source: Environment Canada Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry, 1974, 1976. Data for 1978 provided by Environment Canada.

PRAIRIES - Although the combined production of pulp and paper in this region rose by nearly 70% from 1969 - 1978, the region's share of the national output remains at less than 5%. Suspended solids discharges increased from 1973/1974 to 1975/1976 but by 1978 had fallen to a level below that of 1969. BOD discharges also fell from 1975/1976 to 1978 but not sufficiently to compensate for increases in the years prior to 1975/1976. In 1978, 6 of the region's 7 mills met the federal government's toxicity requirements, an improvement from 3 mills of 6 in 1974.

BRITISH COLUMBIA - This region has maintained its share of the national output of pulp and paper at about 26% over the period. Output declined somewhat from 1973/1974 to 1975/1976. Discharges of suspended solids fell rapidly from 1969 to 1975/1976 but then increased sharply to 1978. The pattern with respect to BOD discharges is quite different. These showed no significant change between 1969 and 1973/1974, falling to only 41% of the 1973/1974 level by 1978. By 1978 exactly 50% of the mills met the federal government's toxicity requirements, having risen by 2 mills since 1974.

Some of the technical and mill specific factors underlying these changes in wastewater discharges, and the limitations in the data themselves, are discussed in the Environment Canada sources from which the information in Tables 2.1 to 2.4 is taken. The most problematic component in the industry is considered to be the sulphite newsprint sector. Most of these mills are located in the Atlantic, Quebec and Ontario regions and many of them are old and small. While a range of technical options does exist for reducing discharges from these mills, all are costly. Conversion to an alternative pulping process or mill closure, both of which have occurred in some regions may be the most attractive long-term solution.[2]

2.2 Industry Expenditures on Water Pollution Abatement

The reductions in effluent discharges reported in the previous section have resulted from two factors: mill modernization and pollution abatement. In principle it is not difficult to distinguish between expenditures for modernization and expenditures for pollution abatement. The former are intended to produce a profit for the company, the latter involve an expense with no commensurate financial return.

In practice, however, a single item of expenditure by a pulp and paper company may be undertaken for both modernization and abatement purposes. Any attempt to estimate abatement expenditures must therefore subtract that portion of the costs attributable to modernization. When the expenditures can be segregated in this manner, that is, where some costs are exclusively for pollution abatement or modernization, this does not present a problem. Severe difficulties arise when joint costs are involved; costs which yield modernization and abatement benefits but which cannot, except by some arbitrary rule, be assigned exclusively to either objective. In these cases, all that can be expected in gathering statistics on pollution abatement expenditures is that a systematic and consistent approach is used in apportioning the costs to modernization and pollution abatement. Then, over time, discernible trends in expenditures should reflect actual increases or decreases, rather than a change in the procedure for dividing the expenditures between modernization and abatement.

One of the services performed by the Canadian Pulp and Paper Association (C.P.P.A.) is the collection and dissemination of industry data. The Association provides mill specific information on a confidential basis to federal and provincial departments. However, the C.P.P.A. only makes public data aggregated by region or by production category. These include estimates of pollution abatement expenditures. To ensure that consistency is maintained across the companies and through time the C.P.P.A., rather than the companies, allocates expenditures to modernization and abatement.

Table 2.5 presents C.P.P.A.'s estimates for each region, of water pollution abatement expenditures by the pulp and paper industry, from 1970 to 1979. The estimates are based on reports submitted to the C.P.P.A. by its member companies. These companies account for about 95% of the industry's total output. The estimates include funds spent on pollution abatement at new and expanded mills as well as at existing ones. Only expenditures by mills discharging wastes directly into receiving waters (that is, not via municipal sewage systems) are included.

The estimated expenditures shown in the first six columns of Table 2.5 are in current dollars. They can be used for comparing expenditures among the regions in any year but an adjustment for inflation is required to permit comparisons over time. The last column of the table presents the Canadian totals in 1979 dollars and shows that according to the C.P.P.A., the industry spent more than $800 million on capital investment for water pollution abatement from 1970-1979.[3] Ontario was the dominant region in the first few years, to be matched by the Atlantic and Quebec regions after 1974, and surpassed by B.C. In real terms, the industry's expenditures on water pollution abatement fluctuated from year to year but did not increase over the decade.

The estimated expenditures reported in Table 2.5 show that considerable sums were spent in the previous decade to secure the reductions in wastewater discharges discussed earlier.[4] In terms of their significance for the industry, however, the expenditures on pollution abatement represented about 10% of the industry's total capital expenditures in the 1970-1979 period. The implications of this and of the additional abatement expenditures

Table 2.5

WATER POLLUTION ABATEMENT EXPENDITURES: 1970--1979 ($'000 CURRENT)

	Atlantic	Quebec	Ontario	Prairies	B.C.	Canada	Canada** ($'000 1979)
1970	5,322	6,486	12,677	1,109	6,858	32,452	72,116
1971	18,352	8,300	20,592	1,590	1,203	50,037	109,081
1972	4,262	6,210	15,237	1,218	7,175	34,102	71,209
1973	1,127	6,511	8,052	216	5,657	21,563	40,489
1974	5,379	15,647	10,890	896	18,346	51,158	80,756
1975	12,374	13,923	15,241	2,844	31,199	75,581	107,200
1976	13,315	14,905	19,865	1,043	31,322	80,450	108,528
1977	21,309	8,057	14,076	6,266	17,486	67,194	84,041
1978	13,885	17,665	11,716	8,118	13,767	65,151	74,595
1979*	12,746	14,180	22,682	5,771	8,894	64,273	64,273
							812,288

*Preliminary

**Adjusted using the Industry Selling Price Index, Statistics Canada, 62-001

Source: C.P.P.A.

required to meet Ontario's water quality objectives are examined in Chapter 4.

It should be noted that the expenditure estimates in Table 2.5, provided by the C.P.P.A., are significantly greater than the estimates obtained from industry claims for the accelerated capital cost allowance on machinery and equipment for pollution abatement for the years 1966 - 1975.* The extent of the difference is shown in Table 2.6.

Table 2.6

Estimates of Water Pollution Abatement Expenditures by the Pulp and Paper Industry from Two Sources

(Current Dollars)

Years	C.P.P.A. Estimates ($ million)	Estimates from ACCA Claims ($ million)
1966 - 1971 incl.	195	54
1972	34	27
1973	21	11
1974	51	35
1975	76	27
Total	377	154

Source: Water & Pollution Control unpublished table prepared as background for the 1979/1980 November/December Directory and Environmental Handbook.

*Statistics Canada, which prepared the latter estimates, have not made estimates for the years since 1975.

One possible explanation for the differences in the two sets of estimates is that the ACCA estimates are based on the year in which the capital cost allowance was claimed. This does not necessarily correspond to the year that the expenditures were incurred since companies have the right to defer their capital cost allowances as they choose. While this may account for year to year differences, it is unlikely to explain the significant difference in the estimates of expenditures over the period 1966--1975.

Despite the reduced wastewater discharges achieved over the past decade, the industry remains some way from achieving the federal government's requirements, and further still from meeting those of the provinces. In 1977 estimates were published by Environment Canada of the costs of meeting the federal requirements.[5] The study assumed that 1976 production rates would continue and that only the minimum treatment consistent with meeting the regulations would be installed. The authors of the study (Beak Consultants Limited) consider their estimates to be accurate, "in total perhaps to within 20 percent".[6] Table 2.7 shows the projected costs by region in 1979 dollars.

Table 2.7

Projected Costs for Meeting the Federal Pulp and Paper Water Effluent Guidelines (1980 Dollars)[1]

REGION	Capital Costs ($ million)[2]	Annual Operating Costs ($ million)[2]
Atlantic	282	3.9
Quebec	594	17.7
Ontario	323	6.3
Northwest	14	3.5
Pacific	224	16.4
TOTAL	1,437	47.8

[1]For mills not in compliance in 1976.

[2]Adjusted from 1976 to 1979 dollars using the industrial selling price index Statistics Canada, 62-001.

Source: Fisheries and Environment Canada, Estimate of Costs for Water Pollution Control Measures in the Pulp and Paper Industry, Report EPS-3-WP-77-11, 1977.

The study also contains cost estimates by production category. The projected average capital costs per mill and total costs by production category are displayed in Table 2.8 showing the wide variation in costs depending on the technology employed.

Table 2.8

Projected Average Capital Costs by Production Category for Mills Not in Compliance in 1976 (1979 Dollars)

Production Category	Average Capital Cost per Mill[1] ($ million)[2]	Total Capital Cost ($ million)[2]
Semi-Chemical	11.2	56
Sulphite Pulp	37.8	302
Non-Integrated Sulphate Pulp	12.7	165
Integrated Sulphate Pulp and Paper	10.3	114
Newsprint	20.7	767
Other Paper and Board	1.8	31
Fibre Building Board	0.7	2
	15.1	1,437

[1] For mills not in compliance in 1976

[2] Adjusted from 1976 to 1979 dollars using the annual rate of increase in industrial selling prices 1976 - 1979

Source: Fisheries and Environment Canada, Estimate of Costs for Water Pollution Control Measures in the Pulp and Paper Industry, Report EPS-3-WP-77-11, 1977.

Table 2.8 and the more detailed table on which it is based gave rise to the following observations in the Environment Canada study (costs adjusted to 1979 dollars using the industrial selling price index):

- total industry cost to meet the suspended solids requirements are estimated at approximately 208 million dollars;

- total industry cost to meet the BOD requirements are estimated at between 417 and 695 million dollars;

- total industry cost to meet the toxicity limitations are estimated at approximately 417 million dollars;

- sulphite and newsprint operations account for about 75% of the total capital costs. On the basis of average mill costs, that for sulphite mills is 2.5 times, and that for newsprint mills nearly 1.4 times the average for all mills.

The extent to which the industry is likely to be able to finance expenditures of this magnitude is considered in Chapter 4.

2.3 Compliance With Federal Requirements

The federal requirements for suspended solids and BOD are expressed in terms of discharge per unit of output. They are mill specific, arrived at by summing the guideline levels for the component processes relevant to each mill. The federal toxicity requirement is a pass/fail test. It is based on the survival of 80% or more of a test species of fish in a mixture of 65% effluent and 35% dilution water for 96 hours.

Tables 2.9 to 2.11 show the actual and projected compliance rates for suspended solids, BOD and toxicity in each region. In the case of suspended solids and BOD (Tables 2.9 and 2.10) compliance rates are given as the percent of production in compliance. The figures with asterisks are actual compliance rates for the years shown. All of the other compliance rates are projections by Environment Canada based on written compliance programs. For toxicity the actual and projected number of mills in compliance are shown (Table 2.11).

The years shown in the left hand columns of the tables are the years in which the projections were made. Reading along the rows one can see the projected compliance rates.

Table 2.9

ACTUAL AND PROJECTED COMPLIANCE WITH FEDERAL REQUIREMENTS FOR SUSPENDED SOLIDS DISCHARGES: PERCENT OF PRODUCTION IN COMPLIANCE

YEAR PROJECTION MADE	PROJECTION FOR YEAR						
	73/74	75/76	77	78	80	83	86
ATLANTIC							
1975	37*		64		81		
1977		42*	65		89	89	
1980				48*	71	71	81
QUEBEC							
1975	19*		91		100		
1977		10*	36		84	84	
1980				30.3*	30.3	30.3	30.3
ONTARIO							
1975	52*		94		100		
1977		59*	76		76	96	
1980				61*	78	86.5	86.5
PRAIRIES							
1975	38*		100		100		
1977		66*	88		88	88	
1980				71*	71	71	71
BRITISH COLUMBIA							
1975	30*		57		80		
1977		44*	50		80	80	
1980				44*	55	55	55

*Actual figure for year shown

Source: Environment Canada Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry, 1974, 1976. Data for 1978 provided by Environment Canada.

Table 2.10

ACTUAL AND PROJECTED COMPLIANCE WITH FEDERAL REQUIREMENTS FOR BOD_5 DISCHARGES:

PERCENT OF PRODUCTION IN COMPLIANCE

YEAR PROJECTION MADE	PROJECTION FOR YEAR						
	73/74	75/76	77	78	80	83	86
ATLANTIC							
1975	51*		51		76	76	
1977		47*	47		76	76	
1980				55*	64	64	64
QUEBEC							
1975	36*		42		55	64	
1977		36*	40		46	69	
1980				49*	49	49	49
ONTARIO							
1975	40*		71		87	87	
1977		58*	58		68	79	
1980				54*	54	71	71
PRAIRIES							
1975	79*		79		79	79	
1977		84*	84		84	84	
1980				84*	84	84	84
BRITISH COLUMBIA							
1975	95*		97		97	100	
1977		98*	98		100	100	
1980				100*	100	100	100

*Actual figure for year shown

Source: Environment Canada Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry, 1974, 1976. Data for 1978 provided by Environment Canada.

Table 2.11

ACTUAL AND PROJECTED COMPLIANCE WITH FEDERAL REQUIREMENTS FOR TOXICITY:

NUMBER OF MILLS IN COMPLIANCE

YEAR PROJECTION MADE	PROJECTION FOR YEAR					
	74	76	77	78	80	83
ATLANTIC						
1975	5*		6			
1977		5*			7	
1980				6*		6
QUEBEC						
1975	4*					
1977		7*			8	
1980				6*		6
ONTARIO						
1975	1*					
1977		9*			11	
1980				9*		9
PRAIRIES						
1975	3*		5			
1977		5*			5	
1980				6*		6
BRITISH COLUMBIA						
1975	10*		13			
1977		10*			16	
1980				12*		18

*Actual figure for year shown

Source: Environment Canada Status Report on Abatement of Effluent from the Canadian Pulp and Paper Industry, 1974, 1976. Data for 1978 provided by Environment Canada.

The regional variation in actual compliance is quite considerable. For suspended solids all regions show an increase in the actual compliance rate from 1973/1974 to 1978.[10] (Quebec's compliance rate dropped from 1973/74 to 1975/76 but more than picked up again by 1978.) Only in Ontario and the Prairies did the compliance rate for suspended solids exceed 50% in 1978. In Quebec it was as low as 30%.

It is remarkable that the actual compliance rates for suspended solids in 1978 failed to equal projections for 1977 which had been made only 2 years previously. In 1975 compliance rates of 90-100% by 1977 were projected for Quebec, Ontario and the Prairies, regions which account for some 60% of the national output of pulp and paper. Actual compliance in 1978 was far below these levels.

This failure of the industry to meet the levels of discharges projected by Environment Canada has led to a "regression" in the projections themselves.[7] Table 2.9 shows how the projections for suspended solids discharges have been revised downwards for every region over the past five years. In all regions except the Atlantic the compliance rate now projected (in 1980) for 1982 for suspended solids is less than the rate projected as recently as December 1975 for 1977.

The situation with respect to BOD discharges is rather similar to that for suspended solids. Actual compliance rates in the Atlantic, Quebec and Ontario regions, with some minor fluctuations, reached a level of about 50% in 1978. Quebec improved the most of these three regions though its compliance rate in 1978 was less than for the other two regions. Ontario's compliance rate declined from 1975/76 to 1978 though it remained well above the rate for 1973/74.

The Prairies and British Columbia regions show 1978 compliance rates of 84% and 100% respectively for BOD. These high rates are projected in 1978 to be maintained in the future. For the Prairies region the compliance

rates projected in 1977 have been raised slightly from the 1975 projection. This probably reflects the achievement in 1977 of a compliance rate in excess of that projected in 1975 for 1977.

The projected compliance rates for BOD discharges for the other three regions have declined somewhat over the past five years. It is now projected that the compliance rates in 1986 will be less than, and considerably so in Quebec, the rates already achieved in the Prairies and British Columbia regions.

Actual and projected compliance with the federal toxicity requirements are less easy to describe since Table 2.11 gives the number of mills rather than percent of production. However, the picture that emerges is one of low levels of compliance, actual and projected, in the Atlantic, Quebec and Ontario regions.[8] Only 32%, 31% and 12% of mills respectively were in compliance in 1978 and no change is projected for 1986. In all three regions, the projections have been reduced from those made in 1977.

Actual and projected compliance rates are considerably higher in the Prairies and British Columbia regions. These regions show actual levels of compliance in 1978 of 86% and 50% respectively, rising, according to the 1980 projection, to 75% of all mills in British Columbia by 1986.

This section highlights a phenomenon that is typical of environmental regulation. Objectives are established for some point in the future. With the passage of time some progress may be made towards meeting the objectives but not at the rate originally envisaged by the regulatory agency, or, it may be presumed, by the public. The objectives are subsequently revised downwards or the date by when they are to be met is postponed. Sometimes, both of these adjustments occur.

The downward revision in projected levels of compliance of the pulp and paper industry began before 1975, the earliest year cited in Tables 2.9 - 2.11. Allowing for increases in production capacity the study on costs[9] gives projections made in 1971 by Environment Canada for total industry discharges of suspended solids (925 tonnes/day) and BOD (3,060 tonnes/day) to be achieved by 1975. The actual suspended solids discharge was 1,618 tonnes/day in 1975/76 and still 1,388 tonnes/day in 1978. Now in 1980 a total of 1,208 tonnes/day is projected for 1986, some 30% higher than the 1971 projections for the year 1975. With BOD the projected daily discharge for 1975 was just about reached 3 years later in 1978 (allowing for production increases), but little if any improvement beyond this level is now being projected for 1986.

While it is not difficult to document the process of regression in actual and projected achievement of environmental objectives, it is far more problematical to come to an understanding of the regulatory processes which gives rise to this result. With the variation in the federal and provincial roles and approaches for regulating the pulp and paper industry, it would be a mistake to attempt a general explanation of the regression in actual and projected performance documented in Tables 2.9 to 2.11. The reasons will likely differ from province to province and from mill to mill. It is therefore necessary to examine the regulatory processes and the condition of the industry in specific provinces. In this study, Ontario has been selected for detailed analysis of this sort.

CHAPTER 2

FOOTNOTES

1. The federal regulations only specify 'guidelines' for existing mills. However, the use of the term 'requirement' in the text is in keeping with the terminology used in Environment Canada's publications.

2. Specific pollution abatement options and costs are explored more fully in Chapter 7.

3. In Chapter 3 these C.P.P.A. estimates for Ontario are compared with estimates based on tax records to give an indication of the caution that should be exercized in interpreting any of these figures.

4. C.P.P.A. sources also indicate that over this period expenditures by the industry on air pollution abatement were about 25% of those on water pollution abatement.

5. Fisheries and Environment Canada Estimate of Costs for Water Pollution Control Measures in the Pulp and Paper Industry, Report EPS 3-WP-77-11, September 1977.

6. Report EPS 3-WP-77-11 op. cit. p.9.

7. Fisheries and Environment Canada Status Report on Abatement of Water Pollution from the Canadian Pulp and Paper Industry - 1976, Report EPS 3-WP-77-9, p.3.

8. Comparisons between the number of mills in compliance with the toxicity requirements in different years are not meaningful since the number of mills tested in these years has varied significantly. Fisheries and Environment Canada, Report EPS 3-WP-77-9, op.cit. p.v.

9. Fisheries and Environment Canada, Report EPS 3-WP-77-11, op.cit.

10. One possible reason for the small increases in actual compliance rates for suspended solids from 1974 to 1976 given by Environment Canada is the change to glass fibre filters for testing. This tends to increase suspended solids test results where biotreatment is involved. (See Fisheries and Environment Canada, Report EPS 3-WP-77-9, p.v..)

CHAPTER 3

ENVIRONMENTAL PROTECTION REGULATION IN CANADA AND THE PULP AND PAPER INDUSTRY

The previous chapter showed that the pulp and paper industry has a mixed record in reducing its wastewater discharges. While there has been some overall reduction in each region it has come about more slowly than Environment Canada intended or anticipated.

Estimates of past and anticipated expenditures on water pollution abatement by the pulp and paper industry were also presented. Despite concerns about the accuracy and completeness of the estimates, it is clear that very considerable funds have been expended and much more is expected by the regulatory authorities if the industry is to meet existing objectives.

This chapter gives an overview of environmental protection regulation in Canada and examines the federal regulatory process and its application to the pulp and paper industry.

3.1 Environmental Protection Legislation and the Pulp and Paper Industry[1]

The Departments and Ministries of the Environment across Canada obtain their authority to regulate the pulp and paper industry, and all other industries, from legislation. The major pieces of this environmental legislation, as they apply to the pulp and paper industry (as of 1977), are summarized in Table 3.1 under four general headings: general approach of the law, ministerial powers in the law, public participation aspects of the law, and other aspects of the law.

Table 3.1

SUMMARY TABLE FOR MAJOR ENVIRONMENTAL LEGISLATION AFFECTING THE PULP AND PAPER INDUSTRY OF CANADA

	ONTARIO			
	Environmental Protection Act	Ontario Water Resources Act	Environmental Assessment Act	Public Health Act
GENERAL APPROACH OF THE LAW				
1. Enforceable water/air quality standards.	A	W*	-	-
2. Inclusion of government/business negotiating.	+	+	-	-
3. Nature of the general prohibitions used in the law.	L	I	C	I
4. Investigation of expected impacts and/or consideration of alternative means.	(1)	(1)	+	-
MINISTERIAL POWERS IN THE LAW				
1. Final Ministerial decision on actions taken.	+	+	(10)	+
2. Explicit recognition of Ministerial exemption powers.	-	+	+	-
3. Use of Ministerial directives for pollution control.	+	+	(2)	+
4. Use of general prohibitions in cases of expected public danger.	+	+	-	+
5. Power to enforce/carry out Ministerial directives.	+	+	-	+
6. Power to prohibit continual offenders from operating.	+	+	-	-
7. Power to delegate monitoring responsibilities.	-	-	-	-
8. Ministerial financial assistance available for control expenditures.	+	(4)	-	-
9. Power to set up advisory councils.	+	-	-	-
PUBLIC PARTICIPATION ASPECTS OF THE LAW				
1. Public access to courts.	+	+	(6)	?
2. Public participation in decision-making process.	-	(7)	+	+
3. Ministerial responsibility to supply information to affected citizens.	-	-	+	-
4. Financial support for research.	+	-	-	-
5. Ministerial option for closed hearings.	n/a	-	+	n/a
6. Incentives to encourage private prosecution.	-	-	-	-
OTHER ASPECTS OF THE LAW				
1. Formation of autonomous review/advisory board.	+	+	+	+
2. Right to appeal board's decision.	+	+	+	?
3. Access to further legal appeal.	+	+	+	+
4. Recognition of approved voluntary programs of restraint.	+	+	n/a	-
5. Guarantee of legal immunity if under approved compliance programs.	+	-	-	-
6. Defendants responsibility to report excessive discharges.	+	+	+	-
7. Maximum fine for first offence	up to $5,000/day	up to $10,000/day	up to $5000/day	up to $500/day

SOURCE: C.I.L. 1977: A Digest of Environmental Protection Legislation in Canada to January 1, 1977; Montreal

Donnan, J.A. and Victor, P.A., 1974: Alternative Policies for Pollution Abatement: The Pulp and Paper Industry of Ontario; Ontario Ministry of the Environment, Toronto.

Estrin, D. and Swaigen, J.S., 1978: Environment on Trial; Canadian Environmental Law Research Foundation, Toronto.

Table 3.1 (continued)

SUMMARY TABLE FOR MAJOR ENVIRONMENTAL LEGISLATION AFFECTING THE PULP AND PAPER INDUSTRY OF CANADA (Page 2)

	BRITISH COLUMBIA	QUEBEC	NEW BRUNSWICK	NEWFOUNDLAND
	Pollution Control Act	Environmental Quality Act	The Clean Environment Act	Department of Provincial Affairs and Environment Act
GENERAL APPROACH OF THE LAW				
1. Enforceable water/air quality standards.	A+W	A*+W*	A*+W*	A+W
2. Inclusion of government/business negotiating.	+	+	+	+
3. Nature of the general prohibitions used in the law.	B	I,B	B,L	I,L,B
4. Investigation of expected impacts and/or consideration of alternative means.	(1)	+	(1)	(1)
MINISTERIAL POWERS IN THE LAW				
1. Final Ministerial decisions on actions taken.	+	+	+	+
2. Explicit recognition of Ministerial exemption powers.	-	+	-	+
3. Use of Ministerial directives for pollution control.	+	+	+	+
4. Use of general prohibitions in cases of expected public danger.	+	+	+	+
5. Power to enforce/carry out Ministerial directives.	-	+	+	-
6. Power to prohibit continual offenders from operating.	+	+	+	+
7. Power to delegate monitoring responsibilities.	-	+	+	+
8. Ministerial financial assistance available for control expenditures.	-	+	-	-
9. Power to set up advisory councils.	/	-	/	/
PUBLIC PARTICIPATION ASPECTS OF THE LAW				
1. Public access to courts.	?	?	?	+
2. Public participation in decision-making process.	(7)	(8)	-	(7)
3. Ministerial responsibility to supply information to affected citizens.	+	+	-	?)Public
4. Financial support for research.	-	-	-	?)Inquiries
5. Ministerial option for closed hearings.	?	?	n/a	?)Act
6. Incentives to encourage private prosecution.	-	-	-	-
OTHER ASPECTS OF THE LAW				
1. Formation of autonomous review/advisory board.	+	Quebec Municipal Commission	-	+
2. Right to appeal board's decision.	?	-	n/a	+
3. Access to further legal appeal.	+	-	?	+
4. Recognition of approved voluntary programs of restraint.	(9)	(9)	(9)	(9)
5. Guarantee of legal immunity if under approved compliance programs.	-	-	-	-
6. Defendants responsibility to report excessive discharges.	-	+	+	+
7. Maximum fine for first offence	up to $10,000/day	up to $5,000/day	up to $5,000/day	up to $500/day

SOURCE: C.I.L. 1977: A Digest of Environmental Protection Legislation in Canada to January 1, 1977; Montreal

Donnan, J.A. and Victor, P.A., 1974: Alternative Policies for Pollution Abatement: The Pulp and Paper Industry of Ontario; Ontario Ministry of the Environment, Toronto.

Estrin, D. and Swaigen, J.S., 1978: Environment on Trial; Canadian Environmental Law Research Foundation, Toronto.

Table 3.1 (continued)

SUMMARY TABLE FOR MAJOR ENVIRONMENTAL LEGISLATION AFFECTING THE PULP AND PAPER INDUSTRY OF CANADA (Page 3)

	FEDERAL GOVERNMENT		
	Fisheries Act	Canada Water Act	Clean Air Act
GENERAL APPROACH OF THE LAW			
1. Enforceable water/air quality standards.	W	W*	A*
2. Inclusion of government/business negotiating.	+	+	+
3. Nature of the general prohibitions used in the law.	I,B	L,F	I,B
4. Investigation of expected impacts and/or consideration of alternative means.	(1)	+	-
MINISTERIAL POWERS IN THE LAW			
1. Final Ministerial decisions on actions taken.	+	(10)	+
2. Explicit recognition of Ministerial exemption powers.	-	-	-
3. Use of Ministerial directives for pollution control.	+	+t	-
4. Use of general prohibitions in cases of expected public danger.	+**	+t	-
5. Power to enforce/carry out Ministerial directives.	+	+t	-
6. Power to prohibit continual offenders from operating.	(3)	+	-
7. Power to delegate monitoring responsibilities.	+	+	-
8. Ministerial financial assistance available for control expenditures.	-	(5)	-
9. Power to set up advisory councils.	-	-	-
PUBLIC PARTICIPATION ASPECTS OF THE LAW			
1. Public access to courts.	+	+	-
2. Public participation in decision-making process.	(7)	(8)	-
3. Ministerial responsibility to supply information to affected citizens.	-	+	-
4. Financial support for research.	-	+	-
5. Ministerial option for closed hearings.	?	?	n/a
6. Incentives to encourage private prosecution.	+	-	-
OTHER ASPECTS OF THE LAW			
1. Formation of autonomous review/advisory board.	-	+	-
2. Right to appeal board's decision.	n/a	?	n/a
3. Access to further legal appeal.	+	?	?
4. Recognition of approved voluntary programs of restraint.	-	-	-
5. Guarantee of legal immunity if under approved compliance programs.	-	-	-
6. Defendants responsibility to report excessive discharges.	-	+	-
7. Maximum fine for first offence	up to $100,000/day	up to $5,000/day	up to $200,000/day

SOURCE: C.I.L. 1977: A Digest of Environmental Protection Legislation in Canada to January 1, 1977; Montreal

Donnan, J.A. and Victor, P.A., 1974: Alternative Policies for Pollution Abatement: The Pulp and Paper Industry of Ontario; Ontario Ministry of the Environment, Toronto.

Estrin, D. and Swaigen, J.S., 1978: Environment on Trial; Canadian Environmental Law Research Foundation, Toronto.

Table 3.1 (continued)

SYMBOL EXPLANATION

A = Air Quality Objectives
W = Water Quality Objectives
* = Part of the Act but not enforced as of January, 1977
** = With Cabinet approval
t = General powers given to the regulatory board to enforce the Act.
- = not part of the Act
(x) = partially covered in the Act, explanation given in note x (if applicable)
+ = included in the Act
? = unknown
n/a = not applicable
L = general prohibition based upon "loss of use of the environment" as well as actions "likely to adversely affect health"
I = general prohibition based on "impairing quality of water" which is defined on the basis of "likeliness to cause injury upon consumption" by any living thing
C = Act is designed to encourage comprehensive research into expected impacts and exploration of alternatives
B = use of "best practicable technology" considerations in determining water quality objectives.
F = use of Effluent Discharge Fees

NOTES

1. Any pollution control plans are subject to review by Ministry officials and conditional approvals may be granted.
2. The Minister may order more research to be done and impose conditions for approval.
3. Procedures must run through criminal court system.
4. Primarily designed to assist municipal waste management facilities.
5. The board may give assistance in its role as a non-profit water quality management agency.
6. Individuals may question the quality of any assessment requesting an injunction pending further hearings.
7. Subject to geographical constraints and/or Ministerial discretion.
8. Subject to proving individual is adversely affected by decision.
9. Assuming Ministerial directives (Power #3) can be voluntarily initiated by the companies.
10. Final decision subject to Cabinet approval.

General Approach of the Law

Considerations which enter into the general approach of an Act include whether enforceable water or air quality standards are allowed, whether there is provision for negotiations between government and the industry the nature of the general prohibitions used in the law and whether investigation of expected impacts and alternative abatement proposals are called for.

Table 3.1 shows the diversity of approaches taken from province to province and some distinguishing features of the federal legislation. Although all jurisdictions have legislation permitting the establishment of enforceable standards for air and water contaminants, Ontario has not introduced such standards for water, and Quebec and New Brunswick have no standards for air or water contaminants.

The prohibitions are usually qualified in one or more of a number of ways, for example, no pollution above specified standards (anything less being acceptable), no pollution without a permit, or no pollution, but provision for exceptions. All jurisdictions use general prohibitions against pollution of one sort or another. These may be against actions which would cause a loss of use of the environment or would adversely affect health, as in Ontario, New Brunswick, Newfoundland and Canada (federal). Ontario, Quebec, Newfoundland and Canada (federal) also have legislation with general prohibitions against activities which impair the quality of receiving waters. In the case of new or expanded mills, Ontario, with its Environmental Assessment Act, has the legislated authority to require research into a wide range of impacts and the examination of alternatives.

Ministerial Powers in the Law

In all jurisdictions in Canada considerable regulatory powers are vested in the appropriate Minister. These include the power to grant exemptions, to give pollution control directives, to prohibit activities when human

health is threatened, to grant financial assistance and to set up advisory councils. Table 3.1 shows how these powers differ from one jurisdiction to another, with perhaps Ontario and Quebec relying, to the greatest extent, on these Ministerial powers for protecting the environment.

An important point to note regarding Ministerial powers is that such powers may be discretionary or they may involve duties. For example, discretionary power is characteristic of Ontario's Environmental Protection Act whereas the province's Public Health Act confers duties on the Minister of Health.

Public Participation Aspects of the Law

The increasing attention paid to environmental issues over the past decade has coincided with growing demands that regulatory processes be more open to public involvement. Although some opportunities for public participation are written into most of the legislation summarized in Table 3.1, it is apparent from the table that the opportunities are often at the Minister's discretion or require proof that an individual is adversely impacted. Ontario's Environmental Assessment Act and the Canada Water Act make the greatest allowance for public participation, but to date neither of these Acts have had any real affect on the pulp and paper industry. The former applies only to new and expanded mills and then only if these are designated by the Minister under the Act; the latter plays a secondary role to the Fisheries Act in the federal regulation of the pulp and paper industry.

Other Aspects of the Law

Key aspects of the law not referred to above include responsibilities for reporting excessive discharges and maximum fines. Most Acts require excessive discharges to be reported by companies, the Pollution Control Act of British Columbia being a possible exception. Maximum fines for a first offence range from $500 per day under Ontario's Public Health Act and Newfoundland's Environment Act, to $200,000 per day under the federal Clean Air Act. Most maximum fines are in the $5,000-$10,000 per day range, though as will be seen later fines of this magnitude have not been approached for offences committed by pulp and paper companies.

3.2 The Federal Approach to Environmental Protection and the Pulp and Paper Industry

It was stated in Chapter 1 that the federal government has based virtually all of its regulatory activity for industrial water pollution abatement on the Fisheries Act. The Canada Water Act passed in 1970 empowers the federal government to make agreements with the provinces on comprehensive resource management programs. If agreement cannot be reached the federal government can proceed unilaterally. Once a region has been designated as a water quality management area, waste disposal becomes an offence subject to a fine of up to $5,000.

The establishment of water quality management areas has obvious implications for extending the Federal role in regulating waste disposal activities which threaten water quality, including, of course, those of the pulp and paper industry. However, ten years after the Canada

Water Act was passed no water quality management areas have been declared and "the Act remains ineffective".[2] This chapter of the report is devoted, therefore, to the use, by Environment Canada of powers under the Fisheries Act to regulate the pulp and paper industry.

3.2.1 Pulp and Paper Effluent Regulations

The Fisheries Act prohibits the discharge of materials deleterious to fish (section 33). It also allows the federal government to make regulations referring to these materials. Regulations for the pulp and paper industry were issued in 1971. They establish permitted discharges of suspended solids and 'oxygen-demanding decomposible organic matter' (BOD). Maximum values for suspended solids and BOD (per ton of product) are specified for a large number of unit operations. The total allowable discharge from a regulated mill is arrived at by summing the values for the appropriate unit processes.

The regulations also prohibit discharge of toxic effluent and specify how the toxicity of an effluent is to be tested. Colour and foaming are not covered by the regulations .

The regulations state the date at which they are to apply to various categories of mills. For new, expanded and altered mills (terms that are defined in the regulations), the regulations apply from November 24, 1971. These mills are therefore subject to standards. Mills existing at that time only become subject to the regulated limits on suspended solids, BOD and toxicity as individual compliance dates are developed through negotiations among Environment Canada, Provincial agencies, and the companies. Negotiations have taken place and compliance dates been established but they have not been transmitted formally to the companies

to bring existing mills under the regulations. It is proper to regard these mills as subject to federal objectives. Such mills can still be prosecuted under the general sections of the Fisheries Act, or, in the case of Ontario for example, for failing to meet a compliance date contained in a provincial Control Order. In this latter way the goals of Environment Canada with respect to existing mills, are pursued via the regulatory efforts of the provincial authorities.

The federal emphasis on the protection of fish as a reason for seeking pollution abatement is entirely consistent with the original intent of the Fisheries Act. However, it may be argued that the pulp and paper effluent regulations themselves are not fully consistent with this overriding objective. This is because the regulations are based on production and pollution abatement technologies and not on the assimilative capacity of the receiving waters. Whether a given loading per ton of product of BOD or suspended solids is likely to affect the receiving water so as to render it deleterious to fish depends on the production level of the mill and the characteristics of the receiving water. In some cases a level of BOD per ton of output will be deleterious to fish, in others it will not.

It is possible, in some circumstances, for considerations of assimilative capacity to enter into the requirements (i.e., standards or objectives) established for specific mills. More stringent requirements can be set for any mill if necessary, as they were for the Fraser Company mill on the Upper St. John River. This was done with the agreement of the New Brunswick Department of Fisheries. Furthermore, the Fisheries Act allows the Environment Protection Service (EPS) of Environment Canada to obtain an order-in-council relieving a company of its obligation to comply with the regulations.

The federal approach to regulation is one which focusses on the effluent, not on the receiving waters. According to E.P.S., a major justification for this is the general lack of understanding "about the movement and effect of specific contaminants, about how much pollution is too much pollution. Until these gaps in our understanding are filled, our strategy must be to play it safe ...".[3] It should be noted, however, that the federal standards and objectives are intended as minima and in so far as they are part of an environmental strategy which errs on the side of caution they do so only with respect to the protection of fish, and not with respect to the environment in general.

In discussing the form of the pulp and paper effluent regulations something should be said about the criterion which is stipulated in the regulations for determining whether or not a waste is toxic. A common measure of the toxicity of an effluent is its LC50. This is the concentration of a sample of effluent at which 50% of the test species of fish survive for 96 hours. Toxicity and LC50 are inversely related. A low LC50 indicates that the effluent, in relatively dilute form, is still lethal to fish. A non-toxic effluent is one in which more than 50% of the fish survive for 96 hours in pure effluent.[4]

The federal regulations do not define toxicity using the LC50 measure. Instead a toxic effluent is defined in the regulations as one in which at least 80% of the test species of fish survive in a mixture of 65% effluent and 35% dilution water.[5] This definition of toxicity constitutes a test which a sample of effluent will pass or fail. As such it

is appealing in its simplicity, though it is simplicity gained at the cost of a loss of information.

Apart from the fact that the test entails what seems to be an arbitrary measure of success, the results of the test yields no indication of the required degree of improvement in the effluent. This is because, unlike the LC50 measure, the test does not measure the degree of toxicity of the effluent. Furthermore, sub-lethal responses are not evaluated (nor would they be in the LC50 test). Consequently, toxicity, which can affect different marine species in different ways, directly on ingestion and indirectly through the food chain, is reduced, for the purposes of federal regulation, to a test whose relevance is somewhat unclear.

3.2.2 The Establishment of the Federal Regulations

The pulp and paper effluent regulations were the first to be established under the Fisheries Act amendments of 1971. As such the process by which they were established has become something of a model for deriving regulations for all other industries.

A task force was set up some two years prior to the formulation of the amendments, to discuss the approach to regulation that the federal government intended to adopt. (However, industry representatives did not think that the approach was really open to modification). This task force is reconstituted when revisions to the regulations are required. Its 25 or so members are drawn from the industry, and from the provincial and federal departments with responsibilities for environmental protection. There has been no participation from the public.

Information on water use and wastewater discharges from each pulp and paper mill was obtained from the companies. A consensus was sought in the task force on the "normal" discharge for a typical mill, the technology available for reducing the discharge, and the "best practicable" pollution abatement technology. Best practicable technology is not defined in the regulation but underlies the standards and objectives specified. If an abatement technology is used in at least two mills (not necessarily in Canada) then it is considered to be practicable technology. The designation of best practicable technology also reflects a judgement by the task force of environmental and economic acceptability. It is not clear, however, how this judgement is exercised, on what additional information besides effluent discharges and use elsewhere it is based, and on how disagreements among the task force members are resolved.*

In 1974, a second round of meetings of the task force commenced, the purpose of which was to revise the 1971 regulations primarily to clarify ambiguities and to give completeness on some minor issues. Fourteen sub-committees were struck, each with responsibilities for studying specific technical issues. Reports of these sub-committees were discussed by the task force during 10 full days of meetings. As in the case of the previous meetings, consensus was sought and only one vote was taken to resolve a disagreement.

One difference between the meetings of the task force in 1974/75 and those of 1969/70 was that by the later period some of the provinces had gone much further in developing their own programs for controlling the industry. These provinces, B.C. and Ontario in particular, did not want the federal government to introduce requirements more stringent than the provincial ones. In addition, the poorer provinces generally wanted less stringent requirements than the others since they were more concerned with the economic viability of the industry.

* The chairman of the task force reported that few, if any, votes were taken and that a consensus was usually reached through discussion.

This round of meetings of the task force was successful in that a revised set of effluent regulations for the pulp and paper industry was drafted. However, such task forces only make recommendations. The revised regulations require approval through a process which involves at least the following: approval by EPS management, approval by Environment Canada management, approval by the Department of Justice, approval by the Privy Council Office, approval by the Federal Minister of the Environment, approval by the Privy Council, approval by a Senate committee, and tabling in the House of Commons.

The revised regulations of 1974 did not get beyond the first approval stage and so the 1971 regulations still prevail. No simple reason for their not being approved emerged in the course of the study, though it seems to have had something to do with an overall change in policy direction that the federal government has been contemplating for some time. If adopted this policy would direct the attention of Environment Canada to the regulation of problematic, toxic waters. The regulation of such common wastes as BOD and suspended solids would then be left to the provinces.

3.2.3 The Compliance Process: Sanctions Under the Fisheries Act

It was shown in Chapter 2 that over the past decade the industry's record in meeting the negotiated compliance schedules has been far from perfect. In Ontario, which is the province most closely examined in this study, enforcement is, by mutual agreement, left to the province. Therefore, an explanation of the delay that has occurred, for Ontario at least, must wait until the regulatory process of that province is taken up in the next chapter. The present section describes the components of the compliance process under the Fisheries Act. It also presents information

on the prosecutions brought against pulp and paper companies by the federal government.

Effluent monitoring is an essential part of any compliance process in which effluent discharges are regulated. The pulp and paper effluent regulations require mills to monitor their wastewater discharges for suspended solids and BOD. Sampling frequencies and measurement methods are also specified in the regulations and further clarified in guidelines to the regulations. The mills also provide monitoring information to the provincial authorities. Although the E.P.S. regional offices would like to receive this information on a routine basis, it is not always submitted to them.

To check the accuracy of the company data the E.P.S. regional offices conduct spot checks which normally take 2 days per mill. Occasionally they will undertake monitoring for compliance purposes, requiring samples taken over 5 days, when it is believed that a province is acting too slowly.

The decision to prosecute a company is taken by the regional E.P.S. offices, but usually in consultation with the Ottawa office. Accords have been reached with the provinces which specify how enforcement activity is to be coordinated. For a new, altered or expanded mill which is in contravention of the Fisheries Act or its regulations the federal authorities have little choice but to prosecute if the province does not. However, in such cases the provinces usually take the lead on enforcement under their own legislation. As long as they seek performance standards that are consistent with the federal regulations there is no independent federal enforcement.

With respect to existing mills, if they are on compliance programs agreed to by Environment Canada, the provincial authority and the company, then they are virtually exempt from prosecution by E.P.S.. If a company falls behind then renegotiation takes place. When renegotiation fails to secure a commitment from the company to take appropriate action in the near term, threats of prosecution may be made and ultimately prosecution itself may proceed.

Table 3.2 summarizes federal prosecutions of pulp and paper companies under the pollution provisions of the Fisheries Act. It is obvious from the table that prosecution by the federal government is infrequent. Those prosecutions that have occurred have concentrated on companies with mills located where the impact of effluent on fish is most significant. This accounts for most of the prosecutions being in British Columbia. Where the prosecution has been successful the fines imposed have been minor, compared with the financial resources of the companies and the costs of pollution abatement. A prosecution under the Fisheries Act brought by the Ontario Ministry of the Environment led to a total fine of $64,000 so the precedent for larger fines does exist. Nevertheless the record of federal prosecutions is one of low fines. The significance of this for obtaining compliance will be stressed in the final chapter.

3.2.4 Federal Provisions of Financial Assistance for Expenditures on Pollution Abatement

Since its introduction in 1966, the accelerated capital cost allowance (A.C.C.A.) has provided for expenditures on pollution abatement facilities and equipment to be depreciated for tax purposes over 2 years on a straight line basis (i.e., up to 50% per year). This does not reduce a company's tax payments over the long term, but it does alter the time at which the taxes are paid. Hence, compared with a lower rate of capital cost allowance, it is equivalent to an interest free loan. The value of

Table 3.2

SUMMARY OF FEDERAL PROSECUTIONS UNDER THE POLLUTION PROVISIONS OF THE FISHERIES ACT AGAINST PULP AND PAPER AND LUMBER MILL OPERATIONS

(not including slash and debris and forestry offences)

COMPANY	LOCATION	DATE OF OFFENCE	PROBLEM	DISPOSITION OF CASE	DATE OF DISPOSITION	GOVERNMENT AGENCY PROSECUTING
Canadian Cellulose	Prince Rupert, B. C.	June 23 to August 13, 1970	Toxic Effluent	$3,000	October 1, 1976	FMS Pacific
Canadian Cellulose	Prince Rupert, B. C.	October 13, 1972	Toxic Effluent	$1,500	October 11, 1976	EPS Vancouver
Rayonier	Port Alice, B. C.	September 10 & 20, 1973	Toxic Effluent	$3,000	March 5, 1974	EPS Vancouver
Eurocan	Kitimat, B. C.	October 24 & 25, 1973	Effluent	$2,500	January 25, 1974	FMS Pacific
Empire Mill	Squamish, B. C.	October 16, 1973	Toxic Wood Preservative	$1,000	March 14, 1974	FMS Pacific
Tahsis	Gold River, B. C.	January 4, 1974	Lime Mud	$1,000	May 27, 1975	EPS Vancouver
McMillan Bloedel	Vancouver, B. C.	March 21, 1974	Toxic Effluent from Plywood Tank	Dismissed (by higher court of appeal)	March 17, 1976	EPS Vancouver
Rayonier	Woodfibre, B. C.	August 8, 1974	Oil Spill	$ 500	May 20, 1975	EPS Vancouver
B. C. Forest Products	Crofton, B. C.	August 9, 1974	Oil Dispersant	Dismissed (under appeal)	June 17, 1976	EPS Vancouver
MacMillan Bloedel	Powell River, B. C.	April 7, 1975	Black Liquor	$2,500	April 25, 1975	EPS Vancouver
Irving	St. John, N. B.	April 5 to 9, 1976	Toxic Effluent	Dismissed (under appeal)	October 1, 1976	EPS Halifax
Irving	St. John, N. B.	January 7, 1977	Toxic Effluent	$3,500	April 16, 1977	EPS Halifax

A.C.C.A. to a company contemplating pollution abatement expenditures will depend on such factors as the total eligible expenditures, and whether the company has sufficient taxable income to take advantage of the allowance. Estimates of the financial benefits from A.C.C.A. to a pulp and paper company are considered in Chapter 7 where, in the case examined, they are seen to be rather modest. In any case, the same favourable rate of capital cost allowance has been extended to all manufacturing, processing and energy conservation equipment so the tax treatment of expenditures on pollution abatement is no longer preferential.

Machinery and equipment purchased to control pollutants generated in the course of manufacturing are generally exempted from the Federal Excise Tax (reduced from 12% to 9% in the November 1978 budget). Furthermore, the duty on pollution abatement machinery and equipment may be remitted if the goods are not available from production in Canada.

Until they were cancelled in March 1979, the Program to Stimulate the Development and Demonstration of Pollution Abatement Technology (DPAT) and the Cooperative Pollution Abatement Research Program (CPAR) were federal programs intended to encourage research activities into pollution abatement by the pulp and paper industry. CPAR, in particular, was considered by Environment Canada to be extremely effective for defining technical abatement problems and for assessing and developing new technologies.

The Federal Enterprise Development Program, which replaced DPAT and CPAR, is administered by the Department of Industry, Trade and Commerce. Under the terms of this program, the federal government provides financial assistance for testing new or untried pollution abatement devices or systems. It will share up to 75% of a project's eligible costs and provide insurance on a term loan to finance a project.

The other important source of financial assistance provided to the industry which bears on pollution abatement is the DREE program under

which two federal/provincial sub-agreements involving Quebec and Ontario have been established. This program is intended to help the industry modernize and to abate pollution. From the federal perspective the emphasis seems to be on the modernization objective. Environment Canada considers any pollution abatement funded under the program to be a benefit, but it is not a requirement for funding. It is the provinces which have made proposals for such an abatement requirement for funding eligibility.

It is questionable whether the various forms of financial assistance and special tax considerations available to all industry for pollution abatement, supplemented in some cases by further actions by the province, are consistent with the Polluter Pays Principle. In 1972 the member countries of the Organization of Economic Development and Cooperation (O.E.C.D.), of which Canada is one, adopted this Principle.

> "The Principle means that the polluter should bear the expenses of carrying out...measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause pollution in production and/or consumption. Such measures should not be accompanied by subsidies that would create significant distortions in international trade and investment."[6]

The O.E.C.D. recognizes that

> "there may be exceptions or special arrangements, particularly for the transitional periods (eg. when new legislation is introduced), provided that they do not lead to significant distortions in international trade and investment."[6]

While the magnitude of any such distortions remain an uninvestigated empirical question, the extent of the "special arrangements" for the

pulp and paper industry, especially in Quebec and Ontario where direct grants for pollution abatement are available, suggests that Canada's commitment to the Polluter Pays Principle is less than complete.

FOOTNOTES

Chapter 3

1. This section is only intended to provide an overview of the formal responsibilities, powers and duties contained in Canada's major environmental legislation affecting wastewater discharges from the pulp and paper industry. It applies to legislation up to January 1977 and, in keeping with the aims of this study, places more emphasis on federal legislation and Ontario's legislation than that of other jurisdictions. (Two Acts, one in Ontario and one in B.C., passed since 1977 give power to deal with responsibilities for cleaning up spills. This is not particularly relevant to the pulp and paper industry.)

2. D. Estrin and J. Swaigen, op.cit. p.179.

3. L. Edgeworth and F.G. Hurtubise "Canada's Approach to Environmental Pollution Control for the Pulp and Paper Industry", op. cit. p.3.

4. If some of the fish die, but less than 50%, the effluent may still be considered toxic, though mildly so.

5. The Pulp and Paper Effluent Regulations EPS1-WP-72-1 say the fish should be "of a species that frequent the waters into which the mill effluent is being discharged." The Guidelines for the Pulp and Paper Regulations EPS1-WP-72-2 say "for legal purposes the test fish should always be rainbow trout." Since rainbow trout do not frequent the waters into which all mills discharge their effluent, the contradiction between the guidelines to the regulations and the regulations themselves is curious. (Apparently the Federal Department of Justice wanted one test species across the country.)

6. O.E.C.D. The Polluter Pays Principle: Definition, Analysis, Implementation, Paris, 1975. pp. 12, 13.

CHAPTER 4

ECONOMIC IMPACTS OF POLLUTION ABATEMENT EXPENDITURES ON THE PULP AND PAPER INDUSTRY

4.1 Nature of the Concern Over Economic Impacts

It is widely believed that environmental protection regulation has serious economic implications for industry. With respect to the pulp and paper industry, in particular, any or all of the following types of negative impacts are possible:

- a contraction of the industry due to increased costs from the installation and operation of pollution abatement equipment via:
  - a decrease in final market demand due to price increases resulting from the increased costs; or
  - a loss of markets to foreign producers;
  - regional changes in employment due to the contraction of certain parts of the industry to the benefit of parts in other geographic regions.

The pulp and paper industry has expressed concern that insensitivity to the precarious nature of the Canadian industry will result in pollution abatement policies which have harmful effects on the long term health of the industry.[1] Some people in the industry believe that an excessive application of pollution abatement requirements will further erode the already disadvantageous position that the Canadian industry holds with respect to its major competitors in the United States.

The importance of these potential negative impacts is heightened by the fact that the industry plays a crucial role in the regional

economy of a number of areas in Canada for example, large areas of Newfoundland, New Brunswick, Quebec, Ontario and British Columbia). The Ontario Standing Committee on Natural Resource Development pointed out in its report that nine communities in Ontario had 29% or more of their employed residents working in a pulp and paper mill and "for many more, the direct and indirect effect of losing a mill and mill-related employment would be crippling".[2]

From the point of view of regulating the industry there are two main issues. The first is what the impact of the implementation of pollution abatement regulation is likely to be. What will attaining specific levels of pollution abatement actually mean for the economic health of the industry? The second question is a normative one. Given the likely impact on the industry, what policies should be pursued? Should measures to mitigate the impact be considered and if so, which ones? Should revision in the required levels of pollution abatement be made in order to avoid undesirable socio-economic consequences?

The first question, namely the economic impact of pollution abatement on the Canadian pulp and paper industry, is considered in this chapter. The focus is not so much on how the industry is likely to be affected as it is on an evaluation of several studies and other published views on this important issue.

The second question, concerning the best direction for policy, is taken up in broad terms in the concluding chapter to the report (Chapter 8). However, the final section of this chapter examines the issue of the kind of information which is needed by the government if it is going to take economic impacts into account when formulating and enforcing pollution abatement programs.

4.2 The Economic Impact of Pollution Abatement Expenditures on the Canadian Pulp and Paper Industry - The Results of Two Studies

This section examines two studies which have attempted to describe the likely economic consequences for the pulp and paper industry of the implementation of proposed pollution abatement programs.

R.A. Muller undertook an econometric study of the Canadian pulp and paper industry in order to examine the impact of the implementation of pollution abatement on employment and output for the industry as a whole.[3] He modelled the Canadian industry to include three different sectors: newsprint, market pulp, and other paper and board. His model estimated the demand for Canadian pulp and paper production in each of these sectors and derived from this the implied sector by sector output and employment. The demand for pulp and paper production was made a function of factors such as gross national product, newspaper circulation (for the newsprint sector), the general price level and the price of paper products in each of the sectors. Price in turn was made a function of sector costs, and the competitive behaviour of U.S. mills.

Muller used data for the period of 1957-1969 in estimating his model. He then employed the model to analyze two situations, one in which pollution abatement expenditures are required and the other in which they are not required. He compared estimated levels of output and employment for these two situations and drew conclusions about the economic impacts of pollution abatement expenditures.

For the case in which pollution abatement expenditures are required, Muller reviewed several studies of abatement costs and arrived at estimates assumed to correspond to the cost of meeting the federal government's effluent regulations promulgated in 1971. He then examined the implications for Canadian output and production given that both Canadian and

U.S. pulp and paper mills are required to incur the same level of pollution abatement expenditures. He also examined the situation in which Canadian mills incur the abatement costs but U.S. mills have no standards imposed on them.

It should be emphasized that Muller undertook his analysis for each sector of the industry on an aggregate Canadian basis. Taking this approach he found that the estimated impact of pollution abatement expenditures on the Canadian industry to be fairly small. Output is not affected greatly; the employment impacts are not large. This is true for both the case where the United States is, and the case where it is not, required to meet the same abatement requirements.

Concerning employment, Muller found that, under the specified assumptions, a rise in employment actually takes place despite the decline in output. This is due to the fact that employment is created through operating the installed pollution abatement equipment and this more than compensates for the decline in employment from decreased output. If this extra employment is ignored (i.e., the employment associated with operating the abatement equipment) then employment in the industry falls by about 1.3% after ten years.

Muller's overall conclusions were as follows:

> "The basic conclusion is that in the case of currently contemplated levels of effluent treatment for the pulp and paper industry, the concern is misplaced...
> In no case did the shortrun loss in employment exceed three-quarters of one percent of the industry's labour force. At current industry employment levels this represents a loss of about 600 jobs. To provide adjustment assistance for this number of persons should not be very expensive relative to the total capital investment involved in pollution control.

> If the special benefits of the proposed treatment programs are judged to exceed the increase in capital and operating costs, then shortrun adjustment costs should not be sufficient to reverse the decision."[4]

Muller qualifed his results in a number of respects. He recognized that the model is not regionally disaggregated; therefore it is quite possible that effects on local unemployment would be much greater than the percentages for the aggregate. He also assumed that all expenditures on pollution abatement equipment can be financed by the mills. During times of over capacity and low profits it is possible that smaller firms especially, will have trouble financing their expenditures (except at higher interest rates) due to capital market imperfections.

> "This might force the closure of some mills which would otherwise remain profitable. Thus adjustment to the long run solution may be more rapid and somewhat greater than is suggested by the model."

Muller was also dissatisfied with the approach used in his model to estimating the U.S. - Canada market share. Consequently the results predicted for the second case (in which unilateral Canadian pollution abatement takes place) are somewhat questionable.

In addition, Muller was concerned about the statistical significance of his model's coefficients, given that the variation in the data was not great for the period chosen.

In an attempt to apply Muller's approach to Ontario, the Ontario Ministry of the Environment adapted his model, using data from the years 1958 - 1974.[5] The conclusions reached for Ontario were similar to those for Canada as a whole. It was found that Ontario pulp and paper mills are unlikely to lose sales or jobs providing pulp and paper mills elsewhere in Canada and the United States incur pollution abatement costs similar

to those in Ontario. Significant impacts on the industry were found only when abatement expenditures exceed 5% of total industry costs and are imposed only on Ontario mills and not on their competitors. Since the study found that the U.S. requirements for pollution abatement are at least as stringent as in Canada, it concludes that only a minimal impact on output and employment in the Ontario industry is to be expected from pollution abatement.

4.3 The Significance of the Findings of These Studies

There are two major reasons for questioning the conclusions reached by these studies. One reason is that the future may not be at all like the past, so that analyses which base predictions on past behaviour will be inadequate. Another is that even ignoring the problem of changes in the future, the particular approach taken by these studies may be incapable of capturing and predicting the true response of the industry to the imposition of pollution abatement expenditures. This section considers the latter concern; the next section looks at the current and future state of the pulp and paper industry. A final section draws out some of the implications for information requirements for policy making.

One problem with these studies is the degree of aggregation they employ. While the models do analyze the performance of the industry on a sector by sector basis (newsprint, market pulp, other paper and board) the analysis is done on the basis of totals (costs, expenditures, etc.) for all mills within each sector. If the mills in any given sector are relatively homogeneous with respect to their costs or production then an aggregate statistical function for each sector is adequate to describe the kind of response that one would expect from the industry. However, if there is a great deal of heterogeneity in the industry's cost structure then it is not possible to use an aggregate function to represent the behaviour of the industry with any confidence.

Quite clearly there is a good deal of variation in the mills both among individual sectors and within specific sectors themselves. This relates to, for the most part, the history of the industry. In the newsprint and in the market pulp sector for example, older inefficient mills exist side by side with modern, highly productive ones. Consequently there is a great degree of variation both in the productivity and in the cost performance of these mills. Profitability varies widely from mill to mill.

Consequently, in aggregate (or "on average") the industry may be able to make pollution abatement expenditures without any appreciable impact on profitability or market strength, while specific companies and mills may be incapable of making the expenditures and surviving. Operating and capital investment decisions are made on a mill and company, not an industry-wide, basis. Thus there may be a significant effect on companies and mills that would not be predicted by an analysis based on industry sector aggregates.

Therefore, the average response to pollution abatement expenditure may be a very misleading indicator of the actual industry response. This is especially true for an analysis of the impact of pollution abatement expenditures on employment; the older more uncompetitive mills happen to be more labour intensive as well. A mill specific perspective is therefore required.

There are great difficulties in attempting to take a mill by mill approach. The mill specific data that are needed for a rigorous analysis of this sort are simply not available in most cases. Companies are not forthcoming with the information required; frequently the information that is volunteered has to be regarded as suspect for reasons relating to the self interest of the mills involved.

One study which did attempt to take a mill by mill approach for Ontario concluded that the Ontario industry could afford the level of pollution expenditures consistent with meeting the Ontario abatement requirements.[6] The study used information in the public domain to examine the costs of production and profits on an individual firm. It pointed out that on a mill by mill basis, profits (rated per ton of output) ranged from $8 to $30 per ton, whereas pollution control expenditures were in the $5 per ton range. These results were based on data for 1971, generally considered a poor year for the industry. The study concluded that on this basis, the industry could afford to make the requisite pollution abatement outlays.

Despite the inadequate nature of some of the data, the study made an important step towards capturing the variation among mill circumstances. However in attempting to predict the viability of a particular capital expenditure it is necessary not only to take into account whether or not the profits are really there; it is also necessary to look at what is likely to happen to the companies' competitive capabilities if the expenditures are actually made on pollution abatement equipment. There are two interrelated concerns: the ability of a company to continue to attract and keep capital, and the impact on a company and its mills of putting funds into pollution abatement rather than some other capital investment, such as modernization or expansion.

As for the first concern, it is significant to note that over the period in question (1960's to the middle of the 1970's) the pulp and paper industry consistently showed lower returns on equity than the manufacturing sector's average.

By putting money into pollution abatement equipment not only is a company reducing the funds available to pay out as dividends, it is also diverting capital from productive investments it could be making in capital expansion or modernization. As the next section shows, the issue of modernization expenditures is a central one in the debate over whether the industry will be able to afford pollution abatement expenditures in the economic ocntext of the 1980's.

It is important to note that the negative impact of the expenditure on pollution abatement may not show up immediately in decreased output and employment. A company may continue to operate in the short term but over the long term, due to a decline in profits, become progressively weaker. This may occur because of insufficient funds to maintain one or more mills in a competitive position through modernization projects. This flagging in strength would show up in the medium term in a

decreased share of the market or continuing lower profits, or both. The result would be that the mill(s) eventually become uncompetitive at the original (or planned expanded) output, so that production must be reduced possibly to the point of mill closure.

Significantly, a study undertaken in the United States which took basically the same point of departure as the Ontario Ministry of the Environment study, but appears to have had access to much more complete company data, concluded that the implementation of the pollution abatement programs then being proposed by the Environmental Protection Agency in the U.S. would hasten the demise of a number of marginal mills.[7]

4.4 The Current State of the Pulp and Paper Industry and Prospects for the 1980's.

One line of argument is that previous levels of capital availability and expenditure and past competitive performance on the part of the Canadian industry are poor guides to the future levels and performance because:

- low levels of modernization investment in the past have created a legacy of old and inefficient capital stock which makes future performance uncertain;
- new, highly efficient competitors are emerging in the U.S. and the Third World.

A number of analyses done in the middle to late 1970's indicated that the pulp and paper industry in Canada in general, and in Ontario in particular, was facing increasingly difficult times. These studies suggested that past patterns of investment and market performance were not going to be adequate to get the industry safely through the coming years.[8]

The studies pointed to a number of structural weaknesses. The key problem identified was the decline in competitiveness in the Canadian industry as a whole with respect to its U.S. counterparts over the early to middle 1970's, which boded ominously for the 1980's. This was attributed to labour and wood cost disadvantages as well as to the lower productivity created by the outmoded nature of the capital equipment of a number of the mills in Canada. Several sectors were identified as having severe weaknesses which could and probably would, lead to a contraction of significant portions of the industry (for example, fine papers and paperboard).

Other sectors of the industry, such as market pulp and newsprint were identified as having good long term prospects, but only if important

weaknesses were promptly rectified. In particular, it was suggested that significant expenditures on plant modernization were necessary if the Canadian industry was to position itself adequately for the 1980's and 1990's. For example, a study by the Department of Industry, Trade and Commerce estimated that $2.5 to $3 billion (1976 dollars) were needed to modernize the Canadian pulp and paper industry.[9] The Ontario Ministry of Natural Resources stated that the industry in Ontario would have to spend $1.2 billion in Ontario over the period 1979 through 1984. $690 million of this was identified as modernization expenditures with a further $143 million stated as "modernization with pollution abatement".

The significance of this for pollution abatement expenditures was fairly clear. A great deal of capital would be required for plant modernization. At the same time, the difficulties that certain sectors of the industry in particular were having in competing meant that profits would probably not be high. Thus pollution abatement would have to compete squarely with modernization expenditures. The problem of the adequacy of funds to do both was raised directly.

It should be emphasized that modernization and pollution abatement are not competing investments in every instance. For example, the Ontario Ministry of Natural Resources estimated that of the $282 million "pollution abatement" expenditures required, $143 million, or slightly over half, would be directly linked with modernization. A further $250 million related to sulphite control would also involve an important upgrading component if thermo-mechanical pulping were used as a substitute. (The Ministry points out that while embodying modernization and improved productivity, this is not necessarily a move that the industry would make on its own. In other words, it is an expenditure that would not be made if improvements in pollution abatement were not required.)

Some studies suggested that it was not possible for the industry to fund modernization and pollution abatement. For example, the Ontario

Ministry of Natural Resources concluded that it would be possible for the industry to manage the modernization component of the capital expenditures over the coming five year period, but that the industry would be unable to handle the pollution expenditures by itself:

> "It would appear that modernization needs can be met since financing at a somewhat high level has been handled for a number of years. It should be possible, in fact, for the industry to manage the full modernization program plus the linked pollution abatement expenditures (138.0 + 28.6 = 166.6), since this sum is less than the 170 million, the average level throughout the 1970's.
>
> "Capital expenditures of $50 million per year for this program, plus $27.8 million per year for pollution abatement of other types are beyond the capacity of the industry to finance on its own if other capital needs are to be met concurrently from industry sources."[10]

What are the most recent trends for the pulp and paper industry? Are the structural problems likely to continue? Currently the industry is enjoying highly prosperous times. The past 2 or 3 years have shown steadily increasing profits. As Table 4.1 shows, net after tax earnings figures for fifteen of the largest forest products companies increased 61% from 1976 (a low year for the industry) to 1977 and a further 94% from 1977 to 1978. The 1978 rate of return on capital of about 10% was close to the 1974 high water mark for the industry. At the time of writing figures on only the first three quarters of 1979 were available. However profits of about $589 million already topped the total for 1978; the first three quarters of 1979 showed a 70% increase over the same period of 1978.

TABLE 4.1

NET EARNINGS AFTER TAXES

FOR FIFTEEN FOREST PRODUCTS COMPANIES

($000)

Year	Earnings
1976	165,000
1977	266,000
1978	516,000
1979 (1st three-quarters only)	589,000

Source: Canadian Pulp and Paper Association
"Net Earnings After Taxes, Forest Products Companies", Dec. 1979.

How likely is this increase in profits to continue? The lower level of the Canadian dollar, which has been a major factor in these increased profits, shows no signs of making a significant recovery in the short or even medium term. It appears that the industry will benefit from the lower level of the dollar for some time to come.[11]

Future prospects are of greatest concern for market pulp and newsprint, the two sectors where the largest pollution abatement expenditures must be made. The pulp market which had been plagued by large inventories, worked these off by the late 1970's, and now, in the opinion of many industry observers, promises to provide good opportunities for Canadian producers in the 1980's. Some short term softness is to be expected in this market, but a combination of good price performance by Canadian producers and improving market opportunities, especially in Japan and Europe, suggest that market pulp will be a strong performer.[12] Newsprint also looks very promising for the same period, although it will have to deal with competition from a number of new mills in the U.S., and can expect a drop in operating rates for late 1980 and 1981.[13]

At the same time cautionary notes have been struck due to concerns about the potential impacts of the U.S. recession and the GAFF tariff reductions.[14] As indicated above, many analysts view the industry's current prosperity both as a harbinger of, and a key opportunity to lay the basis for, a more prosperous decade for key sectors of this industry. However, some interpret the current boom as nothing more than a typical upswing in the cycle to be followed by another cyclical downswing, which could bring the average financial rate of return for the industry over both phases of the cycle to a level much closer to the lower returns of the 1960-1977 period.[15] Clearly the situation is complex and the prospects for the industry far from certain.

Despite the uncertainty however, it is obvious that the current high earnings levels were not taken into account by those studies previously cited which concluded that the industry could not afford to foot the bill for pollution abatement expenditures. Companies eager to be in a much better position than they have in the past tc afford both modernization and abatement expenditures. However, some companies and certain mills of particular companies may find it difficult to maintain short and longer term economic viability and the requisite capital outlays.

It is also clear that the present period presents a great opportunity to implement the needed capital expenditures. It was in recognition of the importance of modernizing the industry and of taking advantage of the industry's current prosperity that government initiatives have been taken to make funds available to the industry on the basis of both modernization and pollution abatement plans and commitments. Both Quebec and Ontario have introduced such plans, jointly with the federal government through DREE. In Ontario the Employment Development Fund makes funds available to qualifying companies. One of the qualifying requisites is that their proposed capital refurbishing should result in an upgrading of pollution abatement facilities satisfactory to the Ministry of the Environment. These programs will assist in bringing mills into compliance with abatement objectives providing:

- the mills take advantage of the money to embark on modernization and pollution abatement expenditures;
- the mills complete not only the modernization (i.e., expenditures related to improved productivity) but also the pollution abatement expenditure part of their programs.

In conclusion, the industry appears to be enjoying one of its healthiest periods and it is clear that significant capital expenditures will be made over the coming period. The way in which these expenditures will be divided between modernization and pollution abatement will depend, at least in part, upon the stance taken by the regulatory authorities.

4.5 Economic Impacts and Policy Making Information Requirements

It is clear from the foregoing that identifying and predicting the economic impacts of pollution abatement programs on the pulp and paper industry is a complicated task requiring detailed information and analysis. How should policy makers concerned with formulating and implementing pollution abatement programs utilize information and analysis of this sort?

Obviously, the relevance of this information depends very much on how economic impacts fit into the policy maker's frame of reference and orientation. Are economic impacts to be of concern at all in formulating pollution abatement programs? If so, at what points in the regulatory process are they to be taken into account and how are they to be dealt with? It is the answers to these questions that will determine the policy making process' need for information about economic impacts.

This section outlines some possible, alternative, orientations to taking economic impacts into account. The analysis of economic impacts consistent with these orientations is discussed, with the emphasis on the orientation which appears to be most common today.

It is useful to distinguish two basic stances toward economic impacts. The first stance holds that environmental regulatory authorities should not take explicit account of the economic impact of proposed policies. One example of this stance is a "pure" market approach which establishes objectives, and implements them as well, by internalizing the external costs of pollution (eg., through a system of effluent charges based on damage estimates). The market is left to sort out all of the implications, including impacts on employment. In this case, the information on economic impacts required by the environmental policy makers is obviously nil.

The second basic stance holds that the economic impact of pollution abatement programs should be considered in formulating pollution abatement policy. There are a number of possible variants of this

orientation, each with different information requirements, depending on precisely how and at what stage in the process economic impacts are taken into account.

One approach is to formulate water quality goals and/or objectives, to establish standards (or objectives) to be met by each mill, and to allow specific exceptions for compliance in view of economic and consequent social impacts. (The timetable and standards or objectives for the industry as a whole may themselves account of likely economic impacts.) These exceptions would be granted either in the form of permitted delays in compliance, or financial assistance would be provided to help the firms comply within the prescribed schedule. What kind of information and analytical capability is required by the government to ensure that this approach is taken in the most effective, systematic and equitable fashion possible?

If a government, in the form of the regulatory authority, is to grant exemptions (or tailor its control orders) to specific mills on the basis of the mills' economic incapacity to meet standards (or objectives) then that incapacity must be clearly demonstrated. Concrete evidence of the financial status of the mills and firms involved must be provided to the authorities. This means the kind of detailed balance sheet information that has generally been unavailable to government in the past. (Information of this sort is required from applicants for the federal/provincial grants referred to above.) It goes without saying that in addition to this information, government must have the expertise, preferably in-house, to which it can turn to interpret this financial information, in a knowledgeable fashion.

In addition to this, government also requires a rigorous analysis of the likely impacts on the industry as a whole of abatement expenditures. This would be useful in providing not just an independent view to be employed as a partial cross-check on the mill specific exemption requests;

it would also provide the kind of information on the industry that would be helpful in formulating detailed pollution abatement programs. This analytical capability could also be used as a framework for examining alternate assumptions concerning the industry's future. A model such as R.A. Muller's[16] (suitably disaggregated within specific sectors to reflect the extent of mill heterogeneity) and supplemented by whatever mill specific information can be gained could provide the analytical framework for generating this information.

FOOTNOTES

CHAPTER 4

1. Ontario Ministry of Industry and Tourism, Report of the Special Task Force on the Ontario Pulp and Paper Industry, November, 1978.

2. Standing Committee on Resources Development, Report on Pollution Control by the Pulp and Paper Industry, October, 1979, p. 7.

3. R.A. Muller, "A Simulation of the Effects of Pollution Control on the Pulp and Paper Industry", Canadian Public Policy, Winter, 1976.

4. Muller, op. cit., p. 101.

5. M. Fortin, The Economic Effects of Pollution Abatement on the Pulp and Paper Industry: Results of an Econometric Study, Working Papers in Environmental Economics and Planning, Ontario Ministry of the Environment, January, 1980.

6. Ontario Ministry of the Environment, Alternative Policies for Pollution Abatement: The Ontario Pulp and Paper Industry Summary and Up-date, October, 1976. (Authors J. Donnan and P. Victor)

7. The Economic Impact of Pollution Control: A Summary of Recent Studies, prepared for the Council on Environmental Quality, Department of Commerce and Environmental Protection Agency, March, 1972, U.S. Government Printing Office.

8. Report of the Special Task Force on the Ontario Pulp and Paper Industry, op. cit.
   Ontario Ministry of Natural Resources, The Ontario Pulp and Paper Industry - Status and Outlook, Timber Sales Branch, Forest Resources, April, 1978.
   Government of Canada Department of Industry, Trade & Commerce, Review of the Canadian Forest Products Industry, November, 1978.
   Analysis of Manufacturing Costs in the North American Forest Products Industries, prepared by Sandwell Management Consultants Ltd., for the Department of Industry, Trade & Commerce, Ottawa, April, 1977.
   "Position paper on Environmental Issues," a submission to the Ontario Ministry of the Environment jointly prepared by nine Ontario pulp and paper companies, June, 1977.

Chapter 4 - Footnotes cont'd.

9. Review of the Canadian Forest Products Industry, op. cit., p. 157.

10. The Ontario Pulp and Paper Industry - Status and Outlook, op. cit., p. 32.

11. The Globe and Mail of February 19, 1980, reports that "The industry is confident of the dollar holding at that (90 cent) level" and quotes Charles Carter, President of the Canadian Pulp and Paper Association in the following terms, "Mr. Carter said the only chance he sees of that not happening is if the United States starts making large energy investments in Canada". See "Forest Firms Favour 90 cent Dollar to Help Pay for Current Expansion", Globe and Mail, Feb. 19, 1980.

12. A February, 1980, article by Albert Sigurdson, points out that the cost of producing a ton of bleached kraft in Canada averages $57. less than in Third World countries, and the current exchange rate gives Canada a slight cost advantage over U.S. mills. Concerning the European market, the article quotes K. Brandstrom, a Swedish paper company executive as saying that "The Swedish forest industry is closing its smaller less economical pulp mills and this should open to Canadian producers a larger share of the European market". See "Forest firms seen at competitive peak", Globe and Mail, February 27, 1980.

13. See "Prospects for Forest Industry Stocks Look Good Despite Current Markets", Globe and Mail, April 28, 1980.

14. The recession should have an impact on all sectors of the Canadian industry, while the tariff reductions will affect market pulp and newsprint much less than printing and writing, tissue, packaging and wrapping grades. For a discussion of these issues, see "Outlook '80", Pulp and Paper, January, 1980. Energy costs and possible labour difficulties have also been mentioned as factors which could erode the current favourable position of the Canadian industry. See the report of remarks made by J.P. Fisher of Fraser Paper Limited in the same article.

15. For example, see Edward Clifford, "Profits in Forest Industry Appear Short-Lived", Globe and Mail, October 22, 1979.

16. See Note 3, above.

CHAPTER 5

WASTEWATER DISCHARGES FROM THE PULP AND PAPER INDUSTRY IN ONTARIO: CONTROL, IMPACT AND REGULATION

Chapter 2 presented information on wastewater discharges from the pulp and paper industry for all of the regions in Canada. This chapter focusses on Ontario and provides more detailed information for that particular province. It also contains some additional information on the quality of the receiving waters in Ontario.

5.1 Ontario's Pulp and Paper Industry

In 1978, 13 companies operated 29 major pulp and paper mills in Ontario.[1] These mills discharged effluents directly into Ontario's lakes and rivers. There are 11 additional mills in Ontario, wastes from which are treated in municipal sewage systems. This latter group of mills accounts for about 7% of total daily production in the province.[2] Since the effluent from these smaller mills is treated in municipal bio-treatment facilities, their environmental impact is minimal. They are not considered further in this study.

Table 5.1 presents information on the mills that discharge effluent directly into rivers and lakes in Ontario. It shows the parent company, the receiving water, major products and pulping technology employed. Actual production data are not available publicly, though they are supplied by the C.P.P.A. to Environment Canada and to the Ontario Ministry of the

Table 5.1

ONTARIO'S MAJOR PULP AND PAPER MILLS, 1978

COMPANY	MILL	RECEIVING WATER	PRODUCT CLASS	PULPING PROCESS INFO.
ABITIBI PAPER CO. LTD	- Iroquois Falls	Abitibi River	Newsprint/Paperboard (Wrappers)	Sulphite
	- Fort William	Thunder Bay (Lake Superior)	Newsprint	Sulphite
	- Sault Ste. Marie	St. Mary's River	Specialty Paper/Pulp	Groundwood and Purchased
	- Smooth Rock Falls	Mattagami River	Bleached Pulp	Kraft
ABITIBI FOREST PRODUCTS LTD.	- Thunder Bay	Thunder Bay (Lake Superior)	Newsprint	Sulphite
ABITIBI PROVINCIAL PAPER	- Port Arthur	Thunder Bay (Lake Superior)	Fine Papers/Pulp	Groundwood and Purchased
	- Thorold	Old Welland Canal	Fine Papers	Purchased and Waste Paper
AMERICAN CAN OF CANADA LTD.	- Marathon	Peninsula Harbour (Lake Superior)	Bleached Pulp	Kraft
THE BEAVER WOOD FIBRE PAPER CO. LTD.	-Thorold	Old Welland Canal	Specialty Board	Waste Paper
BOISE CASCADE CANADA LTD.	- Kenora	Winnipeg River	Newsprint/Pulp	Sulphite
	- Fort Frances	Rainy River	Specialty Paper/Pulp	Kraft & Groundwood
CANADIAN INT PAPER CO.	- Hawkesbury	Ottawa River	Dissolving Grade	Sulphite
DOMTAR FINE PAPERS	- Cornwall	St. Lawrence River	Fine Papers/Pulp	Kraft
	- St. Catharines	Old Welland Canel	Specialty Papers	Purchased and Waste Paper
DOMTAR PACKAGING	- Red Rock	Nipigon Bay	Newsprint/Pulp/ Paperboard (linerboard)	Kraft and Groundwood
	- Trenton	Trent River	Pulp/Paperboard (Corrugating Medium)	Neutral Sulphite Semi-Chemical Process and Waste Paper
DOMTAR CONSTRUCTION MATERIALS	- Thorold	Old Welland Canal	Building Papers (Sheathing Board Roofing Felts)	Waste Paper
E.B. EDDY FOREST PRODUCTS LTD.	- Espanola	Spanish River	Fine & Specialty Paper/Bleached and Unbleached Pulp	Kraft
	- Ottawa	Ottawa River	Fine and Specialty Paper	Purchased and Waste

Table 5.1 - Page 2.
Ontario's Major Pulp & Paper Mills, 1978

COMPANY	MILL	RECEIVING WATER	PRODUCT CLASS	PULPING PROCESS INFO.
GREAT LAKES FOREST PRODUCTS LTD.	- Thunder Bay	Kaministikwia River	Newsprint/Pulp	Sulphite/Kraft
	- Dryden	Wabigoon River	Fine & Specialty Paper/Pulp	Kraft
KIMBERLY-CLARK OF CANADA LTD.	- Huntsville	East River	Cellulose Wadding Towels/Tissues	Purchased
	- Kapuskasing	Kapuskasing River	Cellulose Wadding Towels/Tissues	Purchased
	- St. Catharines	Gibson L/12m Creek	Fine Papers/Tissues	Purchased
	- Terrace Bay	Blackbird Creek	Bleached Pulp	Kraft
MACMILLAN-BLOEDEL LTD.	- Sturgeon Falls	Sturgeon River	Paperboard (Corrugating)	Caustic and Sodium Carbonate Refiner Pulp
ONTARIO PAPER CO, LTD.	- Thorold	Old Welland Canal	Newsprint/Unbleached Pulp	Sulphite/Groundwood
SPRUCE FALLS POWER & PAPER CO, LTD.	- Kapuskasing	Kapuskasing River	Newsprint/Bleached and Unbleached Pulp	Sulphite/Groundwood Thermo-Mechanical Pulping
STRATHCONA PAPER CO.	- Napanee	Napanee River	Paperboard (Boxboard)	Waste Paper

Sources: (1) Donnan, J.A. and Victor, P.A., Alternative Policies for Pollution Abatement: The Ontario Pulp and Paper Industry, Summary and Update, Vol. III.

(2) The Basic Technology of the Pulp and Paper Industry and Its Waste Reduction Practices, Water Pollution Control Directorate, August 1974, Environment Canada.

(3) Report of the Special Task Force on Ontario's Pulp and Paper Industry, 1978.

(4) Pulp and Paper Canada Directory - 1979, Southam Business Publications Ltd., 1979, All company names in the table are consistent with the listings in this Directory.

Environment. The industry's production in Ontario increased from about 11,850 tonnes/day in 1970 to 12,450 tonnes/day in 1975, at an average annual rate of 1%. It then rose from the 1975 level to 13,500 tonnes/day in 1979 at an average annual rate of 1.9%.

5.2 Wastewater Discharges from Ontario's Pulp and Paper Mills and Government Regulatory Objectives

In 1976 the Ontario Ministry of the Environment reported on progress in pollution abatement by the pulp and paper industry.[3] The report noted that between 1970 and 1975 more than half of the mills reduced both their average daily loadings of BOD and suspended solids. Meanwhile 12 mills increased their 1975 average daily BOD loadings over the 1970 levels and 6 mills increased average daily suspended solids loadings. Three mills increased their loadings of both of these wastes from 1970 to 1975.

In 1973 the Ministry developed mill specific effluent objectives which were designed to achieve an acceptable level of water quality at each mill location. (Apparently the companies were not informed of these objectives.) A comparison of the discharges in 1975 with these objectives showed that, despite the modest overall reduction in BOD discharges per day and considerable reductions in daily discharges of suspended solids, few mills had achieved the objectives by 1975.

The data on average daily loadings for 1970 and 1975, and the Ministry's 1973 objectives for suspended solids and BOD, are shown in Tables 5.2 and 5.3. The tables also show actual and planned discharges for more recent years, as well as Ministry of the Environment objectives drawn up in 1979 and Environment Canada's objectives (based on 1978 production levels).

Table 5.2

DISCHARGES OF SUSPENDED SOLIDS BY ONTARIO'S PULP AND PAPER MILLS: 1970-1979 (tonnes/day)

COMPANY & MILL	DISCHARGES							OBJECTIVES			Discharges Per Unit Output Per Day (kg/tonne)	
	Actual 1970	Actual 1975	Actual 1977	Planned 1978	Actual 1978	Planned 1979	Actual 1979	MOE 1973	MOE 1979	Federal 1978	1975	1979
ABITIBI												
Iroquois Falls	29.9	28.2	36.3	6.4	8.4	9.1	7.0	4.9	9.1	12.2	29.4	7.0
Sault Ste. Marie	21.7	17.2	11.8	11.8	8.6	4.5	8.2	2.1	4.5	4.0	49.7	23.4
Smooth Rock Falls	14.2	7.3	6.4	6.4	3.6	5.4	5.0	4.5	4.0	5.6	23.5	15.6
Thorold	18.1	4.2	2.7	2.3	3.6	2.3	3.2	1.4	1.4	3.9	15.3	14.1
Thunder Bay	2.3	3.0	2.3	2.3	2.1	2.1	1.7	2.6	2.5	5.6	7.2	4.1
Fort William	2.6	3.3	1.0	1.4	1.4	1.1	1.1	1.5	1.2	4.8	10.3	3.3
Port Arthur	10.9	7.3	6.5	5.4	5.6	3.6	2.4	3.5	3.9	5.4	26.2	8.0
AMERICAN CAN												
Marathon	10.5	6.7	6.8	9.1	11.2	6.8	7.3	4.9	4.3	10.5	15.8	17.7
BEAVER-WOOD												
Thorold	5.4	3.5	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.9	11.6	3.5
BOISE CASCADE												
Fort Frances	5.0	17.5	17.9	20.0	20.2	10.9	17.9	4.1	9.4	11.1	22.9	19.6
Kenora	15.5	11.3	7.2	11.8	10.7	9.1	12.6	2.7	4.0	11.2	21.2	20.3
C.I.P.												
Hawkesbury	3.3	3.1	5.6	4.3	3.6	5.6	3.8	5.9	5.9	7.1	11.9	14.0
DOMTAR												
Cornwall	81.7	11.4	13.2	11.9	12.4	9.6	13.5	7.3	9.6	11.2	19.7	23.6
Red Rock	15.4	5.5	4.4	4.4	4.7	4.4	4.3	5.3	4.8	14.8	7.7	5.6
St. Catharines	1.6	0.1	0.4	0.4	0.4	0.4	0.4	0.5	0.4	1.6	0.9	2.7
Trenton	0.8	0.2	0.5	0.0	0.2	0.2	0.2	0.1	1.4	1.0	1.3	1.1
Thorold	0.4	0.4	0.2	0.1	0.1	0.1	0.1	0.5	0.0	0.4	7.4	1.5
EDDY												
Espanola	18.1	9.3	7.8	6.4	7.3	6.5	8.2	5.6	6.4	16.3	13.2	10.4
Ottawa	5.4	3.8	3.5	4.6	6.3	6.3	9.1	0.9	0.4	2.4	16.8	41.4
GREAT LAKES												
Thunder Bay	74.4	16.8	17.8	21.8	22.4	18.1	18.2	8.6	12.3	33.4	10.9	8.9
Dryden	22.7	22.6	20.7	20.7	18.6	20.7	23.5	7.3	6.8	13.6	42.4	37.2

cont'd....

Table 5.2 - Page 2

Discharges of Suspended Solids

COMPANY & MILL	DISCHARGES							OBJECTIVES			Discharges Per Unit Output Per Day (kg/tonne)	
	Actual 1970	Actual 1975	Actual 1977	Planned 1978	Actual 1978	Planned 1979	Actual 1979	MOE 1973	MOE 1979	Federal 1978	1975	1979
KIMBERLY-CLARK												
St. Catharines	2.7	0.1	0.3	0.2	0.2	0.4	0.3	0.7	0.4	0.3	1.1	3.3
Kapuskasing	3.6	4.0	4.0	6.4	4.2	6.0	4.0	0.6	Λ	0.5	61.5	70.2
Terrace Bay	3.0	7.0	8.5	7.3	7.1	7.0	7.3	5.0	9.5	8.6	17.8	12.9
MACMILLAN-BLOEDEL												
Sturgeon Falls	9.6	4.7	5.4	2.0	6.8	2.0	6.0	1.1	6.8	3.9	18.4	22.3
ONTARIO PAPER												
Thorold	14.1	12.5	6.5	6.8	8.5	8.0	5.7	5.0	6.8	8.7	19.0	8.9
SPRUCE FALLS P & P												
Kapuskasing	87.1	31.8	36.3	57.1	37.4	54.0	70.0	5.9	12.7	15.3	34.1	78.4
STRATHCONA PAPER												
Strathcona	0.1	0.2	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.7	1.8	0.9
											AVERAGE	
TOTALS	480.1	243.0	234.9	232.3	216.7	205.1	242.1	93.6	129.6	216.0	19.5	17.9

Source: Ontario Ministry of the Environment

Λ: MOE OBJECTIVE (1979) FOR THIS MILL IS INTEGRATED INTO THE MILL OBJECTIVE FOR THE KAPUSKASING MILL OF SPRUCE FALLS P & P.

Table 5.3

DISCHARGES OF BOD_5 BY ONTARIO'S PULP AND PAPER MILLS: 1970-1979 (tonnes/day)

COMPANY & MILL	DISCHARGES							OBJECTIVES			Discharges Per Unit Output Per Day (kg/tonne)	
	Actual 1970	Actual 1975	Actual 1977	Planned 1978	Actual 1978	Planned 1979	Actual 1979	MOE 1973	MOE 1979	Federal 1978	1975	1979
ABITIBI												
Iroquois Falls	52.6	63.5	45.4	31.8	53.6	31.8	52.0	6.8	31.8	28.9	66.2	52.0
Sault Ste Marie	39.0	7.4	11.2	11.2	13.1	11.2	12.7	--	11.2	5.4	21.4	36.3
Smooth Rock Falls	13.6	7.7	14.5	6.2	8.4	5.4	8.0	--	14.5	18.4	24.8	25.0
Thorold	7.1	16.0	9.9	5.4	6.4	5.4	5.0	4.5	4.5	1.9	58.4	22.0
Thunder Bay	27.2	25.9	26.9	26.9	25.2	24.5	23.2	5.4)		13.4	70.0	55.6
Fort William	20.9	26.9	19.5	26.3	24.9	26.3	28.6	4.5)	35.4	11.1	84.1	85.9
Port Arthur	45.4	24.1	28.7	17.2	15.8	4.5	2.7	4.5)		3.6	86.4	9.0
AMERICAN CAN												
Marathon	14.7	19.9	17.8	20.0	21.3	17.8	23.8	4.5	16.0	22.5	46.8	57.8
BEAVER-WOOD												
Thorold	6.4	7.8	2.7	2.7	3.2	2.7	2.2	--	2.7	1.0	25.8	7.7
BOISE-CASCADE												
Fort Frances	4.5	12.4	16.9	9.1	18.4	16.3	20.7	4.5	7.5	23.1	16.2	22.7
Kenora	45.4	35.1	35.2	31.8	29.7	31.8	33.3	11.3	23.0	24.9	53.8	52.7
C.I.P.												
Hawkesbury	159.7	170.6	151.7	155.0	153.7	155.0	161.6	36.3	76.0	76.1	656.2	596.3
DOMTAR												
Cornwall	69.0	10.0	17.4	14.4	14.3	15.0	15.4	--	19.2	25.1	17.3	26.9
Red Rock	20.9	10.3	15.7	16.3	17.0	15.4	15.7	4.5	26.0	29.1	14.5	20.6
St. Catharines	1.1	0.4	0.4	0.4	0.6	0.4	0.6	--	0.4	N/R	3.4	4.1
Trenton	9.1	1.8	1.8	1.8	2.0	2.0	2.3	2.7	5.4	7.0	11.3	12.8
Thorold	0.2	0.3	0.2	0.1	0.1	0.1	0.8	0.5	0.0	N/R	5.6	12.3
EDDY												
Espanola	23.1	25.1	26.3	20.9	24.9	20.9	25.2	4.5	3.6	42.1	35.6	31.9
Ottawa	1.6	2.4	2.3	3.0	3.5	3.5	4.3	--	1.5	N/R	10.6	19.6

cont'd...

Table 5.3 - Page 2

Discharges of BOD_5

COMPANY & MILL	DISCHARGES Actual 1970	Actual 1975	Actual 1977	Planned 1978	Actual 1978	Planned 1979	Actual 1979	OBJECTIVES MOE 1973	MOE 1979	Federal 1978	Discharges Per Unit Output Per Day (kg/tonne) 1975	1979
GREAT LAKES												
Thunder Bay	134.3	59.9	92.8	92.8	102.0	90.7	93.2	13.6	94.0	94.0	38.7	45.6
Dryden	21.8	41.9	33.7	29.9	29.9	29.9	30.2	4.5	27.0	34.8	78.6	47.8
KIMBERLY-CLARK												
St. Catharines	1.8	0.8	0.5	0.5	0.4	0.4	0.5	--	0.4	N/R	87.9	55.0
Kapuskasing	1.4	1.4	9.1	10.0	8.0	9.1	1.5	--	A	N/R	21.5	26.3
Terrace Bay	25.1	33.6	31.5	38.1	40.0	38.1	42.5	4.5	38.0	20.0	85.3	75.4
MACMILLAN-BLOEDEL												
Sturgeon Falls	47.2	43.2	63.0	55.8	54.9	55.8	38.7	5.4	39.0	10.3	169.4	143.9
ONTARIO PAPER												
Thorold	60.0	22.0	29.7	22.7	25.5	23.0	24.3	11.3	18.1	43.4	33.4	38.0
SPRUCE FALLS P & P												
Kapuskasing	148.8	108.9	81.6	89.8	72.0	81.6	110.0	4.5	20.0	56.9	116.9	123.2
STRATHCONA PAPER												
Strathcona	10.9	0.5	0.4	0.4	0.4	0.4	0.2	--	0.2	N/R	4.6	1.8
											AVERAGE	
TOTALS	1,012.8	779.8	786.8	740.5	769.2	719.0	779.2	138.3	515.2	593.0	62.6	57.7

Source: Ontario Ministry of the Environment

A: MOE OBJECTIVE (1979) FOR THIS MILL IS INTEGRATED INTO THE MILL OBJECTIVE FOR THE KAPUSKASING MILL OF SPRUCE FALLS P & P.

N/R: NO REGULATION

Apparently the Ministry's 1979 discharge objectives, which are considerably less stringent than those for 1973, should be regarded as interim objectives. In most cases they represent the average daily loadings that are required under current Control Orders.[4] As such they reflect considerations by the Ministry of what is technically and economically feasible over the next few years as well as what is desirable from an environmental standpoint. In contrast to this, the 1973 discharge objectives represent an attempt by the Ministry to establish long term objectives for each mill, the achievement of which could be expected to meet the Ministry's ambient objectives for the quality of receiving waters.

Recognizing the different bases on which the 1973 and 1979 discharge objectives were developed, it remains an open question whether the Ministry has relaxed its goals for pollution abatement by the pulp and paper industry.

The inclusion in Tables 5.2 and 5.3 of the federal discharge objectives for BOD and suspended solids facilitates a comparison with the provincial objectives. (Note that such a comparison is complicated by the fact that the federal objectives are a function of the production rate, process type, and product mix and hence will vary from year to year). In virtually all cases, the federal objectives are much less stringent than those of the province for 1973. The same is true for suspended solids when the federal objectives are compared with the provincial objectives of 1979. However, there is not a very significant difference between these more recent provincial discharge objectives for BOD and those of the federal government. For about one third of the mills the federal objectives are, in fact, the more stringent of the two.

Given the understanding that the federal dishcarge objectives constitute minimum requirements, this discrepancy can be rationalized again by interpreting the 1979 provincial objectives as only interim objectives. There is, therefore, a clear implication that these provincial objectives will be made more stringent in many cases, possibly to the level of the 1973

objectives. This aspect of the objectives as 'moving targets' is of some concern to the industry, since it renders rational planning for pollution abatement difficult.

A comparison of the actual average daily discharges of suspended solids and BOD in the years 1975, 1978 and 1979 for the whole industry shows marginal decreases to 1978. From 1978 to 1979 there was a return to the 1975 levels. For suspended solids an equal number of mills increased and decreased daily discharges of suspended solids from 1975 to 1979. The number of mills for which daily BOD discharges increased exceeded that for which they decreased. There was, of course, considerable variation in the magnitude of the changes in loadings at specific mills so that these comparisons must be interpreted with care. An 80% decrease in suspended solids at the Abitibi mill at Iroquois Falls is likely to be far more significant, in terms of a reduced impact on the Abitibi river, than the combined impact of smaller increases in discharges at several mills located miles apart from each other.

Another factor to be considered is the changes in production levels overall and from mill to mill. The average discharge of suspended solids per tonne of production fell from 62.6 kg in 1975 to 57.7 in 1979. For BOD the reduction was from 19.5 kg in 1975 to 17.9 kg in 1979. However, on a mill by mill basis 9 mills showed increases in suspended solids discharged per tonne of production and 15 mills increased their discharges of BOD per tonne of output.

These considerations do not alter the impression given by the data in Tables 5.2 and 5.3 which show that very little progress has been made by Ontario's pulp and paper industry between 1975 and 1979 in reducing average daily discharges of suspended solids and BOD.

There is also some evidence that the failure to achieve widespread reductions beyond the 1975 levels represent a deficiency in the regulatory process in Ontario: a deficiency as judged by the Ministry's own goals and expectations.

Tables 5.2 and 5.3 show planned discharges of average daily discharges of suspended solids and BOD for the years 1978 and 1979. These plans were formulated by the Ministry's regional office and take account of the abatement activities of each mill believed to be coming into effect in the immediate future.

In the case of BOD discharges per day for the province, actual discharges in 1979 exceeded planned discharges for that year by 8%. For suspended solids, actual discharges per day exceeded planned discharges by 18%.

It is possible that part of these differences occurred because of production increases, though as noted above, at many mills BOD and suspended solids per unit of production also increased. In any case the Ministry staff do attempt to take expected production levels into account when formulating the planned levels of discharge. It is more likely that this discrepancy between Ministry plans and mill performance, and the minimal reduction in effluent loadings during the past few years, is to be found in the nature of the regulatory process itself. Consequently it is this process which must be examined, as it is in Chapter 6.

An additional aspect of the wastewater discharges from pulp and paper mills is its toxicity. The measurement of toxicity used by the Ontario Ministry of the Environment involves the determination of an 'LC50'. The toxicity of an effluent sample is defined in terms of the concentration of effluent in which 50% of a test fish species (usually rainbow trout) survive for a 96 hour period. If all the fish survive the effluent

is said to be non-lethal. (The LC50 will exceed 100% if less than 50% of the fish tested fail to survive in undiluted effluent. An effluent with an LC50 $>$100% is regarded as non-toxic by the Ontario Ministry of the Environment.) This may be compared with the simpler pass-fail test specified in the federal toxicity requirements. (80% or more of fish tested must survive 96 hours in a mixture of 65% effluent and 35% dilution water for the effluent to pass the test.)

Table 5.4 shows that the effluent from most mills in Ontario is toxic according to both the provincial and federal toxicity tests. Of the 28 mills listed in the table, 7 pass the provincial LC50 test, 9 pass the federal test and for 2 there are no data. (The effluent from these 2 mills is currently being tested).

Table 5.4

The Toxicity of Wastewater Discharges from Ontario's Pulp and Paper Mills

COMPANY AND MILL	Ontario LC 50	Federal 96 Hour Test
ABITIBI		
Iroquois Falls	42%	Fail
Sault Ste. Marie	26%	Fail
Smooth Rock Falls	70%	Fail
Thorold	39%	Fail
Thunder Bay	14%	Fail
Fort William	78%	Pass
Port Arthur	>100%	Pass
AMERICAN CAN		
Marathon	59%	Fail
BOISE-CASCADE		
Fort Frances	32%	Fail
Kenora	16%	Fail
BEAVER WOOD		
Thorold	60%	Fail
C.I.P.		
Hawkesbury	10%	Fail
DOMTAR		
Cornwall	94%	Pass
Red Rock	Non-lethal	Pass
St. Catharines	No data	No data
Trenton	28%	Fail
Thorold	No data	No data
EDDY FOREST PROD.		
Espanola	60%	Fail
Ottawa	Non-lethal	Pass
GREAT LAKES PAPER		
Thunder Bay	30%	Fail
Dryden	21%	Fail
KIMBERLEY CLARK		
St. Catharines	Non-lethal	Pass
Terrace Bay	39%	Fail
Huntsville	Non-lethal	Pass
MACMILLAN BLOEDEL		
Sturgeon Falls	45%	Fail
ONTARIO PAPER		
Thorold	Non-lethal	Pass
SPRUCE FALLS PULP & PAPER		
Kapuskasing	24%	Fail
STRATHCONA PAPER		
Napanee	> 100%	Pass

Source: Ontario Ministry of the Environment

5.3 Industry Expenditures on Water Pollution Abatement

The most complete set of data on capital expenditures for pollution abatement at each mill is submitted each year by the C.P.P.A. to the federal and provincial authorities. While the C.P.P.A. does attempt to separate expenditures on modernization from those on abatement there is no independent check on the procedures employed. Moreover, the data are not available publicly, except in a highly aggregated form, and therefore cannot be compared in detail with expenditure estimates derived from other sources.

In this section several sets of expenditure estimates are reported for Ontario's mills, though owing to variations in the coverage of each estimate and the definition on which they are based, no single, direct comparison among them is possible.

Table 5.3 shows estimates of the expenditures on water pollution abatement equipment by Ontario's pulp and paper mills from 1971 to 1977. estimates were derived from information on grants awarded to the companies under Ontario's Pollution Abatement Incentive Act. This Act, which expired in 1976, and was replaced by a sales tax exemption, permitted grants equal to the sales tax paid on eligible equipment. Staff of the Ontario Ministry of the Environment estimated the capital expenditures implied by these payments by "grossing up" the sales tax refund according to the prevailing rate of tax.[5]

The table shows a considerable variation among the companies and variations from year to year. Over the six year period to which the estimates apply the expenditures on water pollution abatement represented about two thirds of the industry's expenditures on all types of pollution abatement.

TABLE 5.5

ESTIMATED WATER POLLUTION ABATEMENT EXPENDITURES OF ONTARIO PULP AND PAPER COMPANIES 1971-1977
($000 current)

YEAR / COMPANY	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1971/77[1]
Abitibi	582.5	393.0	115.6	279.0	1030.1	309.7	2709.9
American Can Co.	10.3	451.9	NC*	NC	29.8	40.8	548.3
Beaver Wood	NC	NC	NC	NC	NC	NC	NC
Boise Cascade	320.6	1070.8	347.3	4.8	108.6	157.9	2015.1
C.I.P.	NC	NC	NC	NC	NC	NC	NC
Continental Can Co.	9.0	NC	NC	NC	300.3	NC	309.3
Domtar	NC	198.2	554.2	594.4	699.2	946.9	2992.9
Eddy Paper Co. Ltd.	27.8	39.9	74.7	NC	NC	NC	142.4
IKO Industries	NC	NC	NC	NC	NC	NC	NC
Great Lakes Forest Prod.	NC	NC	56.4	NC	NC	1880.1	1936.5
Kimberly Clark	NC	1140.5	NC	NC	NC	NC	1140.5
Ontario Paper Co. Ltd.	792.4	NC	NC	3414.2	NC	NC	4206.6
Reed Paper	NC	NC	NC	NC	NC	556.0	556.0
Spruce Falls Pulp & Paper	NC	576.4	NC	NC	NC	NC	576.4
Strathcona Paper Co.	NC	NC	NC	NC	NC	NC	NC
TOTALS[1]	1742.6	3870.7	1148.2	4292.4	2168.0	3891.4	17,133.9

1. No adjustment for inflation

*NC No claim made by mill under the Pollution Abatement Incentive Act

Source: Ontario Ministry of Environment. Estimates based on grants paid under the Pollution Abatement Incentive Act.

Note that the total expenditures estimated for each year are very much less than the C.P.P.A. estimates given in Table 2.5 and repeated in Table 5.6. Some of the difference is likely to be explained by the limited eligibility of expenditures under the Pollution Abatement Incentives Act, in that buildings and structures were not included. Another factor is that not all companies took full advantage of the modest grants available under the Pollution Abatement Incentive Act, though all of the major companies in Ontario did receive grants during the period in question.

Yet a further set of estimates of capital expenditures on water pollution abatement by the pulp and paper industry is displayed in Table 5.6 These estimates were provided to the Ministry of the Environment by companies applying for Certificates of Approval for pollution abatement equipment. It is not obligatory for applicants to give such cost estimates, and in some cases none was provided. This may account for some of the rather substantial differences between these estimates and those of the C.P.P.A., even though expenditures on buildings and equipment are included in both. Furthermore, Certificates of Approval are applied for before the funds are expended and estimates of the costs are recorded rather than the actual sums spent.

What emerges from a consideration of all these estimates of expenditures by the pulp and paper industry on water pollution abatement is the difficulty in deciding just how much has been spent. The estimates derived from information provided by the companies directly to the government are considerably less than those submitted by the C.P.P.A., also based on industry data. But as explained it is not possible to determine the precise reasons, and their relative importance, for the differences. Since

Table 5.6

A SUMMARY OF ESTIMATES OF WATER POLLUTION ABATEMENT EXPENDITURES BY ONTARIO'S PULP AND PAPER MILLS 1970-1977 $'000 (CURRENT DOLLARS)

Year	C.P.P.A. Estimate[1]	Estimate Based on Grants under the Pollution Abatement Incentive Act[2]	Estimate Based on Applications for Certificates of Approval[3]
1970	12,677	--	6,502
1971	20,592	1,743	6,519
1972	15,237	3,871	13,372
1973	8,052	1,148	5,323
1974	10,890	4,292	5,952
1975	15,241	2,160	3,434
1976	19,865	3,891	4,529
1977	14,076	n/e[4]	16,537

Sources: [1]C.P.P.A.
[2]Ontario Ministry of the Environment
[3]Water & Pollution Control, November/December 1979
[4]n/e - no estimate

estimates of the costs of pollution abatement should enter into any rational assessment of the degree of abatement to be required of the industry, it is disconcerting that there should be so much uncertainty as to past costs. This uncertainty as to costs which have already been incurred by the industry does not give one confidence in the estimates of the costs still to come.

5.4 Future Capital Expenditures for Water Pollution Abatement by the Ontario Pulp and Paper Industry

In November 1978 the Special Task Force on Ontario's Pulp and Paper Industry issued its report.[6] Among the items considered by the task force were the immediate and long term capital expenditures required for water pollution abatement. Immediate expenditures were identified as those required to meet existing Control Orders or those soon to be imposed. The period covered varied from mill to mill but generally went from 1979 to 1982. Long term expenditures applied to the period following 1982.

The report also distinguished between expenditures exclusively for pollution abatement and those which also improve the mills' production performance. No attempt was made to prorate these joint expenditures to modernization and pollution abatement.

Table 5.7 gives the expenditure estimates prepared by the Task Force. It shows the considerable variation among the estimated immediate and long term expenditures required at each mill. It also shows the total industry requirements of $113.9 million for immediate abatement and $55.2 million for immediate joint expenditures. The total requirement of $169.1 million is considerably less than the $323 million (in 1979 dollars) reported in Chapter 2 as an estimate of capital expenditures to meet the federal requirements. This suggests that some or all of the long term expenditures totalling $223 million, reported in Table 5.7, will be necessary to bring the industry into full compliance with existing federal and provincial objectives. The capacity of the industry to support expenditures of this magnitude over the next few years was considered in Chapter 4.

5.5 The Benefits from Water Pollution Abatement by the Ontario Pulp and Paper Industry

It is not easy to determine what benefits have been achieved from past abatement efforts nor what will be achieved if the federal and provincial objectives are attained. Nor is it just a question of inadequate data, though this is certainly part of the problem. The definition of what constitutes a benefit is a matter of some debate. Economists typically define the benefits of water pollution abatement in terms of enhanced uses of receiving waters for which people would be willing to pay. This approach establishes, in principle at least, a means of measuring benefits in dollar terms that can be compared with estimates of abatement costs.[7]

Others emphasize the intrinsically non-quantifiable aspects of environmental benefits and resist the view that only benefits to man should be considered. Still others accept the anthropocentric approach of economics but are unwilling to ascribe normative significance to the prevailing distribution of income and wealth, and hence to measures of willingness to pay for pollution abatement. Part of this concern can perhaps be met by identifying compensation for the pollution as the appropriate principle

Table 5.7

Estimated Capital Expenditures for

Water Pollution Abatement
(millions of 1979 dollars)

COMPANY AND MILL	Immediate		Long Term	
	Joint	Pollution	Joint	Pollution
ABITIBI				
Iroquois Falls	-	2.8	30.0	3.4
Sault Ste. Marie	-	-	-	0.5
Smooth Rock Falls	-	3.0	-	8.1
Thorold	-	1.2	-	-
Thunder Bay	20.3	0.5	-	2.0
Fort William	-	1.3	25.0	2.0
Port Arthur	-	1.0	12.0	2.0
AMERICAN CAN				
Marathon	0.6	0.1	0.6	8.3
BEAVER WOOD				
Thorold				
BOISE CASCADE				
Fort Frances	-	4.0	-	2.3
Kenora	-	-	-	10.3
C.I.P.				
Hawkesbury	3.3	15.0	3.0	2.0
DOMTAR				
Cornwall	-	-	-	1.0
Red Rock	-	-	-	22.0*
St. Catharines	-	-	-	1.8
Trenton	-	-	0.8	0.8
Thorold				
EDDY FOREST PROD.				
Espanola	7.0	19.8	-	1.0
Ottawa	-	0.2	2.5	1.0
GREAT LAKES PAPER				
Thunder Bay	-	16.0	0.6	35.2
Oryden	-	16.7	20.0	10.0
KIMBERLEY CLARK				
St. Catharines	-	0.3	-	1.8
Kapuskasing				
Terrace Bay	-	4.0*	-	-
MACMILLAN-BLOEDEL				
Sturgeon Falls	-	1.7	-	2.0
ONTARIO PAPER				
Thorold	-	8.5	-	10.0
SPRUCE FALLS P & P				
Kapuskasing	24.0	17.8	-	1.0
STRATHCONA				
Strathcona				
TOTALS	55.2	113.9	94.5	128.5

* air and water pollution abatement

Source: Ontario Ministry of Industry and Tourism, Report of the Special Task Force on Ontario's Pulp and Paper Industry, November 1978

for measuring benefits. This measure is unconstrained by income and wealth (though not unaffected by it). It presumes that people have a right to an unpolluted environment, whereas the willingness to pay approach presumes that polluters have a right to pollute.

This is not the place to attempt to resolve these important theoretical issues. They will have to be addressed in future work on the valuation of benefits from pollution abatement. The concern of this section is far more modest.

Any benefits from reducing wastewater discharges depend on there being discernible improvements in the quality of the receiving water. The Ontario Ministry of the Environment maintains an extensive water quality monitoring program which commenced in 1964. It now consists of more than 800 sampling stations throughout Ontario.[8] As part of this study, the monitoring data from sampling stations in the proximity of pulp and paper mills were analysed. It was thought that the data would be useful in establishing a relationship between reductions in wastewater discharges from the mills and improvement in water quality.

Even a quick perusal of the data collected for the 1970 to 1978 period shows that they contain numerous gaps. This severely limits the extent to which the data are useful to assessing trends in water quality. Other considerations are also important for drawing valid conclusions from the data. The mills must be the only major source of effluent and they must be located on rivers so that upstream and downstream water quality sampling results can be compared.

also important for drawing valid conclusions from the data. The mills must be the only major source of effluent and they must be located on rivers so that upstream and downstream water quality sampling results can be compared.

Taking account of all of these factors, the number of mills for which the trends in water quality could be analysed was reduced to 5. The approach taken considered the trends in the difference between the average upstream and downstream values of several water quality parameters (dissolved oxygen, BOD, total suspended solids, total dissolved solids, phenols, Ph.), for each of the 5 mills.

These differences in the values of each of these parameters upstream and downstream were regressed against time using a least squares model. It was hypothesized that the funds spent on pollution abatement at the mills should have resulted in a decline in the difference between upstream and downstream measures of water quality if any benefits are to be claimed for the regulatory efforts of the past decade. No such trends emerged from the analysis for any of the mills and any of the parameters.

In the case of each of the measures of water quality and each of the mills, indications of improvement and deterioration were found. However in no instances were the trends statistically significant. This may not be surprising with respect to dissolved oxygen and BOD (in the rivers) since the mills have not shown very significant reductions in BOD discharges over the 1970-1978 period. This is less true with respect to suspended solids where considerable reductions have been achieved at some of the mills. However, the overall and rather strong conclusion is that, for those isolated mills where the data are sufficient for analysis, there was no significant improvement (or deterioration) in the quality of the receiving waters in the 1970-1978 period.

The lack of evidence for improvements in water quality may be due entirely to the inadequacy of the data and the limited scope of the monitoring program. (Ontario's water quality monitoring program commenced in 1964 with 210 stations. In 1978 there were 833 stations, two fewer than in the previous year.) In light of the large expenditures that are required of the pulp and paper industry to meet federal and provincial abatement objectives, it would seem advisable for the federal and provincial regulatory authorities to assure themselves and others that benefits have been obtained from past efforts and that further benefits will be forthcoming in the future.

That future benefits are uncertain is evidenced by the Ministry of the Environment's own attempt to judge future benefits from pollution abatement.[9] The Ministry's study identified 6 categories of benefits from water pollution abatement as shown in Table 5.8. Three levels of abatement were defined:

-- meet Ministry of Environment effluent objectives (i.e., the mill specific objectives of 1973 in Tables 5.2 and 5.3).

-- additional treatment of waste loading reduction beyond the Ministry of Environment objectives, (assumed to be technically feasible and commercially available).

-- mill closure (i.e., complete cessation of wastewater discharges).

The benefits from these three levels of abatement were considered for each mill using the 6 categories of benefits identified in Table 5.8. All the results were qualitative and often reflected informed judgement rather than the results of detailed studies. Nevertheless, it was apparent that few benefits would be achieved if all the mills were to meet the Ministry's objectives. Most of the benefits that could be achieved require additional treatment or waste loading reductions. Si nificantly, few if any extra environmental benefits could be gained from mill closures.

Table 5.8

BENEFITS OF WATER POLLUTION ABATEMENT

Category	Benefit	Explanation
1	Water Supply	Is water quality improved to the point where: 1) costs of water treatment are lower? 2) water can be used as water supply where it could not be prior to abatement?
2	Eliminate toxic materials a) Mercury b) Other	N.B. Not relevant (N/R) if mill is not a source of toxic substances in river.
3	Contact recreation permitted (swimming)	Prior to abatement, swimming is not permitted.
4	Fishing. b) Tainting eliminated c) Environment for fish species upgraded	Fishing may refer to commercial, sport fishing or subsistance fishing by natives.
5	Aesthetics improved a) Sludge - accumulations b) Odours eliminated c) Foaming eliminated d) Colour normal	It is assumed that non-contact recreation (i.e. boating, camping, and riparian cottages) is a function of the aesthetic quality of the water in question. Hence, if the aesthetics of a river or lake are enhanced, then so is the potential for these other uses
6	Protection of unique features	Are there any unique or special aspects of the water course or of the area in general which will be enhanced or otherwise affected by pollution abatement at the mill in question?

SOURCE: Alternative Policies for Pollution Abatement: The Ontario Pulp and Paper Industry. Ontario Minstry of the Environment, J. Donnan and P. Victor, October, 1974.

The Ministry's study stressed the need for further investigation and empirical verification of these results, but in the years since 1974 there seems to have been little effort to do this. Hence, the situation remains one of uncertainty about the benefits obtained in the past from water pollution abatement by the pulp and paper industry, and uncertainty about what will be achieved in the future.

5.6 The Administrative Costs of Regulating Ontario's Pulp and Paper Industry

The administrative costs of regulating the pulp and paper industry in Ontario are borne principally by the Ministry of the Environment. Some administrative costs are incurred by Environment Canada's regional office; these are estimated to be about 0.25 of a man year. Environment Canada in Ottawa also employs staff concerned with regulation and other aspects of the pulp and paper industry, estimated in total to be about 1.35 man years for the whole country.[10]

Table 3.9 summarizes the manpower used in the regional offices of the Ontario Ministry of the Environment for regulating the pulp and paper industry. The functions performed include:

- -- surveillance and monitoring
- -- establishment of abatement programs
- -- investigation of complaints (the number of complaints received against the pulp and paper industry are shown in Table 3.9).

The proportion of the regional offices professional staff time devoted to the pulp and paper industry was 6% in 1978/79 and 10% in 1979/80. (The lower figure is considered more typical by the Ministry.) This corresponds to budget allocations of $228,000 and $378,000 respectively in the two years.[11] Of course, both the manpower and budget estimates

relate to all forms of environmental regulation, not just for wastewater discharges. At the same time the head office costs (about 1 manyear) and costs of services provided by regional and provincial laboratories are not included.[12]

As for the industry's commitment of man-power, no figures are gathered routinely by the C.P.P.A. Indications were received from company spokesmen that the companies themselves do not keep records on manpower allocations for responding to environmental protection regulation. It was also suggested that these costs are not particularly significant especially in comparison with the costs of reducing wastewater discharges.

The information provided in this section is somewhat imprecise. Nevertheless, it seems clear that the administrative costs for regulating wastewater discharges from the pulp and paper industry in Ontario are extremely modest. Consequently, there is little to be gained from reducing these costs significantly by revising the approach to regulation, or by making the existing system more efficient.

Table 5.9

ONTARIO MINISTRY OF THE ENVIRONMENT

MANPOWER RESOURCES FOR INDUSTRIAL ABATEMENT AND COMPLAINTS

- THE PULP AND PAPER INDUSTRY[1]

Region	1978 Number of Mills	1978 Production tonnes/day	Complaints (1978-1979)* Air	Water	Noise	Odour	Man Years
Central	1	103	2	-	-	-	.2
West Central	6	1,479	5	5	4	10	.8
North West	10	6,563	50	30	20	80	3.8
South East	5	1,345	5	7	2	30	1.5
North East	6	3,425	30	20	-	15	1.9
			92	62	26	135	8.2
	1979		(1979-1980)*				
Central	1	108	4	1	-	1	0.4
West Central	6	1,455	4	5	0	6	1.0
North West	10	7,009	40	30	10	40	8.0
South East	5	1,353	6	7	3	20	1.3
North East	6	3,679	2	32	-	-	2.2
			56	75	13	67	12.9

Source: Program Planning and Evaluation Branch, Ontario Ministry of the Environment.

[1]Head Office staff and regional clerical support staff excluded.

*Fiscal Year.

FOOTNOTES

Chapter 5

1. Pulp and Paper Canada Directory - 1979, Southam Business Publications 1979.

2. Fisheries and Environment Canada Status Report on Abatement of Water Pollution from the Canadian Pulp and Paper Industry - 1976, Report EPS-3-WP-77-9, September 1977.

3. Ontario Ministry of the Environment Alternative Policies for Pollution Abatement: The Ontario Pulp and Paper Industry, Summary and Update October 1976, Revised Edition, (Authors J. Donnan and P. Victor).

4. A control order specifies an enforceable program of pollution abatement. Control orders as regulatory instruments are examined in detail in Chapter 6.

5. This simple estimation procedure was complicated by the fact that during the 1971-1977 period the rate of the provincial sales tax was changed seven times, from one fiscal year to another (i.e. April 1 - March 31). Grants under the Pollution Abatement Incentive Act are recorded for each calendar year. Therefore, in some years, more than one rate of sales tax applied during the year so that the grossing up procedure only approximates the total funds expended on pollution abatement equipment.

6. Report of the Special Task Force on Ontario's Pulp and Paper Industry, Ontario Ministry of Industry and Tourism, November 1978.

7. A good review of the theory and practice of benefit estimation is provided in A. Myrick Freeman III The Benefits of Environmental Improvement, Johns Hopkins Press, 1979.

8. Ontario Ministry of the Environment Water Quality Data for Ontario, Volume XIV, 1978.

9. Ontario Ministry of the Environment Alternative Policies for Pollution Abatement, 1974.

10. Both of these estimates were made by staff members of the respective offices.

11. Program Planning Branch, Ontario Ministry of the Environment.

12. Typically the average cost for testing a sample for BOD in 1978/79 was $2.64 and $2.00 for suspended solids. These cost estimates include an amount for staff, supplies, equipment, supervision, quality control, method development and administration. Capital and operating costs for laboratory facilities and grounds are excluded. (Information provided by the Ontario Ministry of the Environment.)

CHAPTER 6

ENVIRONMENTAL PROTECTION REGULATION IN ONTARIO AND THE PULP AND PAPER INDUSTRY

6.1 Background

In the period leading up to 1965 the Ontario Water Resources Commission had very little success in getting the pulp and paper companies to control their waste water discharges. The experience with other major industries, such as iron and steel and chemicals, had been far more successful. Consequently, in 1965 the Commission sent a directive in the form of a letter to all the pulp and paper companies with mills in Ontario. The companies were given two non-negotiable deadlines for achieving specified wastewater quality objectives:

By December 31, 1966:

- remove suspended solids from the effluents discharges to a level of 50 mg/L or less.

By December 31, 1969:

- remove BOD and/or chemical oxygen demand (COD) to ensure that the dissolved oxygen concentration in the receiving waters does not fall below 4 mg/L.;

- remove substances imparting taste and odours to the receiving waters or to fish;

- remove substances that are toxic to aquatic life or render the receiving water unsuitable for potable or recreational use;

- control waste components that impair the aesthetic quality of the receiving waters by foam, colour or other effects.

Progress towards these objectives has been slow and most mills have not yet achieved them. In 1978, the discharge of suspended solids by the industry were nearly 110 mg/L on average, an increase over the two previous years and more than double the value that was to be met by each mill in 1966. Moreover, the industry's record in reducing suspended solids discharges has been far better than for BOD or toxicity control.

These objectives have provided a benchmark by which to measure both the pollution abatement activities of the industry and the success of Ontario's regulatory process: both abatement and regulation leave much to be desired. However, times have changed since 1965. The unilateral declaration of pollution abatement objectives by the Ontario Water Resources Commission has given way to a far more flexible process in which discussion and negotiation between the Ministry and the industry plays a central role.

Upon its formation in 1971, the Ontario Ministry of the Environment became the provincial body charged with responsibility for environmental protection in Ontario. Other ministries such as the Ministry of Health and the Ministry of Natural Resources also have some responsibilities in this area: the former administers the Public Health Act and the latter oversees the use of natural resources in Ontario. The Ministry of Natural Resources plays an important role with respect to the pulp and paper industry since most of Ontario's forests are on Crown Land and this Ministry is responsible for timber management and reforestation.

The most important provincial legislation for pollution abatement in Ontario is the Ontario Water Resources Act and the Environmental Protection Act. It is these Acts which are most used for regulating wastewater discharges from Ontario's pulp and paper mills. The more recent Environmental Assessment Act, which embodies a far reaching definition of 'environment'

including social, cultural and economic factors, is only relevant to new mills. Even then, proposals for such 'undertakings' would have to be designated by the Minister of the Environment for inclusion under the Act before it would apply to them.

One proposal, that of Reed Paper Ltd., to build a new mill in a northern part of the Province was so designated. The Royal Commission on the Northern Environment was established to examine, among other things, the pattern of development most suitable for Northern Ontario. This was to provide a context for the environmental assessment of the Reed proposal which was to follow. An important component of this proposal is the possibility of exploiting a very large area of northern forest. A Memorandum of Understanding between Reed Paper and the Ontario Government provided for this to be studied.

Although the Royal Commission is still proceeding with its work, Reed Paper withdrew its interest in developing the new mill and, in 1979, sold its existing mill at Dryden to Great Lakes Paper Ltd. This transaction was facilitated by a guarantee given to Great Lakes Paper by the Ontario Government. The guarantee limits the liability of Great Lakes Paper and Reed to $15 million for any damages that may be awarded in actions brought against the company for mercury deposits in the English-Wabigoon river system. The mercury discharges came from the chlor-alkali plant in Dryden which supplied chlorine and caustic soda to the pulp mill. In 1975 the plant converted its process and mercury is no longer discharged to the river.[1] It has still not been stated publicly, or apparently to the Royal Commission on the Northern Environment, whether the Memorandum of Understanding between Reed Paper and the Ontario Government was transferred to Great Lakes Paper as part of the deal.

At present no new mills are proposed for Ontario and the emphasis in the remainder of this chapter is on the regulatory processes arising out of the Ontario Water Resources Act and the Environmental Protection Act.[2]

6.2 The Regulatory Process in Ontario: A Detailed Analysis

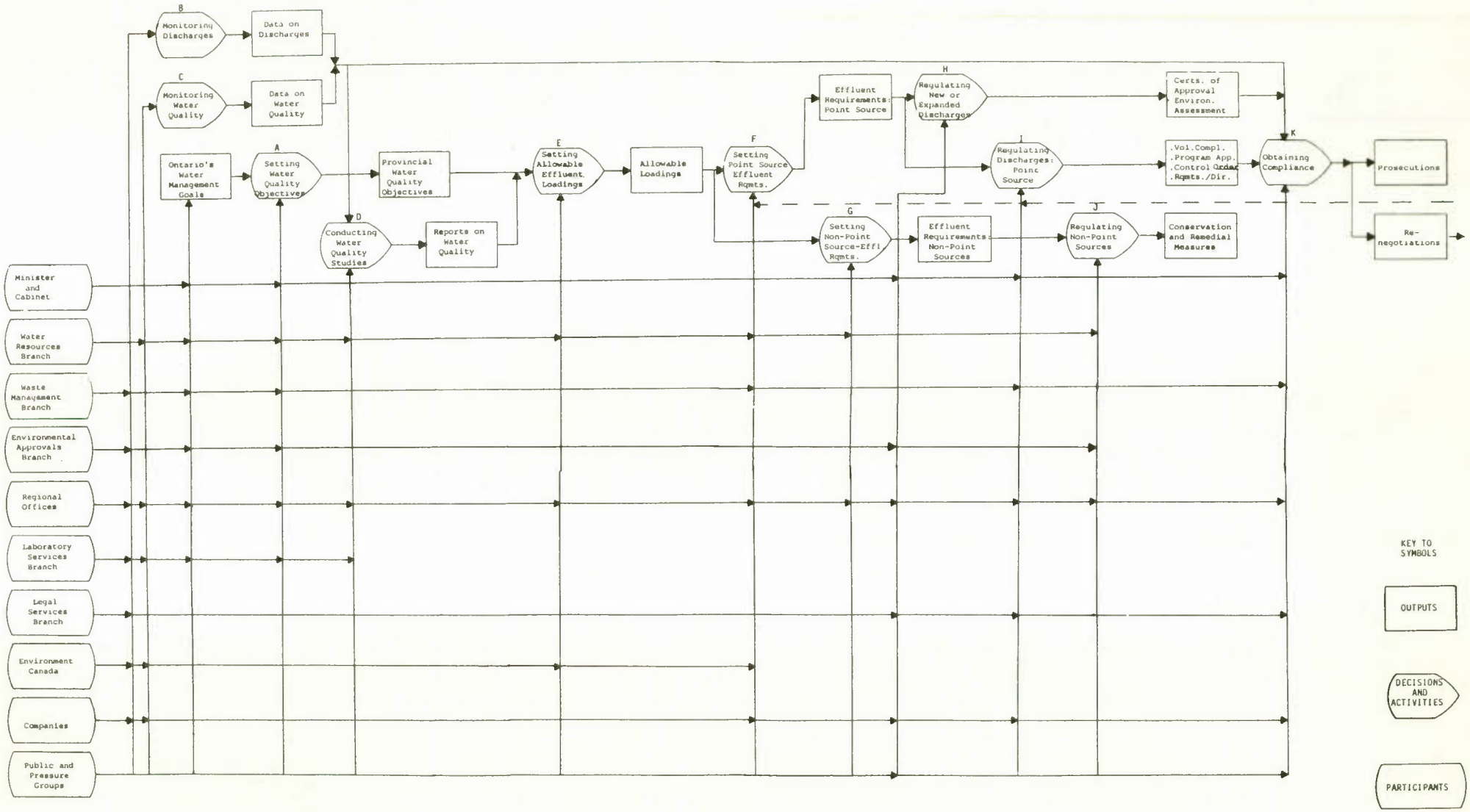
In the course of this study numerous interviews were conducted with staff members of the Ontario Ministry of the Environment. Out of these interviews and from the direct experience of the study's principal investigator, a picture has emerged of the regulatory process as it applies to the pulp and paper industry. (Much the same process applies to all industries which discharge wastewater directly into Ontario's lakes and rivers. To a somewhat lesser extent the process applies to the regulation of municipal sewage treatment plants.) A representation of this process is shown in Figure 6.1.

The figure is a flow diagram showing the major decisions and outputs from the decisions involved in the regulatory process. The figure also shows the major participants in this process, and in particular, the parts of the process in which these participants are actively involved.[3] The diagram may be read as follows: entries in "bullets" indicate key decisions or sets of decisions; entries in rectangles indicate the major outputs from these decisions; entries in the ovals indicate the major participants. Reading along the bottom half of the figure, one can see which of the decisions each of the participants is actively involved in.

The major decisions, as indicated in the figure, have been labelled from "A" to "K" and, after a brief overview of the decision-making process, these individual sets of decisions will be discussed in more detail.

The regulatory process begins from Ontario's Surface Water Management Goals, which call for water quality satisfactory for aquatic life and recreation.[4] To achieve these goals, the Ministry of the Environment has established Provincial Water Quality Objectives for receiving waters. These objectives are used in conjunction with reports on water quality and information on effluent discharges to determine the assimilative capacity of receiving waters. The assimilative capacity is equivalent to the total loadings of particular

Figure 6.1: Outline of Ontario's Industrial Water Pollution Regulatory System



kinds of contaminants that if allowed into a receiving water, would not lower its quality below that required under the Provincial Water Quality Objectives. The estimates of assimilative capacity, which are specific to each receiving water, become the basis for setting allowable point source effluent requirements and non-point source effluent requirements. Combined, these effluent requirements should not exceed the assimilative capacity of the receiving water.

Once the effluent requirements for the point and non-point sources have been determined, three sets of important and sometimes interrelated decisions have to be made regarding: the regulation of new or expanded discharges, and the regulation of existing discharges from both point and non-point sources. Various options are available to the Ministry of the Environment for controlling and regulating these various sources of discharges. After decisions as to which instruments to adopt in any particular case have been taken, it is necessary for the Ministry to ensure that compliance is obtained. Again, at this stage there are options open to the Ministry, the two most important being prosecutions and renegotiations. As Figure 6.1 illustrates, if there are renegotiations, this has the effect of altering the point source effluent requirements or delaying the time by which they must be met. Renegotiation may also lead to a change in regulatory approach taken to controlling these point sources.

Ontario's Water Management Goals

Ontario has published Water Management Goals for: surface water quality management, surface water quantity management, ground water quality management, and ground water quantity management. In this study, the primary concern is with surface water quality management. The stated goal for surface water quality management in Ontario is "to ensure the surface waters of the province are of a quality which is satisfactory for aquatic life and recreation". This goal is deliberately general, though it is recognized by the Ministry that water which meets the water quality criteria

for aquatic life and recreation will be suitable for most other beneficial uses, such as drinking water and agriculture. This goal was endorsed by the Minister of the Environment with the publication of the Blue Book, November 1978. However, it is a goal which has a long history in Ontario and pre-dates the formation of the Ministry of the Environment. Figure 6.1 shows that many of the branches of the Ministry had the opportunity to review this goal when the Blue Book was being written and therefore can be said to have contributed to its re-affirmation as the major over-riding goal for water management in Ontario.

Even though the surface water quality management goal requires more specific objectives for its implementation, it does contain one very important principle which underlies Ontario's approach to water quality management. This is that all of the lakes and rivers in Ontario should be suitable for all uses. (Exceptions to this are recognized in cases where previous discharges of wastes may have accumulated as sludge and where rehabilitation of a water course in these circumstances is not yet considered practical.) One of the policy implications of such a goal is that the use of stream classification, whereby specific water courses in the province are designated for various and different uses calling for different levels of water quality, is not permitted.

A. Setting Water Quality Objectives[5]

The Ministry of the Environment has set Water Quality Objectives which, if satisfied, will fulfill the surface water quality management goal of the province. These objectives are both quantitative and qualitative. As Figure 6 .1 indicates, several branches of the Ministry were involved in drawing up the Objectives and, working through a committee, they drew upon a wide range of scientific expertise in deriving them. "The Objectives for protection of recreational water uses are based on public

health and aesthetic considerations. With respect to aquatic life, the Objectives are set at such values as to protect all forms of aquatic life and all aspects of the aquatic life cycle. The clear intention is to protect all life stages during indefinite exposure to the water." The supporting documentation for these Objectives goes on to say that, "ideally, Water Quality Objectives should be established on 'no negative effect' data derived from chronic, long-term tests on sensitive organisms".

It is clear from these statements that the Objectives are not based on any consideration of the costs of meeting them except in the extreme case where, for technical reasons, it is acknowledged that they cannot be met owing to the accumulation of past discharges in the receiving waters.

The Ministry of the Environment recognizes that, "it is not practical to treat all effluents so that they meet the Objective concentration". What this means is that if some effluent discharges are permitted which do not meet the Objectives for the receiving waters, then there will be certain locations where the Water Quality Objectives are not met. These are referred to as "mixing zones". The size of a permitted mixing zone at any point then becomes a question of policy and the Ministry has laid down a set of criteria for determining the nature of allowable mixing zones. "The mixing zone mainly represents a loss of habitat, but it must not be allowed to become an area where aquatic life is killed or seriously damaged." Terms and conditions related to the mixing zones may be outlined in Certificates of Approval, based on minimum requirements specified in the Blue Book.

In addition to the specific Water Quality Objectives set out in the Blue Book, there are five general conditions which should be met. "All waters shall be free of substances attributable to man-caused point source or non-point source discharges in concentrations that: (1) settle to form objectionable deposits; (2) float as debris, scum, or other matter to form nuisances; (3) produce objectionable colour, odour, taste or turbidity; (4) injure, are toxic to or produce adverse physiological or behaviour responses in humans, animals, or plants; or (5) produce undesirable aquatic life or result in a dominance of nuisance species".

These Provincial Water Quality Objectives appear to provide the basis for all of the regulatory activity of the Ministry with respect to water quality management. However, it should be made clear that the Objectives are ultimate Objectives. They do not, in themselves, imply anything about the rate at which improvements will be achieved. It is the nature of the regulatory process directed towards their achievement which is of critical importance in this study. In describing this process, it will become clear that trade-offs between costs and benefits are in fact made by postponing the data at which the Objectives have to be met, even though the Objectives themselves are not based on any such assessment.

B. Discharge Monitoring

Most of the effluent discharge monitoring undertaken in Ontario is performed by the companies and other dischargers (eg., municipalities). The Ministry of the Environment receivies information from the companies on their discharges, usually supplied on a voluntary basis, though the Ministry does have the authority to require such information. The regional offices of the Ministry which receive these data perform their own monitoring activities to assure themselves of the accuracy of the data that are submitted. The regional offices may also specify the nature of the required monitoring activity. This would include the frequency of

the monitoring, the way in which samples are gathered, and the precise nature of the tests to be performed on the samples. When the regional offices of the Ministry perform their own sampling, the Laboratory Services Branch conducts the tests to ascertain the contents of the samples.

Owing to the limited resources of the Ministry and of many of the companies with which it has to deal, important decisions have to be taken regarding which companies must provide what sort of data, and the extent to which the regional offices must check the data submitted to it. While it is the responsibility of the Regional Directors to make these decisions, they do so often on the advice of the Waste Management Branch and the Water Resources Branch. The Environmental Approvals Branch becomes involved in the process when a company that wishes to install treatment devices applies for a Certificate of Approval. (All companies operating any potential source of pollution, new or old, must have a Certificate of Approval.)

The data gathered on effluent discharges are used as an input into the water quality studies (to be discussed later) and that part of the regulatory process involved with obtaining compliance.

C. Water Quality Monitoring

The Ministry of the Environment collects information about the quality of the receiving waters. Most of the work done to obtain these data is performed by the staff of the regional offices, supported by the Laboratory Services Branch. Another participant in this process is the Water Resources Branch, which provides data processing, statistical analysis and data publishing support, and which may offer technical advice to the regional offices and may be involved in specific detailed studies of individual water courses (e.g., the Grand River and the Thames River). Companies themselves may also be required to provide data on receiving water quality under a Control Order

or Certificate of Approval. Environment Canada has an interest in maintaining an information base on the quality of the receiving waters and its staff also obtain data from their sampling stations.

The data on water quality monitoring are an important input into the Ministry's water quality studies and into the regulatory process. In particular, when water quality data indicate that a receiving water is declining in quality or failing to improve in the way expected, then this is used as a flag for the appropriate regional office to take regulatory action. Such action involves identifying the source or sources of discharges which require control. Having said this it should be remembered that the analysis in Chapter 3 of the available water quality data, upstream and downstream of Ontario's pulp and paper mills, suggests the actual data gathered are not always adequate for these purposes.

D. Conducting Water Quality and Wastewater Assimilation Studies

Water quality and wastewater assimilation studies typically consist of a description of the river basin and the water uses, a survey of the effluent discharges into the river or lake concerned, an analysis of the water quality measures, and recommendations for action. The main responsibility for undertaking these water quality studies rests with the regional offices, supported by the Water Resources Branch and the Laboratory Services Branch. It is up to the regional offices to select the rivers or lakes or portions thereof for study. These priorities are chosen according to the severity of the problems believed to exist in the rivers or lakes, and the availability of previous work which bears on the issue.

The reports on water quality indicate the extent to which the Provincial Water Quality Objectives are being met in the lake or river concerned. They are also the basis for the establishment of receiving water effluent

requirements which specify the total amount of various kinds of contaminants that can be discharged at different points in the receiving water.

E. SETTING ALLOWABLE EFFLUENT LOADINGS FOR RECEIVING WATERS

Once the assimilative capacity of a receiving water has been estimated and with it the total loadings consistent with achieving or maintaining the Provincial Water Quality Objectives, these total loadings are not automatically allocated among the dischargers. Some assimilative capacity will remain unallocated. The unallocated assimilative capacity is intended to provide for: (1) possible synergistic effects among various contaminants; (2) the possibility of excess discharges owing to equipment failures; (3) extremely adverse hydrological conditions; (4) uncertainty as to the accuracy of the data used in the water quality study for determining the effluent requirements of the receiving waters; (5) the location of new sources of effluent at or near existing ones.

In the Ministry guidelines which preceded the publication of the Blue Book, a formal allowance was made for spare capacity. This has been replaced by an informal understanding within the Ministry that the total discharges into receiving water should be less than the assimilative capacity. Although a decision to maintain some spare assimilative capacity may impose significant costs on those discharging wastes into a receiving water, no consideration of these costs enters into this potentially important policy decision.

F. Setting Point Source Effluent Requirements

This is a critical part in the regulatory process and involves negotiations among Ministry staff and the companies which are being regulated. Environment Canada is also involved, though in Ontario this involvement is largely passive. For those industries, such as pulp and paper, where federal regulations regarding effluent discharges have been established, both the federal and provincial governments agree that if their requirements differ for any specific mill the more stringent of the two will apply. However, from the comparison of federal and provincial objectives written into current compliance programs (Tables 5.2 and 5.3) it is apparent that this policy is not always acted upon.

The Provincial Water Quality Objectives make no distinction between existing and new discharges, but at this point in the regulatory process such a distinction is made. In the case of proposed new or expanded discharges, the effluent requirement (i.e., objectives for waste loadings and concentrations), is incorporated into a Certificate of Approval, and a high level of performance is expected immediately. For existing dischargers in areas with water quality worse than the Provincial Water Quality Objectives, the regional offices of the Ministry normally develop a pollution control program with each mill that will eventually bring the receiving water up to the quality specified in the Objectives.

In the case where there is only one major source of effluent into a receiving water at a particular location, the estimated assimilative capacity, less some allowance for the reasons given above, provides an upper limit for the point source effluent requirement.

Where there are dischargers competing for the same assimilative capacity, there is no clear policy laid down by the Ministry as to how the assimilative capacity will be allocated. However, this does not seem to be an issue of particular relevance to the pulp and paper industry since many mills are located at a considerable distance from other large sources of effluent.

The process described to this point is clearly intended to lead to receiving waters of a quality equal to or better than that specified in the Provincial Water Quality Objectives. However, the Ministry recognizes that:

> "...in exceptional cases, where it is clearly demonstrated that all reasonable and practical measures to attain the Provincial Water Quality Objectives have been undertaken but where:
>
> 1) the Provincial Water Quality Objectives are not attainable because of natural background water quality; or
> 2) the Provincial Water Quality Objectives are not attainable because of irreversible man-induced conditions; or
> 3) to attain or maintain the Provincial Water Quality Objectives would result in substantial and widespread adverse economic and social impact; or
> 4) suitable treatment techniques are not available;
>
> then deviations from the policy of upgrading water quality to the Provincial Water Quality Objectives may be allowed, subject to the approval of the Director, Water Resources Branch, in consultation with the Regional Director.
>
> Where public hearings into proposals for new or expanded discharges are held under Sections 7 or 12 of the Environmental Assessment Act or Sections 43 and 44 of the OWR Act, such hearings may be utilized to consider this issue."[6]

This section of the Blue Book has been quoted at length because it is one of the very few instances where adverse economic and social impacts are explicitly stated to have some bearing on the applicability of the Provincial Water Quality Objectives. Implementation of this policy requires documentation from the company and the Ministry's offices with head office support as to what effluent parameters cannot be controlled to the level required to meet the Provincial Objectives. An analysis of the economic and social impacts must also be prepared by the regional office. At present no such analyses have been undertaken as the Ministry's head office has not laid down guide-

lines for how these impacts should be assessed. Consequently, though the Ministry does permit "deviations", the decision to do so is not based on a systematic study of social and economic factors.

The Ministry recognizes that water quality can be improved by restoration techniques as well as by waste treatment. However, it is the Ministry's policy not to consider restoration as "a substitute for proper treatment. In the event that all practical measures have been made to control waste inputs, but residual pollution exists, restoration techniques may be applied."[7]

This policy is open to question to the extent that it may prevent the Provincial Water Quality Objectives from being achieved at the least cost.

G. Setting Non-Point Source Effluent Requirements

The Ministry of the Environment does not set explicit requirements for non-point sources. Where non-point sources are believed to "contribute significantly to violations of the Provincial Water Quality Objectives", informal objectives for the reduction of non-point sources are developed by the regional offices in conjunction with the Water Resources Branch. In practice what usually happens is that estimates of non-point source loadings, such as from urban and agricultural runoff, are deducted from the estimates of a receiving water's assimilative capacity. The resulting difference becomes the maximum total discharge normally allowed to the point sources.

H. Regulating New or Expanded Discharges

In the event that a new pulp mill is constructed in Ontario, it will, in all likelihood, utilize efficient production techniques from which the effluent discharge is very small. It is also possible that any proposed new pulp and paper mill would require

approval under the Environmental Assessment Act, in which case a full consideration would be given to all of the environmental impacts of such a mill. In any event, a Certificate of Approval issued under the Environmental Protection Act is required for all new waste treatment and disposal facilities and these are only issued after a careful review by the Ministry of the proposed treatment systems and expected loadings.

I. Regulating Existing Discharges - Point Sources

The normal process by which point source effluent requirements are established for existing discharges consists of several stages:

Stage 1 - the regional office identifies a water quality problem and traces the problem to a specific discharger. The regional office also attempts to identify the parts of the industrial process which are creating the problem and prepares a preliminary list of particular sources requiring some sort of remedial action.

Stage 2 - the staff of the regional office meet with technical staff of the company concerned and seek agreement with the company on the location and source of the problem at hand. At this meeting, the regional office announces its intention to ultimately meet with the company management to finally determine the steps that the company will take to solve the problem. If agreement cannot be reached as to the technical source of the problem, a study may be called for which can either be a cooperative endeavour between the Ministry and the company, or it could be a requirement imposed on the company under the Ontario Water Resources Act.

Stage 3 - once the problems are agreed to between the company and the regional officials there is a technical discussion on the best approach for resolving the problems. Prior to such agreement being reached, it is often necessary for further studies to be conducted, usually by the company concerned at its expense.

Stage 4 - the staff of the regional office and the Ministry of the Environment's head office decide priorities for reducing discharges from various parts of the mill. The timing of these reductions is also negotiated. It is based on their own best estimate of what is reasonable. It is at this stage that the Ministry gives some consideration to the costs of compliance based on estimates provided by the company and compared informally with the Ministry's knowledge of costs incurred at other mills.

Stage 5 - Ministry staff from the regional office and sometimes from head office discuss with company management, up to the vice-president level, the various options open to the company for dealing with the discharge problem. It is customary for the Ministry to call this meeting and to conduct it. The company usually takes some time to deliberate on the Ministry's proposals, though in the event it may not agree to undertake any of the proposals put to it by the Ministry of the Environment. In relation to pulp and paper companies, it is usually the case that agreement on the technical issues has been reached. However, management has often claimed they cannot afford to implement all that is being asked by the Ministry. In the unusual event that companies are asked to provide detailed evidence in support of such claims, it is shown only to the Minister and Deputy Minister.

A variety of options are open to the Ministry at this point in order to secure reductions in the effluent discharges from the pulp and paper mills. One option is for the Ministry to issue a Requirement and Direction under the Ontario Water Resources Act, a device which is particularly useful for obliging companies to perform studies. A voluntary compliance program may be established, usually at the initiative of the company concerned. However, if such a compliance program is agreed to, the company cannot be prosecuted for not complying with the program. A variation on this is for the Ministry to issue a Program Approval, thereby formally approving of the pollution control program. Again, the company cannot be prosecuted for not implementing the approved program. It is also protected from prosecution for depositing wastes into the receiving waters during the time for which Program Approval applies as long as the terms of the Approval are met. These approaches were used extensively with the industry up to the mid-1970's.

A third option for the Ministry of the Environment is to issue a Notice of Intent for a Control Order in which the desired quantity and/or concentration of effluent may be specified, the type of treatments and/or process changes may be specified, the monitoring activity may be specified, and the time by which certain actions must be performed in specified. A company has up to 15 days to 'make submissions' to the Minister of the Environment for changes in the intended control order. Once issued the company has a further 15 days to give a written notice requiring a hearing by the Environmental Appeal Board. Decisions of the Board may be appealed, on a question of law, to the County Court. Any matters other than a question of law may be appealed to the Minister of the Environment up to 30 days after the appeal has been dealt with, whether in the County Court or by the Board. The Minister may 'confirm, alter or revoke' the Board's decision "as he considers in the public interest". The Control Order does not take effect until after the appeal to the Board, the appeal (if any) from the Board to the County Court, and the appeal from the Board (if any) to the Minister have all been disposed of.

Once a Control Order is in effect, a company which complies with the order for the time it applies (sometimes for 5 years) is exempt from prosecution. This holds even if the approved program proves to be inadequate for dealing with the pollution problem for which it was intended. If a company fails to comply with the terms of the Control Order, then it may be prosecuted for non-compliance. In 1977, most of the pulp and paper mills in Ontario that were not meeting the Ministry of the Environment discharge objectives were placed under Control Orders.

J. Regulating Non-Point Sources

The regulation of non-point sources is especially problematic since it is far more difficult to identify those responsible. To date the Ministry has taken virtually no steps to control non-point sources though this is of little direct relevance to the pulp and paper industry.

K. Obtaining Compliance

The regulatory procedures described above do not guarantee that the companies being regulated will comply with the Ministry's requirements (i.e.,discharge objectives). If data on discharges indicate that the terms of the Control Order or Program Approval, voluntary compliance program or Certificate of Approval have not been met, the Ministry has basically two options: to renegotiate with the company or to prosecute. (When the Ministry believes a discharge may cause immediate damage to life, health or property, a Stop Order may be issued. Such Orders take effect immediately but can be appealed to the Environmental Appeal Board and the courts. No Stop Orders have ever been imposed against pulp and paper companies. The only attempt by the Ministry to impose one (on a lead smelter) was over-ruled by the court.) The decision as to how to proceed at this point

involves the regional office, which may choose to renegotiate the point source effluent requirements. This may be initiated by the company in seeking a Control Order Amendment. It has recently become the policy of the Ministry to hold public meetings so that the company can present its case for the amendment. Such meetings have been held for several pulp mills and were regarded positively by Ministry and company officials. The public's reaction is less certain.

The regional office may wish to reconsider the way in which a company is being regulated if its performance is less than satisfactory. For example, the regional office may decide that the best strategy in the case of a company which has not, in fact, done what was stated under a Program Approval, is to require the same actions under a Control Order. In such an event, and whenever a Control Order is drawn up, the Legal Services Branch will assist in drafting the Control Order, ensuring that it meets the necessary requirements under the law. If the regional director thinks that a prosecution is called for, the regional staff assemble a file of information on discharges, and possibly on complaints reported by members of the public against the company, and submit this file to the Legal Services Branch. The Branch acts as solicitor to the Ministry and assesses the adequacy of the data provided to it for purposes of bringing a successful prosecution against the company. The Branch may inform the regional office that the data are not satisfactory and indicate the sort of data that are required. The Legal Services Branch also takes a view of the nature of the charges that should be brought against the company. Once the Branch believes that the information is in order, the file is passed to the senior management of the Ministry and to the Minister himself, where the final decision is made as to whether the prosecution shall proceed.

6.3 The Regulatory Process in Ontario: Some Critical Observations

Ontario's regulatory process appears to be a flexible path towards an inflexible water management goal. The inflexible goal requires all of the Province's receiving waters to be suitable for all uses. This prevents any particular stream or lake from being formally designated for restricted uses such as waste disposal. The regulatory process has the appearance, therefore, of bringing the same, high level of water quality to all parts of the province. As a long term goal, one never perhaps to be achieved, this is laudable. However, in practice the Ministry does allow considerable variation in ambient water quality, though this tends to be implicit in the process rather than something that is publicly stated by the Ministry.

From a different perspective, deviations from the Ministry's long term goals are evidence of the flexibility of Ontario's regulatory process. The Ministry, in the person of the Minister and his staff, can exercise considerable discretion in virtually every aspect of the process. This includes what to require of any mill, both in substance and timing, and how compliance with the requirements is to be achieved. Moreover, there is very little scope for any public input into these decisions, although the recent public meetings to consider proposed Control Order Amendments, may be the start of a new trend.

One view of the extent to which discretion is built into the process is that it allows the necessary flexibility for the Ministry to respond to new information and to take account of the changing fortunes of the industry. Another view is that the discretion provides excessive opportunities for delay in achieving the regulatory objectives. There seems to be some validity to both of these views, but in explaining the lack of progress in pollution abatement made by the industry since the initial regulatory efforts of twenty years ago, it is the opportunities for delay that are most apparent.

Something which goes a long way in explaining the relatively slow rate of improvement in the pulp and paper industry's abatement record is the lack of enforcement activity undertaken by the Ministry. Table 6.1 summarizes the prosecutions brought against Ontario's pulp and paper companies from 1968 to the present. When fines have been imposed they are usually $2,000 or less. The case of American Can is a notable exception to this, the total fine being a provincial record of $64,000 for a pollution offence.[8]

Up to 1977 most companies were on voluntary control programs or Program Approvals. Recognizing the limited success achieved in the 12 years since the 1965 directives were issued, the Ministry put most of the mills not in compliance in 1977 on Control Orders. At the time it was believed by the Ministry that this change in strategy would ensure compliance would be achieved in accordance with the Control Orders. It is interesting, therefore, that from 1977 to 1979 several Control Order Amendments had been granted. These included one involving a relaxation of an objective (for the MacMillan Bloedel mill at Sturgeon Falls) and another the postponement of a date for achieving an objective (the Great Lakes mill at Thunder Bay). It may be argued that in both of these cases and perhaps some others too, genuine technical difficulties were encountered. But in accepting these as valid reasons for Amendments the incentive to the companies to devote resources to minimizing such difficulties may be weakened.

Since 1979 pulp and paper companies have been applying for financial assistance under the joint federal/Ontario program (see Chapter 4). One of the conditions imposed on these companies for receiving a grant is that the Ministry of the Environment should be satisfied that the proposed 5 year capital expenditure program is adequate for pollution abatement. Early indications are that eventually all of the major pulp and paper companies will request funding under the program. Four companies (Spruce Falls Power and Paper, E. B. Eddy, Domtar, Abitibi) operating 13 mills have already been awarded grants and most of the remainder are in the process of negotiating. Over the course of the program it is expected

TABLE 6.1

SUMMARY OF ONTARIO PROSECUTIONS FOR POLLUTION BY PULP AND PAPER MILLS

DATE OF OFFENCE	DATE OF HEARING	NAME OF COMPANY	CHARGE	FINAL DISPOSITION
November 1, 1968	March 27, 1969	Brown Forest Industries Ltd., Sudbury	S.27(1) O.W.R.A.	Conviction - $500 Fine
November 29, 1969	January 22, 1970	Domtar Newsprint Ltd., Red Rock	S.27(1) O.W.R.A., 2 counts	Conviction- $1,000 Fine; 1 count withdrawn
Unknown	February 4, 1970	Garden City Paper Mills, St. Catharines	S.27(1) O.W.R.A.	Conviction - $700 Fine
Unknown	May 4, 1970	Abitibi Paper Co. Ltd., Thunder Bay	S.27(1) O.W.R.A.	Conviction - $350 Fine
January 28, 1970	May 18, 1970	Eddy Forest Products Ltd., Espanola	S.27(1) O.W.R.A., 4 counts	Conviction - $1,000 Fine on each count
April 14, 1970	June 17, 1970	Abitibi Paper Co. Ltd., Smooth Rock Falls	S.27(1) O.W.R.A., 3 counts	Conviction - $1,000 Fine on each of 2 counts 1 count withdrawn
Unknown	June 26, 1970	Beaver Wood Fibre Co. Ltd., Thorold	S.27(1) O.W.R.A.	Conviction - $700 Fine
Unknown	July 20, 1970	Kimberly-Clark of Canada Ltd., St. Catharines	S.27(1) O.W.R.A.	Quashed
Unknown	April 28, 1971	Abitibi Panel Products, Sturgeon Falls	S.27(1) O.W.R.A.	Conviction - $500 Fine
May 30, 1973	--	Canadian International Paper,	S.15-8(1), S.15-5(3), E.P.A.	Conviction - $2,000 Fine
November 30, 1972	November 28, 1974	Canadian International Paper,	S.15-8(1), S.15-5(3), E.P.A.	Conviction - $2,000 Fine
July 6, 1974	December 3, 1974	Ontario-Minnesota Co., Fort Frances	S.14-1(b) - E.P.A.	Conviction - $1,500 Fine
July 16, 1974	December 3, 1974	Ontario-Minnesota Co., Fort Frances	S.14-1(b) - E.P.A., 2 counts	Conviction - $2,000 Fine; 1 count withdrawn
August 1, 1975 July 21, 1976	April 4, 1977	American Can Co., Marathon	S.33(2) Federal Fisheries Act, 16 counts	Convicted on all counts - $4,000 each for total of $64,000
October 18-19, 1976	April 19, 1977	Reed Paper Co.	S.14-1(a), S.14-1(b) - E.P.A. 10 counts	Conviction - $5,000 Fine for 5 counts, all counts on S.14-1(b) dropped
November 8-19, 1976	July 11, 1977	Abitibi Paper Co.	S.14-1(a), s.14-1(b) - E.P.A. 20 counts	Stay of proceedings, to be appealed.
November 15-16, 1976	July 11, 1977	Abitibi Paper Co.	S.32-1 O.W.R.A., 2 counts	Stay of proceedings, to be appealed.

that the companies will be committed to expenditures of more than $160 million (1978 dollars) on pollution abatement alone. (This includes air pollution abatement and solid waste disposal as well as water pollution abatement.) If a company does not spend the funds on pollution abatement that are required in the program for which the grant was awarded then a prorated portion of the grant must be refunded. (Provincial money is provided when the program is approved.) Unless the terms of the Control Orders are vigilantly enforced this may prove an inadequate incentive for obtaining full compliance, in which case the promise of the program, with respect to pollution abatement, will go unfulfilled.

In summary, Ontario's approach to regulating wastewater discharges from pulp and paper mills has been of limited effectiveness in the past. This review has made several observations about the process and its inadequacies. These observations will influence the recommendations for change that will be detailed in the final chapter:

- mill specific discharge requirements are based on an insufficient consideration of economic and social factors;
- economic and social considerations enter into the negotiated compliance schedules. However, they do so in an informal way, on the basis of minimal study and documentation;
- the regulatory process lacks adequate incentives for compliance;
- the opportunities for public involvement in the regulatory process are very limited. This tends to undermine the credibility of the process and makes the process less sensitive to the concerns of the public than it would otherwise be.

6.4 Some Distinguishing Features of Environmental Protection Regulation and the Pulp and Paper Industry in British Columbia and Quebec

It was not possible, in the course of this study, to examine the regulation of the pulp and paper industry in other provinces in the same detail as for Ontario.[9] Nevertheless, it is instructive to review some of the features which distinguish the regulatory approaches in other provinces from that in Ontario.

In British Columbia public inquiries are used to develop objectives for receiving water quality and for industry specific pollution control measures. These inquiries may be convened by the Pollution Control Board, appointed directly by cabinet, or by the Director of the Pollution Control Branch of the British Columbia Ministry of the Environment.

Such hearings were held prior to the publication in 1971 of the Report on Pollution Control Objectives for the Forest Products Industry of British Columbia.[10] Participants at the hearings included industry representatives, members of the public, and staff of the Environmental Protection Service of Environment Canada. The chairman of the inquiry was the Director of the Pollution Control Branch.

After the inquiry the panel of inquiry drafted pollution control objectives which were referred to the Pollution Control Board for consideration. With some amendments these objectives were accepted by the Board as the Board's policy for pollution control in B.C.'s forest products industry. In 1977 the Board published a second report on Pollution Control Objectives after an inquiry to review the discharge objectives established six years previously.

The major regulatory instrument in British Columbia is the discharge permit, issued by the Director of the Pollution Control Branch. (It is somewhat similar to the Control Order used in Ontario.) All existing and new pulp and paper mills must obtain a permit, the terms of which can be appealed to the Director, the cabinet or to the Supreme Court of British Columbia. Objections may be filed when a permit is applied for and the permit itself may become the subject of a public hearing should the Director of the Pollution Control Branch so decide. Failure to comply with the terms of a permit, once issued, constitutes an offence under the B.C. Pollution Control Act.

In comparison with Ontario, British Columbia has adopted a regulatory process in which public inquiries and provisions for appeals play a far more prominent role. Quebec, on the other hand is closer to Ontario in this respect. Under Quebec's Environmental Quality Act, 1972, effluent discharge objectives are promulgated by the Minister of the Environment after consultation with the Advisory Council on the Environment. These objectives are similar in concept to those of the federal government in that they are defined for unit processes. Objections to the objectives can be filed after their publication in the Quebec Gazette. This is the only means by which the public can participate in the objective setting process. However, an amendment to the Act in 1978 gives "every person the right to obtain from the Environment Protection Branch a copy of any available information concerning the quantity, quality or concentrations of contaminants emitted, discharged or deposited by a source of contamination".[11] Quebec is the only province in which the right of access to effluent data is guaranteed.

As in British Columbia, Quebec's discharge objectives are not directly enforceable (despite their designation as 'standards' in the Quebec literature). They only become enforceable when incorporated directly or

with modification, into a Certificate of Approval as must be obtained by all pulp and paper mills operating in the province.

It is not possible to determine how well these variations in regulatory approaches adopted in British Columbia and Quebec compare with Ontario's approach without undertaking the same type of detailed review described earlier in this chapter for Ontario. The distinction between how a system is supposed to operate and how, in fact, it does can be quite considerable. Nevertheless, the greater provision for public hearings in British Columbia and the guaranteed access to effluent data in Quebec have some bearing on opportunities for improving Ontario's regulatory approach, and this will be returned to in the final chapter of the report.

FOOTNOTES

CHAPTER 6

1. Discussions with people in the industry, the Ministry of Environment and the Ministry of Industry and Tourism indicate a widely held view that such a guarantee was necessary for any company to buy the Dryden mill. Given that the Ontario Treasurer believes it most unlikely that any damages will exceed $15 million it is difficult to see why the mill would not have found a buyer at some price had the guarantee not been given. As it is, the guarantee no doubt raised the market price of the mill so that Reed, the departing owner, clearly benefitted. Great Lakes' gain is less obvious. This is unfortunate since from the Province's point of view, it would have made more sense to assist the company that by its actions was prepared to make a commitment to the future of the Dryden community, rather than the one whose main interest was in taking its capital elsewhere.

2. Even if a proposal for a new mill is forthcoming and it is designated under the Environmental Assessment Act, the proponent will have to demonstrate that the mill will be in compliance with these other Acts with regard to wastewater discharges.

3. One problem with representing the process in this way is that it appears static. In fact, the Ontario Ministry of the Environment is currently reviewing the way in which it regulates the industry and some of the likely changes are discussed later. However, it is understood that no fundamental changes are being contemplated by the Ministry. Figure 6.1 is intended to represent the process as it exists now.

4. Ontario Ministry of the Environment, Water Management, November 1978, (referred to in the text as the Blue Book). All the quotes in this section are from the Blue Book.

5. The "A" corresponds to the decision and activities so indicated in Figure 6.1. This convention is maintained in the following sub-sections.

6. Ontario Ministry of the Environment, op. cit., p. 14.

7. Ibid., p. 14.

8. The offence involved a discharge of mercury from the company's chlor-alkali plant. This is a chemical plant, the output of which is used in the company's pulp and paper mill.

9. This is in accordance with the terms of reference for this study.

10. Report on Pollution Control Objectives for the Forest Products Industry of British Columbia, Department of Lands, Forests and Water Resources, B.C., September 1971.

11. This translation of the amending clause was provided by Bruce Walker, Research Coordinator of STOP.

CHAPTER 7

MILL SPECIFIC CASE STUDIES: THE POTENTIAL FOR ANALYSIS IN REGULATION

Previous chapters have examined the record of the pulp and paper industry in controlling its wastewater discharges. They also reviewed the regulatory activities of the federal and Ontario authorities. Much of the discussion was based on highly aggregated information. Some mill specific data were presented for Ontario, but they were used to analyse Ontario's approach to regulation in general rather than with respect to the problems and circumstances of particular mills. A primary purpose of this chapter is to investigate the role that certain types of mill by mill analysis might play in improving the information available to regulatory authorities.

The chapter reports on some preliminary results obtained for two Ontario mills with the Ministry of the Environment's Waste Treatment Analysis Program (WATAP). This program enumerates the waste treatment (including waste reduction) options available at any mill. It calculates their costs and associated waste loadings. Least cost treatment options are identified under several policy regimes: in this study two rates of capital cost allowance and three levels of effluent charge are considered. The results provide an empirical basis, albeit one that is illustrative rather than comprehensive, for some of the policy recommendations that are presented in the final chapter.

More detailed information about treatment options, their cost and impact on effluent loadings, is relevant to the regulation of the industry for several reasons. It will allow the costs of abatement to enter more systematically into efforts to set abatement objectives for each mill. The Ontario Ministry of the Environment is pursuing the development of WATAP for this purpose. Its use will supplement the information that regional directors are required to provide to head office in support of proposals for new Control Orders or amendments to existing ones. However, the program has not yet been used in this way by the Ministry.

In the current policy regime in all jurisdictions, negotiations between companies and the regulators play an important role. A more complete appreciation of the options available at any mill will assist government officials in these negotiations, and will also be of interest to members of the public to the extent that they are involved in the regulatory process. From the companies' perspective, it may be to their benefit to have a clearer understanding of what the regulatory authorities believe they can do to abate their effluent discharges, and at what cost.

If it should be decided that some form of effluent charge be used as a regulatory instrument then an analysis of the cost and performance of treatment options will be useful for setting the level of the charge. This issue will be addressed in the next chapter when recommendations for improving environmental protection regulation are considered. For the present, it is sufficient to note that the growing interest in and possible introduction of economic incentives for pollution abatement provides a further reason that favours the development of such tools as WATAP. The results obtained with this program in the course of this study are interesting in themselves, but are perhaps more important for showing the potential that the program has for improving the regulatory process.

In Ontario, as in some other jurisdictions, use is made of water quality simulation models. These models simulate the effects on a receiving water of varying levels of wastewater discharges. Results from the simulations are then used to establish waste loading objectives. This is very much part of the regulatory approach in Ontario with respect to pulp and paper mills.

A second analytical exercise in this study takes the output on waste loadings obtained from the WATAP program for a particular mill, and uses it as input into a water quality simulation model. This model was developed

by the Ontario Ministry of the Environment and used to establish waste loading objectives for pulp mills. It will be shown that, while the Ministry may be on the right track, the manner in which the water quality model has been used for regulating the company concerned can be improved. This is especially so when the water quality models and WATAP are used in tandem.

Finally, to go one step further, this chapter also reports on and gives examples of how an index of water quality can be employed to measure the benefits of abatement. Again, the purpose is primarily to illustrate the potential of such analytical tools for improving the regulatory process although the results obtained are not without interest in their own right.

This chapter, then, has two main objectives:

i) to review the application of economic and environmental analysis in regulating the pulp and paper industry;

ii) to report on results obtained from which some immediate lessons about regulation can be learned.

7.1 Water Pollution Abatement Options in the Pulp and Paper Industry

There is an extensive literature on wastewater reduction and treatment technology, a considerable portion of which is devoted specifically to the pulp and paper industry. A summary of these technologies is presented in Appendix A. A distinction is made between internal and external treatment options, describes the applications for each of them, and provides estimates of effectiveness, cost and equipment lifetime. The Appendix is by no means exhaustive but it does serve to illustrate the wide range of treatment options that are available to the pulp and paper industry. When the individual circumstances of each mill are considered, so that the scale of treatment also becomes a variable and specific inplant adjustments are possible, the number of options and combinations of options can increase enormously. At the same time, some forms of wastewater treatment will be

technically infeasible at some mills; they may be inappropriate for the problems at hand or some necessary resource such as land for aerated lagoons, will be unavailable.

In light of these complexities, it is questionable that a regulatory authority can expect to know what can be done at each mill. Moreover, a regulatory process which depends upon the regulatory authority having this information is unlikely to be very efficient. Partly as an attempt to overcome this problem the Ontario Ministry of the Environment has developed WATAP which will now be described in some detail.

7.2 The Waste Treatment Analysis Program (WATAP)

WATAP is a computer program which is run for individual mills. They need not be pulp and paper operations, though it was with these in mind that the program was written[1].

The program performs two distinct tasks: the generation of all possible combinations of pollution control alternatives and the calculation of the costs and effluent reductions achieved through their implementation. The model is quite comprehensive and is capable of handling internal process changes and external pollution control technologies; water, air and solid waste discharges, and any effluent loading interrelations between these forms of discharge (eg., wastewater treatment may generate a sludge which can either be incinerated or disposed of on land). Furthermore, effluent parameters may be included, as measures of effluent loadings and as elements in cost functions associated with a particular treatment.

The basic data needed to run the first step of the program is a list of all pollution abatement technologies that may be applied to the plant in question. With this and a matrix describing the mutually dependent or mutually exclusive nature of any pair or groups of treatments, the model will compute all possible pollution abatement plans open to that mill. For

each plan, the resulting waste discharge is computed.

The second step of the program requires the following data and computes the costs and effluent reductions that would result from the implementation of each pollution abatement plan:

1. Basic Engineering Data: Initial effluent loadings at the various mill sewer outlets, list of outlets and parameters affected by each treatment (including inplant process changes), the efficiency of pollution reduction offered by each treatment, the year of introduction and economic life of the plant and equipment.

2. Abatement Cost Data: Capital cost and yearly operation and maintenance cost for each treatment, additional final waste disposal costs, any additional revenue (or cost savings) generated through the use of a particular technology (eg., chemical recovery) and economic incentives for pollution abatement (eg., an effluent charge), if applicable.

3. Economic Accounting Data: Interest rates on loans, the time period of loan repayment, inflation rates for all forms of costs and revenues, capital cost allowance parameters, sales tax and sales tax rebate percentages, length of planning period. (For simplicity, all funds spent on pollution abatement are assumed to represent a net increase in a company's borrowing requirements. WATAP must be modified to allow for alternative forms of funding.)

Appendix B contains a more detailed description of the model. As the reader will note in the Appendix, two forms of output are available: a summary report which gives a description of the abatement alternatives, the net present value and the final year's effluent loadings (see as an example Table B.1, Appendix B, and a detailed final report which includes a yearly breakdown of all costs, revenues and effluent loadings, as well as the data given in the summary report (see Table B.2, Appendix B).

7.3 Analysis of Wastewater Treatment and Reduction Options at Two Mills in Ontario

In consultation with the Ontario Ministry of the Environment two mills were selected for analysis using WATAP. The mills chosen were:

- The E. B. Eddy mill at Espanola
- The Boise-Cascade mill at Kenora

Several factors entered into the choice of these mills, in addition, of course, to the availability of data needed for the program. Within this constraint, the two mills were selected for their differences as much as for what they have in common. Thus, one is a kraft mill (Eddy) and the other is a sulphite mill (Boise-Cascade). This serves to highlight the different abatement options for these pulping technologies. In terms of environmental impacts, the Eddy mill is perceived by the Ontario Ministry of the Environment to be responsible for a marked deterioration in water quality owing to BOD discharges, so that there is considerable potential for benefits if this pollution is abated. In contrast, benefits from reducing the discharges from the Boise-Cascade mill are more uncertain, and, suspended solids rather than BOD are considered the more pressing problem at this mill.[2]

One thing that the mills do have in common is their importance in the towns in which they are located. In 1973 the Eddy mill employed 97% of all people engaged in manufacturing in Espanola, and the equivalent figure for the Boise-Cascade mill was 61%.[3] Both of these mills are in towns in which the municipal tax base is heavily dependent on industrial taxes. It is obvious that the economic health of the towns depends on the prosperity of the mills. One way or another, a consideration of this factor must influence the regulatory process.

Finally, amendments to the Control Order for these mills are being considered so that the results obtained with WATAP, preliminary as they are, have some direct relevance to the ongoing regulatory process.

Before reporting on the application of WATAP to these mills it should be emphasized that the selection of these mills for analysis in no way reflects on the companies' past performance in abating pollution or on their willingness to cooperate with the regulatory authorities. During the study all the direct contact with the companies was through the Ministry in the normal course of its regulatory activities. This was deliberate, in order to illustrate the type of analysis that could be performed by the Ministry given the data that are available on a routine basis.

7.3.1 The E. B. Eddy Mill at Espanola[4]

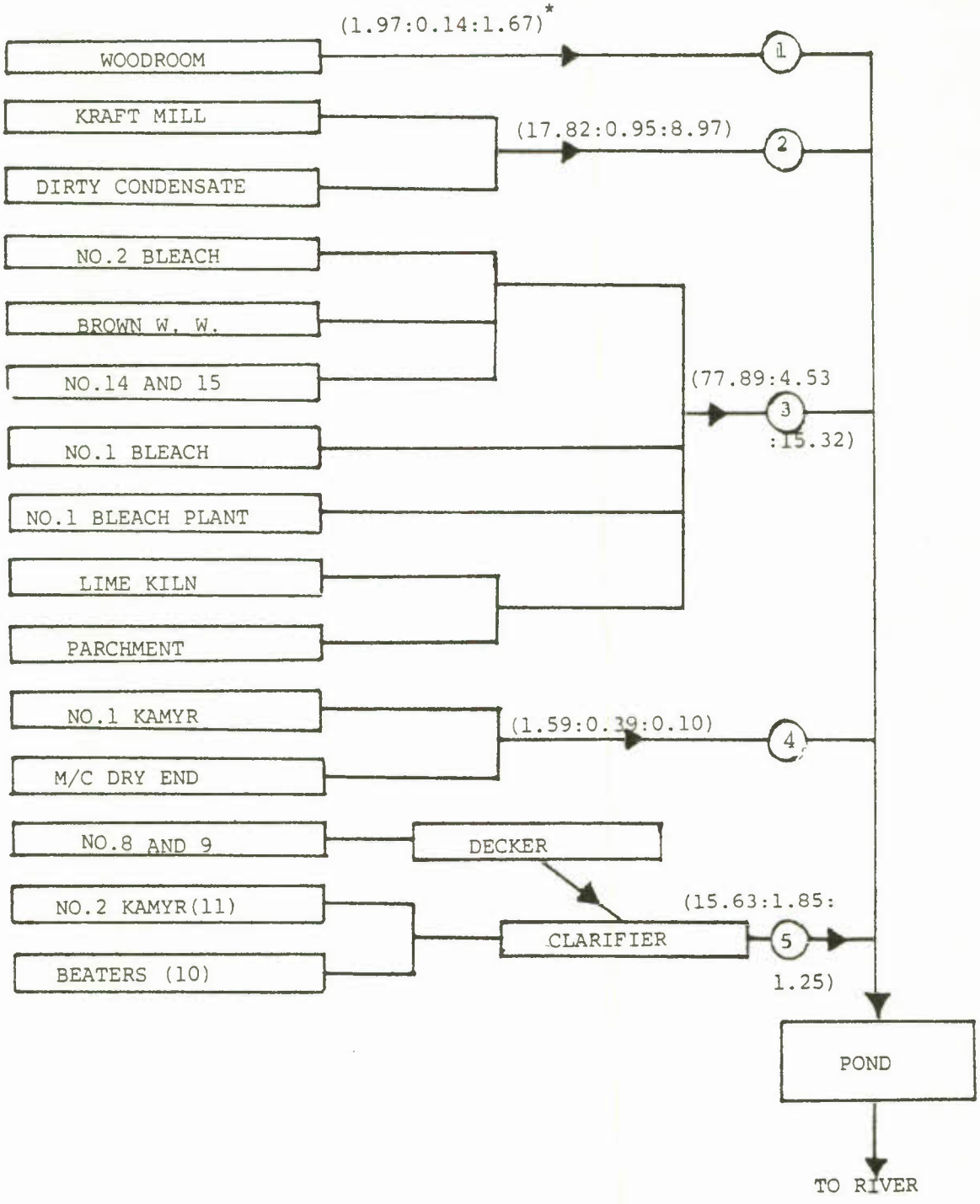
A schematic diagram of the major production process units, discharge points and wastewater loadings for the Eddy mill is given in Figure 7.1. Details of the component effluent loadings are provided in Table 7.1, and the numbered outlets (1 to 5) correspond to the numbered flows in Figure 7.1.

The effluent from the mill for 1979 was:

		Source
Total Flow	- 114.9 $10^3/M^3$/day	(Ministry of the Environment)
BOD	- 25.2 tonnes/day	(Table 3.3)
Suspended Solids	- 8.2 tonnes/day	(Table 3.2)

For the purpose of this part of the study, a BOD loading of 27.31 tonnes/day was used. This was the loading estimated by Ministry officials for August 1979. (The discharge in August is critical since it is the month in which the flow in the Spanish river is usually the lowest. Normally, BOD loadings do not vary much from month to month. Suspended solids discharges were not

FIGURE 7.1
EXISTING WATER EFFLUENT OUTLETS AND THEIR EFFLUENT FLOWS, EDDY FOREST PRODUCTS LTD., ESPANOLA.SEPTEMBER 1979



*(FLOW IN $10^3/M^3$/DAY:TSS IN TONNES/DAY:B.O.D IN TONNES/DAY)

SOURCE: ONTARIO MINISTRY OF ENVIRONMENT

Table 7.1

OUTLETS AND EFFLUENT LOADINGS AT THE EDDY MILL, ESPANOLA (AUGUST 1979)

Outlet (As per Figure 7.1)		EFFLUENT LOADINGS BEFORE TREATMENT		
		Flow ($10^3/M^3$/Day)	BOD (tonnes/day)	Suspended Solids (tonnes/day)
Woodroom Sewer	(1)	1.97	1.67	0.141
Kraft Mill Sewer	(2)	17.82	8.97	0.954
Main Sewer	(3)	77.89	15.32	4.53
#7 Sewer	(4)	1.59	0.1	0.391
Clarifier Outlet	(5)	15.63	1.25	1.85

Source: Ontario Ministry of the Environment

considered since the mill has virtually achieved the Ministry objective and information on treatment efficiencies for suspended solids reduction was not provided by the Ministry. (It may be noted, however, that contrary to Ministry expectations of 1978, the 1979 discharge of suspended solids increased over the 1978 level to more than 25% greater than the objective for the mill - see Table 5.2)

Table 7. 2 lists 5 waste treatment options for the Eddy mill. It shows the outlets affected by each option, the per unit reduction in BOD and flow, the capital, operating and maintenance costs, equipment life span and installation dates. These installation dates are those either required by the existing Control Order or, in the case of bio-treatments (i.e., activated sludge and aerated lagoon), the dates that are currently being considered in a Control Order Amendment.

Additional economic assumptions used in WATAP are presented in Table 7.5.[6]

The cost analysis was conducted using 1978 as the base year. It is recognised that the projected values for the interest rate on loans and the inflation rate may be questionable. However, for the purposes of this analysis it is the difference between them rather than their absolute magnitudes which is most significant. In any event, WATAP can be used to test the sensitivity of the results to the economic assumptions. It was assumed that all sales taxes on pollution abatement equipment are fully refunded, and that taxable income in any year is always sufficient for the company to take advantage of the capital cost allowances available to it.

It was quickly determined through the use of WATAP that the deployment of oxygen bleaching in the mill's second bleaching plant will yield considerable net revenues for the company. Since the company has already embarked on a plan to make this conversion in its bleaching facilities all the results reported below are based on the assumption that oxygen bleaching

Table 7.2

TREATMENT TYPES, PARAMETERS AND COSTS

Treatment Name	Short Name	Mill Outlets Affected (See Fig. 7.1)	Waste Parameters Affected and % Reduction		Capital Cost ($ Million 1978)	Annual O and M Costs ($ Million 1978)	Life Span (Years)	Installation Date
			BOD	Flow				
Condensate Stripping	CNST	2	40	0	.84	.095	20	1980
Oxygen Bleaching #2	OB2	3	75	60	14.0	.315[1]	20	1980
Activated Sludge	AS	1,2,3,4,5	90	0	a	a	20	1983
Aerated Lagoon	AL	1,2,3,4,5	80	0	a	a	20	1983

Source: Ontario Ministry of the Environment

[1] Savings of $2.7 million/year also generated

[a] Costs of these treatments are flow dependent. Capital costs were estimated from a graph provided by the Ontario Ministry of the Environment. The capital cost for an aerated lagoon was estimated at 80% of that for an activated sludge plant. Annual O & M costs were estimated at 16.5% of the respective capital cost.

Table 7.3

ECONOMIC ASSUMPTIONS USED IN W.A.T.A.P.

Year	Interest Rate on Loans (%) [1]	Inflation Rate (%) [1]	Discount Rate (%) [2]	Profit Tax Rate (%) [3]	Sales Tax Rate (%) [3]
1978	13.0	12.5	6.5	50.0	7.0
1979	13.5	9.0	6.7	50.0	7.0
1980	12.0	8.0	6.0	50.0	7.0
1981	12.0	8.5	6.0	50.0	7.0
1982	12.0	9.0	6.0	50.0	7.0
1983	11.0	8.0	5.5	50.0	7.0
1984	9.5	8.0	4.7	50.0	7.0
1985	10.5	9.0	5.2	50.0	7.0
1986	11.0	8.5	5.5	50.0	7.0
1987	11.0	5.5	5.5	50.0	7.0
1988	9.5	6.0	4.7	50.0	7.0
1989	10.0	6.6	5.0	50.0	7.0
1990	10.0	6.0	5.0	50.0	7.0
1991	10.0	6.0	5.0	50.0	7.0
1992	10.0	6.0	5.0	50.0	7.0
1993	10.0	5.5	5.0	50.0	7.0
1994	9.5	5.5	5.0	50.0	7.0
1995-	9.5	5.5	4.7	50.0	7.0

[1] 1% higher than the rate forecast in Ontario Hydro's Economic Forecasting Series, 1979, (Loan repayment period of 15 years).

[2] Equal to the interest rate on loans multiplied by the profits tax rate to give the opportunity cost on borrowed funds.

[3] Prevailing rate in Ontario, 1979.

in the mill's second bleaching plant has been installed. Consequently, the "do nothing" option corresponds to a flow of 68.17 $10^3/M^3$/day and a BOD loading of 15.82 tonnes/day. These were calculated using the treatment efficiencies for oxygen bleaching shown in Table 7.2.

The Results

Table 7.4 shows the 18 wastewater treatment plans identified by WATAP from the input data. They represent the technically feasible combinations of the waste treatment options listed in Table 7.2. Mutually incompatible options have been omitted, eg., aerated lagoons and activated sludge, both forms of biological or secondary treatments which are alternatives to one another. Furthermore, the amount of flow treated is considered a variable. Hence, biological treatment may be applied to the combined flow of various sewers in the mill. It is this sort of flexibility which increases the options available to a mill beyond the small number indicated in Table 7.2. Arguably, WATAP raises the awareness of all concerned that a wider range of options exists than is immediately apparent.[5]

The 18 plans in Table 7.4 have been sorted into ascending order of BOD discharges. At the bottom of the table is alternative number 1 at zero cost, with BOD at the level expected when oxygen bleaching is installed. This is the least cost option for the company, and the most attractive to it for this reason. It may be noted that any of the top seven plans give BOD loadings that meet or exceed the Ontario Ministry of Environment's objective of 3.6 tonnes/day.

From Table 7.4 it is apparent that some treatment plans are dominated by others in the sense that they involve higher costs and higher levels of BOD discharges. Plans 7 and 10 are dominated by plan 2. If indeed, BOD is the only wastewater parameter of concern then plans 7 and 10 should

Table 7.4

FEASIBLE WASTEWATER TREATMENT PLANS FOR THE EDDY MILL AT ESPANOLA

Plan Number	Plan Description[1]	Present Value of Costs ($ million 1978)	Present Value of Taxes Avoided ($ million 1978)	BOD_5 tonnes/day
3	CNST, AS (1-5)	25.3	30.7	1.2
4	AS (1-5)	23.7	28.7	1.6
15	CNST, AS (1-3)	21.2	25.7	2.4
5	CNST, AL (1-5)	20.7	25.0	2.5
9	AS (1-3)	19.6	23.7	2.8
6	AL (1-5)	19.0	23.0	3.2
18	CNST, AL (1-3)	17.3	21.0	3.5
12	AL (1-3)	15.7	19.0	4.2
14	CNST, AS (1,2)	12.1	14.6	5.9
8	AS (1,2)	10.5	12.6	6.2
17	CNST, AL (1,2)	10.0	12.1	6.6
11	AL (1,2)	8.4	10.1	7.3
13	CNST, AS (1)	3.9	4.7	10.7
16	CNST, AL (1)	3.4	4.0	10.9
2	CNST	1.6	2.0	12.2
7	AS (1)	2.3	2.7	14.3
10	AL (1)	1.8	2.2	14.5
1		0	0.0	15.8

[1] The numbers in brackets refer to the flows in Figure 7.1 affected by the treatment

not be considered further since they are more costly and less effective than another feasible plan. In the case of the Boise-Cascade mill the implications of several relevant wastewater parameters are examined. (Additional parameters can easily be handled by WATAP, though toxicity, in particular, does not lend itself to this in that it is best measured by effects rather than by constituents of the effluents.)

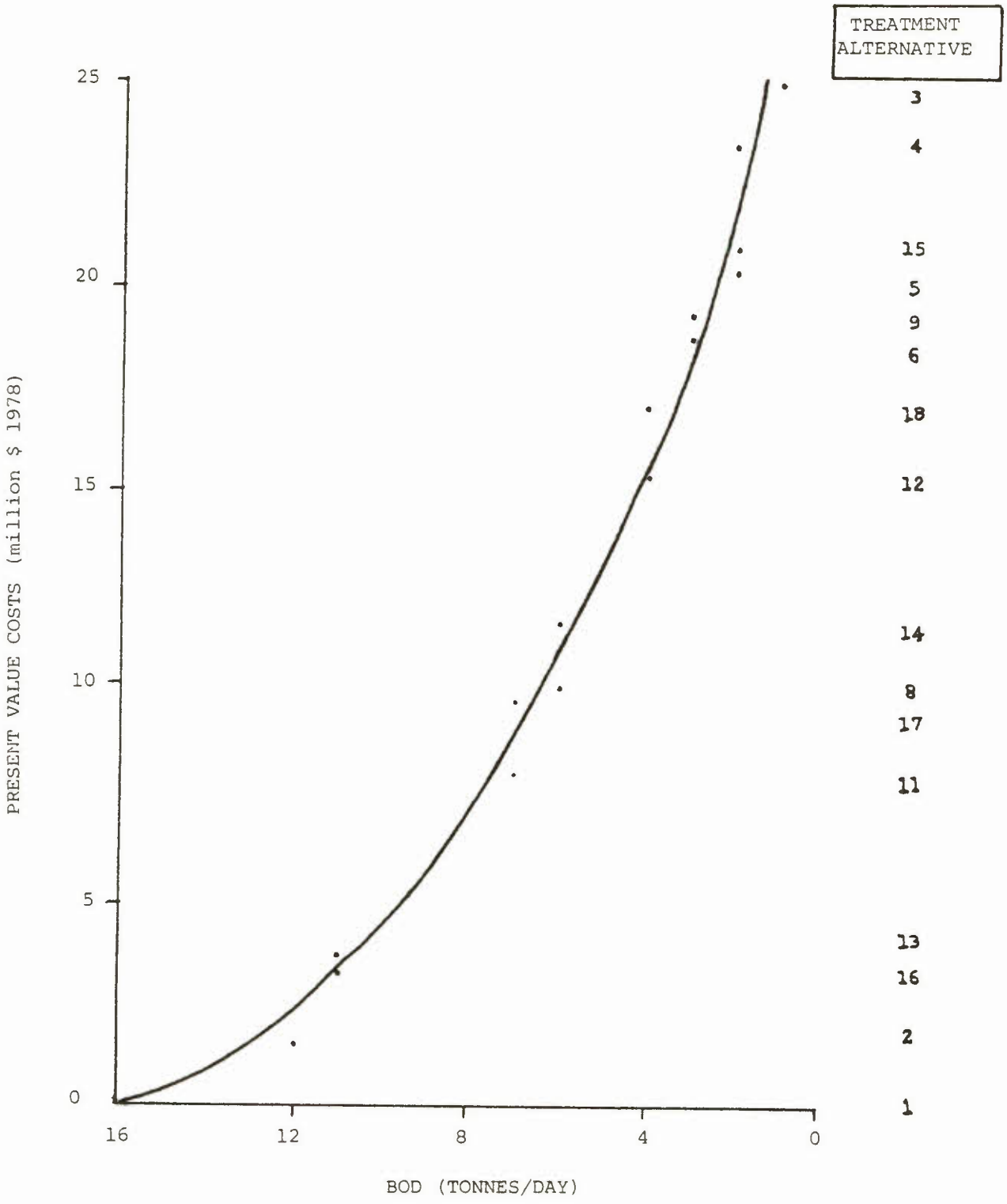
Figure 7.2 shows the relationship between BOD reduction and cost estimated for the Eddy mill, using only the cost effective plans for each level of abatement. The cost curve has the general shape commonly assumed in economic theory, reflecting rising marginal costs of abatement.

It should be noted that the curve is made up of a series of discontinuous points through which a line of best fit has been plotted. But not all levels of BOD reduction indicated by the curve are necessarily technically feasible. At the same time it is likely that a greater number of options are available than those considered in Table 7. and so some of the intermediate costs and reduction in BOD shown in Figure 7.2 may be achievable.

In Chapters 2 and 3 various estimates of expenditures by the pulp and paper industry on pollution abatement were discussed. The concern there was the lack of correspondence among expenditure estimates from industry and government sources, though various possible explanations for this were offered. What was perhaps not apparent was that the expenditures that are incurred by the industry are deductible for tax purposes. This means that the reduction in net profits, (i.e., after taxes) of a company from pollution abatement expenditures can be substantially less than the pre-tax costs involved.

With a corporation profits tax of 50%, the reduction in net profits will be approximately 50% of the pollution abatement expenditures. It will

FIGURE 7.2
THE ESTIMATED COSTS OF BOD REDUCTION AT THE EDDY MILL
ESPANOLA



deviate from this depending on the relevant provisions for capital cost allowances and will approach the full pre-tax cost if the company earns insufficient gross income against which to write-off eligible expenses. (However, such expenses can be carried forward against future income.) Table 7.4 shows the present value of the taxes avoided for each treatment plan, under the specific assumptions given earlier regarding financing, tax rates and allowances, and the discount rate. It appears then, that the burden of the expenditures on pollution abatement at the Eddy mill would be divided between the company and the federal and provincial governments such that the company only bears some 45% of the costs of abatement measured after tax.

One of the important features of WATAP is the ease with which it can be used to analyse the impact on costs of variations in pollution abatement policies. In this study two such variations were considered:

- a change in the capital cost allowance from 2 year, straight line to diminishing balance at 20% per year;

- the introduction of an effluent charge on BOD at rates of $150/tonne, $200/tonne and $300/tonne (in 1978 dollars, indexed at the projected inflation rate)

The value to the company of the accelerated capital cost allowance is approximately 3% of the present value of the costs after tax to the company. In other words the more favourable treatment of expenditures on pollution abatement equipment for tax purposes confers a benefit on the company of about 3% of the present value of the post-tax costs calculated with the diminishing balance. This percentage does vary slightly from one treatment plan to another, reflecting different mixes of capital and operating costs, though the variation is small. From a regulatory perspective this result shows that the accelerated capital cost provision can only be expected to make pollution abatement marginally less costly than it would be under the less generous, depreciating balance allowance. Stronger incentives

for abatement are required to secure the levels of expenditure thought by the authorities to be necessary to meet pollution abatement objectives.

One such incentive for which an extensive amount of analysis has been done and which has gained a considerable body of support among economists is the effluent charge. The simplest form of effluent charge is a fee per unit of waste. It is believed that a fee of this type would provide companies with a powerful incentive to reduce their use of receiving waters for waste disposal. Pollution abatement would be cheaper than pollution, up to a point at least. What that point is depends on the costs of abatement and the effluent charge rate.

As part of this study, WATAP was used to estimate the impact of an effluent charge on the costs of treatment options for the Eddy mill. In particular, the least cost option for the mill was determined under the three rates of effluent charge specified above. Table 7.5 shows the least orderings of cost effective treatment plans according to their costs to the company including the effluent charge which is assumed to be non-deductible for tax purposes.) The no charge case is also displayed for comparison.

At the bottom of each listing of treatment plans is the least cost option for the level of effluent charge specified. That is:

Effluent Charge Rate ($/tonne BOD)	Least Cost Plan # (Table 7.5)	BOD Discharge tonnes/day
0	1	15.8
150	2	12.2
200	16	10.9
300	17	6.6

Table 7.5

COST EFFECTIVE TREATMENT PLANS FOR THE EDDY MILL

AT ESPANOLA WITH AND WITHOUT AN EFFLUENT CHARGE ON BOD

No Effluent Charge				Effluent Charge $150/tonne BOD				Effluent Charge $200/tonne BOD				Effluent Charge $300/tonne BOD			
Plan #	Cost[1]	BOD[2]	Charge Payment	Plan #	Cost[1]	BOD[2]	Charge Payment	Plan #	Cost[1]	BOD[2]	Charge Payment	Plan #	Cost[1]	BOD[2]	Charge Payment
3	25.3	1.2	0	3	28.6	1.2	3.3	3	29.7	1.2	4.4	3	31.8	1.2	6.5
4	23.7	1.6	0	4	27.9	1.6	4.2	4	29.3	1.6	5.6	15	30.3	2.4	9.1
15	21.2	2.4	0	15	25.7	2.4	4.5	15	27.3	2.4	6.1	5	29.8	2.5	9.1
5	20.7	2.5	0	5	25.2	2.5	4.5	5	26.8	2.5	6.1	18	28.9	3.5	11.6
9	19.6	2.8	0	9	25.1	2.8	5.5	18	25.0	3.5	7.7	17	28.3	6.6	18.3
6	19.0	3.2	0	6	25.0	3.2	6.0	14	23.2	5.9	11.1				
18	17.3	3.5	0	18	23.1	3.5	5.8	8	22.9	6.2	12.4				
12	15.7	4.2	0	12	22.8	4.2	7.1	17	22.2	6.6	12.2				
14	12.1	5.9	0	14	20.4	5.9	8.3	16	21.9	10.9	18.5				
8	10.5	6.2	0	8	19.8	6.2	9.3								
17	10.0	6.6	0	17	19.2	6.6	9.2								
11	8.4	7.3	0	11	18.9	7.3	10.5								
13	3.9	10.7	0	13	17.6	10.7	13.7								
16	3.4	10.9	0	16	17.3	10.9	13.9								
2	1.6	12.2	0	2	17.0	12.2	15.4								
1	0.0	15.8	0												

Notes:

[1] Present value in millions $1978

[2] tonnes/day after all components of plan completed

These would be the plans that the company could be expected to select if the effluent charge were the only the regulatory instrument apart from the tax allowances built into the cost calculations.

Several interesting points emerge from Table 7.5.

i) With the effluent charges imposed, the least cost option, for the company always involves a reduction in BOD discharge. Since cost minimization is consistent with the achievement of virtually any goal the company might be presumed to have, this result supports the idea that the company would respond to an effluent charge by reducing its wastewater loadings at the Espanola mill,

ii) The discharge of BOD associated with the least cost options are quite sensitive to variations in the effluent charge rate. This suggests that some care will be necessary in selecting the appropriate charge rate. Plan 18 is the most cost effective means by which the mill can meet the Ministry's discharge objectives of 3.6 tonnes/day BOD. A change rate of $32/tonne would be necessary to make this plan the least cost option.

iii) The cost difference between the most effective abatement plan (plan 3) and the plan which constitutes the least cost option (attach specified charge rate) decreases as the charge rate increases. The cost difference goes from $1.68 million at a charge rate of $150/tonne to $I.36 million and $1.12 million for charge rates of $200/tonne and $300/tonne respectively. Hence, the higher the charge rate, the less will be required of the other regulatory instruments to induce a company to adopt a treatment plan which is more costly but more effective in reducing discharges.

iv) The total charge payment does not bear a close relation to the charge rate (per tonne of effluent). The payment associated with the least cost option at a charge of $150/toone BOD is only 16% less than that for a charge of $300/tonne BOD. The payment when the charge is $200/tonne BOD is actually greater than for the $300/tonne BOD charge rate.

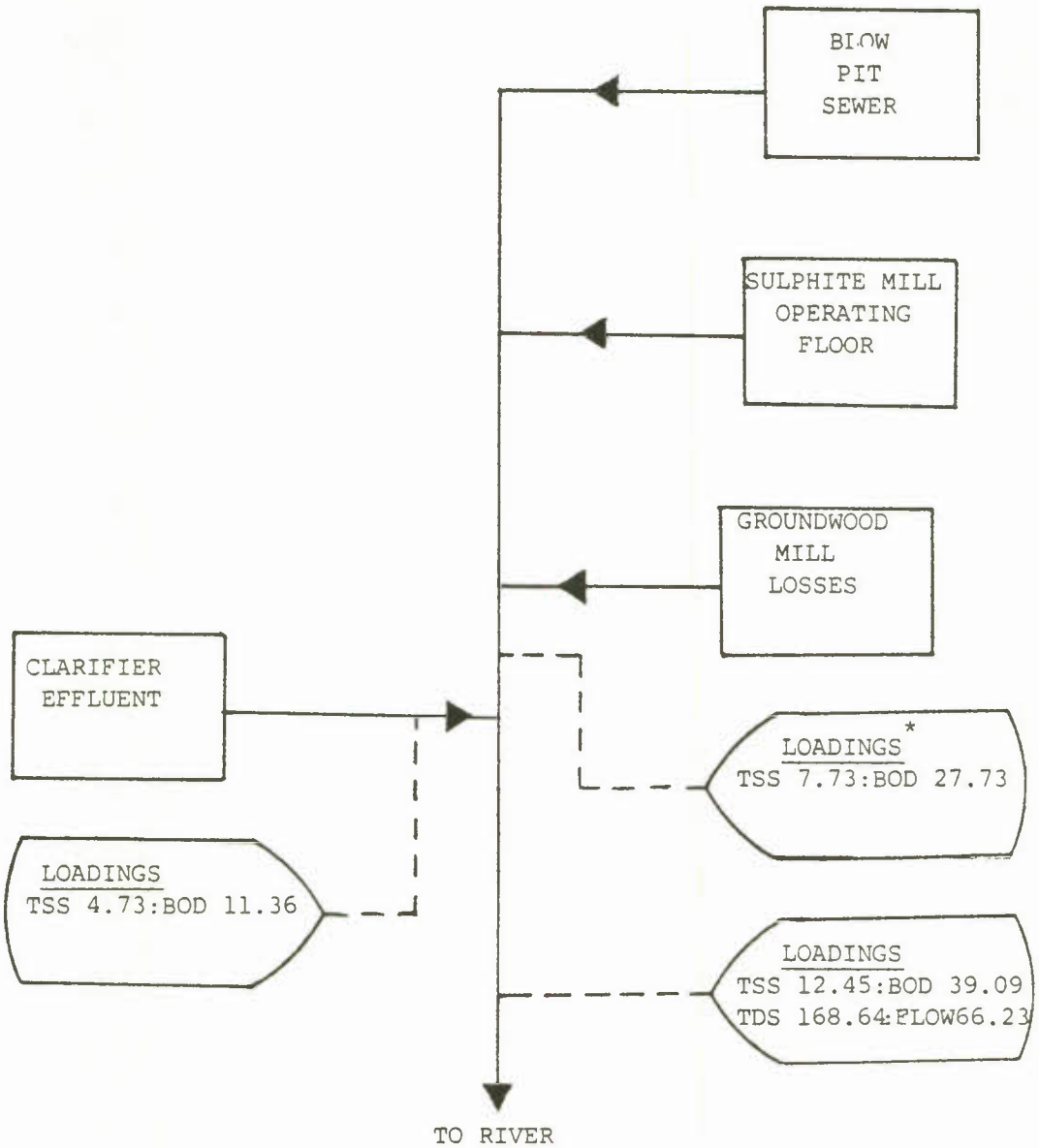
v) The charge payment as a percentage of the total cost to the mill including the charge varies from 12% to 91% for the lowest effluent charge rate. The range of variation decreases as the charge rate is increased. In all of the least cost cases where a charge is imposed, the company would spend considerably more on the effluent charge than on pollution abatement. The implications of the revenue raising potential of an effluent charge should be considered explicity, and is an issue which will be taken up in the next chapter.

7.3.2 The Boise-Cascade Mill at Kenora[4]

The analysis in this section follows closely that which was described in the previous section for the Eddy mill at Espanola. To avoid repetition the comments on method will be kept to a minimum, and the emphasis will be on the results and their interpretation.

Figure 7.3 shows the major production process units, discharge points and wastewater loadings for the Boise-Cascade mill. The available information on the effluent from this mill is more highly aggregated than for the Eddy mill. Hence, only the total loadings have been identified. As of January 1980 the Ontario Ministry of the Environment reports these to be:

FIGURE 7.3
EXISTING WATER EFFLUENT OUTLETS AND THEIR EFFLUENT FLOWS, BOISE-CASCADE CANADA LTD., KENORA, AUGUST 1979



* (TSS IN TONNES/DAY, BOD IN TONNES/DAY, TDS IN TONNES/DAY, FLOW IN $10^3/M^3$/DAY)

SOURCE: ONTARIO MINISTRY OF ENVIRONMENT

total flow	-	74.18 $10^3/M^3$/day
BOD	-	35.7 tonnes/day
total suspended solids	-	12.45 tonnes/day
total dissolved solids	-	168.6 tonnes/day

These values (for BOD and suspended solids) differ slightly from the average values for 1979 reported in Tables 5.2 and 5.3 but provide a valid basis for the analysis which follows.

Table 7.6 lists 6 waste treatment possibilities for the Boise-Cascade mill. All are assumed to affect the final mill effluent, since no information on individual flows in the mill was available. The percent reduction for BOD, suspended solids, dissolved solids and flow for each option is shown and so is the capital, operating and maintenance cost, equipment lifespan and installation dates. Owing to a reorganization of the mill management, and an accompanying name change to that of the parent company (Boise-Cascade), the company is in the process of amending the original Control Order. Table 7.6 shows installation dates that were chosen to reflect a feasible program of abatement designed to bring the mill into compliance with the provincial and federal objectives. The precise options that will be specified in a new Control Order and their timing may differ from those given in the table.

The additional economic assumptions used in the cost analysis are the same as those and for the Eddy mill (see Table 7.3). All the results are given in 1978 dollars.

The Results

Table 7.7 shows the 20 wastewater treatment plans identified by WATAP from the input data for the Boise-Cascade mill. It also shows their estimated costs to the company and the value of the taxes avoided. As with the Eddy mill, the company would only incur roughly 45% of the costs of the

Table 7.6

TREATMENT TYPES, PARAMETERS AND COSTS[1]

Treatment Name	Short Name	Water Parameters Affected and % Reduction BOD	Flow	TSS	TDS	Capital Cost $ million 1978	Annual O & M Costs $ million 1978	Life Span (Years)	Installation Date
Woodroom Pollution Control Improvements	WRI	3.5	0	10.9	0	.1	0.078	16	1980
Screening of Flows Bypassing Clarifier	SNCF	0	0	14.6	0	.33	0.002	16	1983
Conventional Sulphite Recovery System	CSR	46.5	0	8.6	38.5	27.5	1.405[a]	16	1986
Replace Sulphite With Kraft Furnish	RKP	69.8	24	9.1	58.0	5.265	30.940[b]	16	1986
100% Thermo-mechanical Pulping	TMP	26.2	7	0	32.3	48.6	13.600[c]	16	1986
External Biological	BIO	60.5	0	-9.5	0	10.0	0.750	16	1986

Source: Ontario Ministry of the Environment

[1] All treatments affect the final mill effluent

[a] Savings of $0.44 million/year also generated

[b] Savings of $7.44 million/year also generated

[c] Savings of $15.3 million/year also generated

treatment plans, though there is considerable variation in this from one plan to another. The remainder is accounted for by reduced tax payments to the federal and provincial governments. To determine which plans are cost effective it is necessary to assume some weighting system for the three waste parameters: BOD, suspended solids and dissolved solids. These weights which, ideally, should reflect the relative environmental damage of these parameters can be used to form an index so that the alternative treatment plans may be compared.

No attempt was made in this study to develop appropriate weights. Instead several sets of weights were used to test the sensitivity of the cost effective plans. As Table 7.8 shows, the number and ordering of these plans are sensitive to the weights used. This indicates that the selection of the "best" treatment plan for this mill is highly dependent on the relative significance given to the various environmental objectives. For example, with the first set of weights in Table 7.8, 12 treatment plans are included in the set of those that are cost effective. When only BOD is considered, in the second set of weights, fewer plans are cost effective and maintaining the status quo involves a BOD discharge nearly three and one half times the level of that obtainable with plan number 10. This option is extremely costly, however. More than a 50% reduction can be obtained far more cheaply with plans number 17 or 18.

Considering only suspended solids, as in the third set of weights, the number of cost effective plans is reduced still further and their difference in terms of the index is also curtailed. The most that can be achieved is a 30% reduction from existing discharges with plans 8 or 12. Note that neither of these options are capable of bringing the mill into compliance with the Provincial objectives for the mill. (i.e., 23.0 tonnes/day BOD and 4.0 tonnes/day of suspended solids - see Tables 5.2 and 5.3).

Table 7.7

FEASIBLE WASTEWATER TREATMENT PLANS FOR THE BOISE-CASCADE MILL AT KENORA

Plan Number	Plan Description	Present Value of Costs ($ million 1978)	Present Value of Taxes Avoided ($ million 1978)	Suspended BOD (tonnes/day)	Suspended Solids (tonnes/day)	Dissolved Solids (tonnes/day)
12	WRI, SNCF, RKP	225.7	244.4	10.4	8.6	70.8
11	SNCF, RKP	224.8	243.3	10.8	9.6	70.8
10	WRI, RKP	225.6	243.8	10.4	10.0	70.8
9	RKP	224.7	242.6	10.8	11.3	70.8
8	WRI, SNCF, CSR	27.1	39.9	18.4	8.6	103.7
7	SNCF, CSR	26.2	38.7	19.1	9.7	103.7
6	WRI, CSR	27.0	39.2	18.4	10.1	103.7
5	CSR	26.1	38.0	19.1	11.3	103.7
16	WRI, SNCF, TMP	15.1	34.7	25.5	9.4	114.7
20	WRI, SNCF, BIO	14.4	19.8	13.4	10.4	168.6
15	SNCF, TMP	14.1	33.5	26.4	10.6	114.7
14	WRI, TMP	15.0	34.0	25.5	11.1	114.7
19	SNCF, BIO	13.4	18.6	13.9	11.7	168.6
18	WRI, BIO	14.3	19.1	13.4	12.2	168.6
13	TMP	14.0	32.9	26.4	12.4	114.7
17	BIO	13.3	18.0	13.9	13.6	168.6
4	WRI, SNCF	1.1	1.8	34.5	9.4	168.6
3	SNCF	0.1	0.7	35.7	10.6	168.6
2	WRI	1.0	1.2	34.5	11.1	168.6
1	--					

Table 7.8

LEAST COST WASTE TREATMENT PLANS FOR THE BOISE-CASCADE MILL AT KENORA

Weights			Weights			Weights		
BOD	SS	DS	BOD	SS	DS	BOD	SS	DS
4	16	1	1	0	0	0	1	0
Plan Number	Present Value of Costs ($ million 1978)	Index	Plan Number	Present Value of Costs ($ million 1978)	Index	Plan Number	Present Value of Costs ($ million 1978)	Index
12	225.7	1	10	225.6	1	12	225.7	1
11	224.8	1.07	9	224.7	1.04	8	27.1	1.01
9	224.7	1.18	18	14.3	1.29	4	1.1	1.09
8	27.1	1.26	17	13.3	1.34	3	0.1	1.23
7	26.2	1.34	2	1.0	3.32	1	0.0	1.44
5	26.1	1.45	1	0.0	3.43			
16	15.1	1.47						
15	14.1	1.56						
13	14.0	1.68						
4	1.1	1.83						
3	0.1	1.93						
1	0.0	2.04						

Paralleling the analysis conducted for the Eddy mill at Espanola, consideration was given to the implications of an effluent charge for the Boise-Cascade mill. The same rates for the charge were assumed.

- $150/tonne BOD
- $200/tonne BOD
- $300/tonne BOD

A result of the analysis performed for the Eddy mill was that the least cost discharge of BOD was sensitive to variations in the effluent charge rate. The situation is quite different with respect to the Boise-Cascade mill. For each rate of charge, treatment plans 17, 18, 19, and 20 have total costs, including the charge, that vary by less than 1%, and BOD levels that are almost as close. Hence, while even the lowest charge rate considered makes any of these options much cheaper than doing nothing (a savings of $23 million was estimated), a doubling of the charge rate does not justify further abatement. This would appear to be the case for an effluent charge of $500/tonnes BOD or more.

An important implication of this result, insofar as it may be generalized to other mills, is that when the costs of reducing effluent discharges are sharply discontinuous, estimation of the appropriate effluent charge rate to induce some expected level of abatement is not too difficult. Within a wide band of values for the effluent charge much the same level of abatement will be achieved. Beyond that, however, very considerable increases in the effluent charge imposed under these circumstances could lead to large revenues and not much additional abatement.

It should be noted that this result would also obtain in the case of the Boise-Cascade mill, if suspended solids were subject to an effluent charge. Table 7.8 shows that a substantial reduction in suspended solids can be achieved at a modest cost, if plan 4 is adopted. Implementation of this level of abatement might easily be secured through a relatively low effluent charge rate. However, to induce the mill to adopt the level of suspended solids discharge possible under plans 8 or 12 by an effluent charge would require

a massive increase in the charge rate. A smaller increase might generate considerable revenues for the government but it would not encourage the company to spend additional funds on pollution abatement. To achieve that, the regulatory agency would be advised to rely on other instruments.

The policy implications of this analysis of effluent charges will be taken up again in the final chapter. It is hoped that the analyses performed for the Eddy mill and the Boise-Cascade mill have highlighted some of the major characteristics, advantages and disadvantages, of a charges scheme. The challenge in the next chapter will be to suggest how such a scheme, or some other variant of an economic incentive for abatement, can be integrated into a more comprehensive approach to environmental protection regulation for pulp and paper mills.

7.4 Benefits from Pollution Abatement

As explained in Chapter 6, Ontario's goal for surface water quality management is "to ensure that the surface waters of the province are of a quality which is satisfactory for aquatic life and recreation."[7] According to the Provincial Water Quality Objectives, a necessary condition for the achievement of this goal is the maintenance of dissolved oxygen (DO) levels in receiving waters of 5 mg/L for cold water biota and 4 mg/L for warm water biota at a temperature range of 20 - 25^{o}C. This is the temperature range of most of Ontario's rivers in mid-summer when their flow is usually lowest.

To determine the total allowable discharge of BOD into a receiving water, the Ministry works back from the appropriate warm water or cold water biota DO objective, assuming some appropriate low flow level, and estimates the BOD loadings that will achieve it. Some proportion of the allowable BOD loadings are then allocated to the various sources of BOD. These allocations become the Ministry waste loading objectives for these point sources.

One interpretation of this process is that it reflects an assumed relationship between the DO level in the receiving waters and the benefits from enhanced uses that are made possible. What is unclear is whether and to what extent these benefits are forgone if the DO level falls below the Provincial Objective. On the other hand, if the DO level exceeds the Provincial Objective it seems to be implied that no additional benefits will be attained.

In this section of the report, the analytical work that went into establishing the BOD discharge objective for the Eddy mill is looked at in some detail. Simulations of water quality in the Spanish River are reproduced using the Ontario Ministry of the Environment water quality simulation model. The results provide the basis for a further discussion of the adequacy of the mill's BOD objective and, by implication, the process by which it was set. Though interesting in itself, the discussion is intended to throw light on this aspect of the regulatory process in general. As such, it is hoped that the rather detailed analysis of the relationship between BOD in the mill effluent and DO in the Spanish River will be relevant not only to the other mills in Ontario, but to mills across the country.

As a final step in the analysis, a water quality index, based on the sports fishing potential of the receiving water, is discussed and a simplified example of its use in regulating a mill is presented.

7.4.1 The Relation Between BOD and Dissolved Oxygen

In 1972 the Ontario Ministry of the Environment prepared a report on the water quality of the Lower Spanish River.[8] This report describes the river basin and water uses. It presents information on effluent loadings into the river as well as their implications for water quality. (In 1972 the E.B. Eddy mill accounted for 99% of the BOD loadings at this location. The

remainder came from the Espanola sewage treatment plant. In this study the Ministry employed a water quality model to relate BOD discharges from the mill to dissolved oxygen (D)) levels in the river downstream from the mill. Appendix C includes a description of this model. The Ministry conducted an on-site survey of the Spanish River in August 1971 and used the results to estimate the values of the parameters employed in its model. (See Appendix C.) The model was then used to simulate the DO level in the river for various levels of flow, temperature, and BOD loadings from the mill.

To determine an acceptable level of BOD loadings into the river it is necessary to specify the conditions under which the DO objective of 5 mg/L must be met. (This was the DO objective used by the Ministry in 1972.) For this purpose the Ministry specified a river flow of 35,400 litres/second (1250 cfs) at the mill, and a water temperature of 22°C. A statistical analysis of the daily flows from 1947-1970 indicated that a 7-day flow of this level had a 5% likelihood in any year. (A flow of this frequency is referred to as 7Q20.) Although the Ministry has hever specified an acceptable probability level for achievement of the Provincial Water Quality Objectives, the selection of the 7-day low flow that occurs, on average, once in 20 years, has become the norm.[9]

With the use of the model it was determined that a loading of 5.4 tonnes/day of BOD, under the assumed low flow conditions, would be consistent with the achievement of a DO level downstream from the mill of at least 5 mg/L. Following its policy of only allocating a portion of the allowable loadings to the wastewater discharges to allow for contingencies and future uses, a mill objective of 3.6 tonnes/day (8,000 lbs./day) was established.

In the period 1970-1979 the mill's discharge of BOD reamined virtually unchanged. (Table 5.3 shows that it was 23.1 tonnes/day in 1970 and 25.2 tonnes/day in 1979). With the introduction of oxygen bleaching, primarily for economic reasons, the mill's discharge of BOD is expected to

decline to less than 16 tonnes/day (see section 7.3.1). This will still be more than 300% above the mill's objective which in 1977 was written into a Control Order, though no date for its attainment was specified. A proposed amendment to the Control Order requested by the company was granted by the Ministry of the Environment in 1980 and calls for "full biological treatment of the company's wastewater discharges" by 1983.[10] The Ministry believes that "this will substantially improve the water quality of the Spanish River."[11]

This account of how the objective for the mill was established is interesting for three reasons. First it shows the lack of any consideration being given to the cost of achieving the objective. Benefits enter only very indirectly through the (unstated) rationale for the Provincial Water Quality Objective. Secondly, it provides the basis for some further analytical work, the results of which call into question the validity of the mill discharge objective on the grounds that its attainment will not be sufficient to meet the Provincial Water Quality Objective with the frequency expected by the Ministry. Finally, it will be suggested that the introduction of a water quality index may greatly improve the information on which such mill specific objectives can and should be established.

The Ministry's water quality model was used to undertake some additional analysis.[12] Five sets of simulations were performed. The first was an attempt to replicate the Ministry's standard run to check the accuracy with which the model was reproduced for this study. As the figure contained in Appendix C (Table C.1) demonstrate, the results from the two are very close.

The other 4 sets of runs may be summarized as follows:

		With Sludge	Without Sludge
Minimum Flow of River (L/S)	35,400	X	X
	24,355	X	X

The sludge referred to rests on the river bed and consists of the organic fraction of settleable solids previously discharged by the mill. It extends some 26 kilometres downstream from the mill and not only places a demand on the DO in the river, but provides an unsuitable habitat for fish life. From observations on several rivers in Ontario receiving pulp and paper mill discharges, the Ministry has learned that, if the input of bark, chips and fibre is reduced, the existing deposits will be dispersed. This will result from high flow scour and resuspension from anaerobic formation during the warm weather period. It is acknowledged, however, that this flushing action may take many years.

The two flows considered in this analysis are the 7Q20 flow estimates from two different periods: 1950 - 1970, (on which the Ministry has based its BOD discharge objective for the mill) and 1953 - 1977. The latter estimate fo the 7Q20 flow, which constitutes a revision of the previous estimate, has not affected the Ministry's current (i.e., 1980 BOD objective for the mill, despite the fact that the flow is about 30% lower.

This means that even if the mill achieves the Ministry's BOD objective, the DO level in the river will not satisfy the Provincial Water

Quality Objective with the standard level of confidence (95% probability). (A flow as low as 35,400 litres/second is now estimated to recur, on average, once every 5 years, not once every 20 years.)[13]

Furthermore, the publication of the Blue Book by the Ministry in 1978 lowered the Provincial Water Quality Objective for dissolved oxygen from 5 mg/L to 4 mg/L for warm water biota. According to the Water Resources Branch this lower value applies to the Spanish River. However, this revision has not been reflected in the Ministry's discharge objective for the mill, which, at 8000 lbs/day BOD, has been written into a Control Order issued in May 1980. (This analysis proceeds on the assumption that the North Eastern Regional Office is still seeking a DO level of 5 mg/L in the Spanish River.

Six levels of BOD loadings from the mill were chosen for analysis. These are loadings for which corresponding DO levels have been estimated and were selected as follows:

3.6 tonnes/day	- the Ministry's objective for the mill
5.4 tonnes/day	- the total BOD loading stated by the Ministry to be consistent with a level of DO of at least 5 mg/L for a flow of 35,400 litres/second (the objective for the mill is 67% of this total BOD)
6.6 tonnes/day	- the least cost BOD discharge, given an effluent charge of $300/tonnes BOD
10.9 tonnes/day	- the least cost BOD discharge given an effluent charge of $200/tonnes BOD
12.2 tonnes/day	- the least cost BOD discharge given an effluent charge of $150/tonnes BOD
15.8 tonnes/day	- the least cost BOD discharge with no effluent charge (after oxygen bleaching is installed)

The estimated DO levels recorded in Table C.1 and C.2 in Appendix C give rise to the following comments:

- Analysis of the results with sludge (the Ministry established its allowable BOD loading for the river and the mill on the assumption that the sludge will remain):

i) The mill objective of 3.6 tonnes/day BOD would be consistent with a DO level greater than 5 mg/L in every reach of the river if the flow is 35,400 litres/second.

ii) The maximum allowable loading estimated by the Ministry, 5.4 tonnes/day BOD, would not give a DO level of at least 5 mg/L in reaches 3 and 4 of the river, at a flow of 35,400 litres/second. This discrepancy, admittedly a small one, seems to have been overlooked in the Ministry's analysis which concentrated on reaches 1, 5, 9, and 13. A DO level of 5 mg/L is exceeded in these reaches.

iii) The least cost discharge of BOD with the highest rate of effluent charge considered in this study (6,6 tonnes/day) gives a DO level of 4 mg/L or more in each reach, with a flow of 35,400 litres/second. This would meet the minimum DO level specified in the 1965 directive from the Ontario Water Resources Commission to all mills. (see Chapter 6).

iv) At the lower river flow of 24,355 Litres/second (the 7Q20 value based on 1953-1977 data) none of the levels of BOD considered gives a DO level of at least 5 mg/L in all reaches. This includes the Ministry's objective of 3.6 tonnes/day BOD which supposedly would not use all the assimilative capacity of the river even under low flow conditions that only recur, on average, once in 20 years.

- Analysis of the results without sludge

(The absence of the sludge means a reduction in the oxygen demand of benthic organisms and a greater capacity of the river, at any flow, to assimilate BOD.):

i) At a flow of 35,400 litres/second, BOD discharges of 3.6 and 5.4 tonnes/day give DO levels greater than 5 mg/L in all reaches. Even at 6.6 tonnes/day the DO falls below 5 mg/L in only 2 reaches, and then only by 2%, well within the range of error in the model.

ii) With a flow of 24,355 litres/second the Ministry's objective for the mill of 3.6 tonnes/day BOD gives a DO level that exceeds 5 mg/L in all reaches. All the other levels of BOD considered fail in this regard.

Before moving beyond a consideration of DO levels per se, one further point is worth noting. Under present conditions in the river, with the sludge bed, the model estimates zero levels of DO in some reaches, at a flow of 24,355 for the three highest levels of BOD discharges. Even the highest of these BOD levels (15.8 tonnes/day) is considerably lower than the 25 tonnes/day that typifies the mill's loading over the past decade. It would seem likely, therefore, that DO levels at or near zero would have been observed in the Spanish River downstream from the mill sometime in the past few years.

As the previous discussion of Ontario's water quality monitoring data indicated, the statistical record is far from complete. The measured levels of DO for the years 1970-1978, at the first monitoring station 9.6 kilometres downstream from the Eddy mill, never fell below 8 mg/L, let alone 5 mg/L, and never approached zero. (At the station 11 kilometres further on the DO did go to 3 mg/L in February 1973 and to 4 mg/L in August 1975). One reason for this good record is that in the years 1970 to 1975 the annual 7 day average low flow level in the Spanish River was above the historic mean. Another possible reason for the lack of any observed low levels of DO is that the parameters of the model were estimated from observations when the flow in the river was 72,200 litres/second, and they may not remain unchanged when the flow is less than one third of this

level. Consequently, it may be that the model is inaccurate when simulating the impact of BOD on low river flows and such low levels should not be expected.

In light of this second possibility, it is unfortunate that in 1976, when the 7 day average low flow level in the Spanish River went as low as 18,125 litres/second, the Ministry did not measure the DO level at either of the monitoring locations downstream from the mill. Apparently, this was due to staff turnover in the region during this period. Curiously, enough, the Ministry did monitor the DO level upstream from the mill at this time. A valuable opportunity to improve the accuracy of the model, and possibly to revise the mill's BOD objective has been missed.

7.4.2 The Relationship Between Dissolved Oxygen and Sports Fishing Benefits

The Provincial Water Quality Objective for dissolved oxygen is intended to be satisfactory for aquatic life and recreation. Among the range of benefits that a river of this quality can provide is the opportunity for sports fishing. Whether or not such a river will support this activity also depends on other characteristics of the river, its accessibility and its proximity to population centres.

The Water Quality Study of the Lower Spanish River says about the Spanish River basin that "because of its proximity to large growth centres and transportation routes in Northern Ontario complemented by its natural beauty, (the river) offers excellent potential for recreational uses".[14] There is also evidence that the river used to support commercial fishing and so there can be little doubt that given the appropriate water quality conditions the Spanish River could become an important sports fishery. Bearing in mind the close relation between a river's ability to support

a sports fishery and its suitability for other beneficial uses, further examination of the Spanish River's potential as a sports fishery seems warranted.

Among the conditions necessary for fish to thrive in the Spanish River is the maintenance of an adequate DO level, reduction of substances that cause odour and fish tainting, reduction of substances toxic to fish, and reduction of the sludge bed which is an unsuitable habitat for fish. The 1977 Control Order calls for the mill to adopt measures by 1982 that will reduce the level of toxicity in the mill effluent to meet federal guidelines. Recognizing that the mill has made considerable progress in reducing discharges of suspended solids and phenolic substances (which cause fish tainting), the DO level in the river is becoming a critical variable for determining its suitability as a sports fishery. At any rate, the emphasis that the Ministry is giving to the reduction of BOD in regulating this mill and the rationale for the DO objective, is consistent with this interpretation.

In 1977 some researchers at the University of Toronto designed a Sports Fishery Benefit Index (SFBI).[15] This index relates the quality of a river to its potential as a sports fishery. It does not estimate the value of sports fishing benefits in dollars. Instead it purports to measure the proportion of the maximum potential benefits from sports fishing that could be obtained from a river for varying levels in its quality. In particular, the index treats DO as the critical variable for determining the survival rates and growth rates of numerous fish species. The index incorporates a simple ecological model which relates these rates to the expected level of DO in the river. It is described in more detail in Appendix D.

The SFBI has been employed, with interesting results, on a study of water quality management options of the Lower Thames River.[16] One conclusion reached in the study was that "policies will be evaluated differently by the SFBI than they would by a simple criteria of maintaining a single minimum DO level".[17] The reasons for this is that the value of the index is sensitive to fluctuations in the DO level over the duration of a year (or any chosen time period). It does not concentrate exclusively on avoiding a short period of time in which the DO falls below some fixed level such as 5 mg/L. The likelihood of occurrences of this sort do influence the value of the index, but at the same time, expected DO values greater than 5 mg/L affect the SFBI positively.

This attempt to compare different temporal patterns in the DO level of a receiving water rather than consider only the worst conditions is consistent with the finding that the critical levels of DO for fish survival and growth, "vary significantly among the various species of fish of interest to anglers. This suggests that there is not a single sharp threshold level of DO, below which all fish are lost, but that there is a range of DO levels over which the fish stock is reduced as lower levels become more prevalent".[18]

To have used the SFBI in the present study would have required extensive use of the DO model for the Spanish River to simulate daily DO levels over a long time period. A different approach was taken; one that is more in keeping with the provincial policy of prescribing BOD objectives for mills that will give a satsifactory water quality under extreme low flow conditions.

When considering only short periods of potentially low DO levels, the impact on fish growth can be ignored. The only important question relates to fish survival. Using data on DO levels and the support of fish species gathered by Everson and Braune,[19] a fish survival factor was estimated for the river conditions and BOD loadings shown in Table C.1, Appendix C. This simplified version of the SFBI was calculated in the following manner:

- Proceeding downstream from the mill, the DO levels estimated by the model for each adjacent pair of reaches were compared. For calculating the index, the lower of the two values was used so that, in any stretch of the river consisting of two reaches, the minimum estimated DO level was used.

- With sludge present the first 5 reaches of the river cannot support sports fish and so the survival factor for each of these reaches was set at zero. (This assumption may be too strong in that the sludge deposits do not cover the entire river bottom and so some fish might survive.)

- Fish species that could be expected to survive in the Spanish River were identified by referring to historical records of fish life in the River.[20] The weights describing the sports fishing desirability of these species were taken from Everson and Braune, and are shown in Table 7.9.

- The length of each reach was used for the weights describing accessibility; a quite reasonable assumption in the case of the Spanish River which has a highway adjacent to it from Espanola to the North Channel.

Table 7.9

NATIVE FISH COMMUNITY OF SPANISH RIVER AND ASSOCIATED SFBI PARAMETERS

Sensitivity Group	Common Name of Fish Species	Angling Desirability Rating	Sensitivity Group Weighting
A	-----	-----	0
B_1	Smallmouth Bass	6	28
	Walleye	6	
	Redhorse Sucker	4	
	Dore	6	
	Yellow Pickerel	6	
B_2	Largemouth Bass	6	12
	Rock Bass	6	
B_2	White Sucker	4	14
	Bluegill	6	
	Pumpkinseed	4	
D_1	-----	-----	0
D_2	-----	-----	0
C	Yellow Perch	6	13
	Minnow	1	
	Perch	6	
E	Brown Bullhead	4	4

Source: Pollution of the Spanish River, a report to the Special Committee of the Research Council of Ontario,
J. R. Dymond and A. V. Delaporte
Research Report #25, Ontario Department of Lands and Forests, Division Research, September 1952.

Results Obtained with the Simplified SFBI

Table 7.10 is a reproduction of the results from the Ministry's Water Quality Model presented on Table C.2 in Appendix C. The penultimate row of the table shows the survival factor calculated for each set of river conditions and BOD loadings. It is a weighted aggregate of the survival factors for each species that would normally be expected to inhabit the Spanish River (i.e., all other conditions for fish survival are assumed to be satisfied.) Since the river flow is a 7-day average, the percentage of fish surviving after this period of adverse conditions can be estimated by raising the survival factor to the power 7. (Variations about this average flow would affect the percentage of the population surviving after 7 days, but this possibility is neglected here.) These percentage survivals, again weighted by reach length and fish desirability are shown in the last row of Table 7.10.

Given the assumption that DO is the only factor affecting fish survival, the case with sludge is not considered. The results may be summarized as follows:

i) The survival factor is equal to unity for mill loadings up to 12.2 tonnes/day for a river flow of 35,400 litres/second and up to 6.6 tonnes/day for a flow of 24,355 litres/second. Therefore, under the flow conditions assumed by the Ministry of the Environment (35,400 mg/L) fish life would not be threatened even with a BOD loading almost 4 times as great as the mill's objective.

ii) As soon as the survival factor dips below unity, the percent surviving after a 7-day period drops off rapidly. (For example, a .76 survival factor implies the elimination of some 85% of the fish after 7 days.) This supports the notion of a threshold value for DO when relatively long time periods are considered (i.e., 7 days rather than 24 hours).

Table 7.10

WATER QUALITY MODELLING RESULTS FOR THE SPANISH RIVER

(Without Sludge)

Initial Flow in (litres/s)		35,400*						24,355*					
Mill Loading BOD_5 (tonnes/day)		3.6	5.4	6.6	10.9	12.2	15.8	3.6	5.4	6.6	10.9	12.2	15.8
River Reaches Downstream of Mill Outflow	Reach Length & Distance From Outflow (Km)	Dissolved Oxygen at Reach End (Mg/L)						Dissolved Oxygen at Reach End (Mg/L)					
1	0- 4.4	6.78	6.55	6.38	5.82	5.65	5.18	6.38	5.93	5.62	4.53	4.21	3.29
2	4.4-11.4	6.32	5.76	5.37	4.02	3.62	2.48	5.53	4.54	3.85	1.44	0.73	0
3	11.4-18.5	6.17	5.46	4.96	3.22	2.70	1.25	5.41	4.26	3.46	0.66	0	0
4	18.5-25.6	6.21	5.44	4.90	3.03	2.47	0.90	5.63	4.49	3.70	0.95	0.12	0
5	25.6-26.6	6.44	5.77	5.31	3.69	3.20	1.84	6.07	5.15	4.52	2.30	1.64	0
6	26.6-30.0	6.47	5.80	5.34	3.72	3.23	1.87	6.10	5.20	4.57	2.39	1.73	0
7	30.0-31.4	6.53	5.87	5.41	3.81	3.32	1.98	6.24	5.38	4.78	2.69	2.06	0.31
8	31.4-33.0	6.54	5.88	5.42	3.82	3.34	1.99	6.25	5.39	4.79	2.71	2.08	0.34
9	33.0-36.7	6.60	5.95	5.49	3.91	3.43	2.11	6.36	5.54	4.97	2.98	2.38	0.70
10	36.7-40.7	6.67	6.03	5.59	4.04	3.57	2.27	6.49	5.71	5.17	3.29	2.71	1.12
11	40.7-44.1	6.73	6.11	5.67	4.15	3.70	2.42	6.61	5.86	5.34	3.54	3.00	1.47
12	44.1-47.8	6.81	6.20	5.78	4.31	3.86	2.62	6.74	6.04	5.55	3.86	3.35	1.93
13	47.8-51.5	6.89	6.29	5.88	4.45	4.02	2.82	6.85	6.19	5.73	4.12	3.64	2.29
Survival Factor		1	1	1	1	1	.76	1	1	1	.68	.55	.23
% population surviving after 7 days		100	100	100	100	100	15.0	100	100	100	6.7	1.5	<0.1

*Input Values - River Temperature in ^{o}C = 22
- 100% Saturation Dissolved Oxygen (Mg/L) = 8.83
- Average Upstream Dissolved Oxygen (Mg/L) = 7.06

At first sight, the conclusion that may be drawn from these results is that the BOD objective for the Eddy mill is too stringent merely to protect fish life during an extended period of low flow in the Spanish River: the survival factor remains at unity for loadings above 12.2 tonnes/day BOD, a level more than three times the Ministry's objective of 3.6 tonnes/day. However, on closer inspection this BOD objective may be justified as reflecting a suitably risk averse attitude by the Ministry of the Environment. It has already been stated that the Ministry's continued use of a 35,400 litres/second flow for setting the objective seems to be an error. The 7Q20 flow for the river is now estimated to be only 24,355 litres/second. Under these flow conditions a BOD loading approaching that of the Ministry's objective for the mill is required to ensure fish survival. Moreover, the dramatic loss of fish life over 7 days when the survival factor falls marginally below 1 is an added reason for caution in setting the BOD objective. Finally, of course, the accuracy and validity of the water quality simulation model and the simplified SFBI used to generate the results is open to question. Both merit further work before any firm conclusions can be drawn with confidence.

In this regard the Ministry of the Environment has made considerable efforts to improve its capabilities in water quality modelling. Far more sophisticated models are now used by the Ministry than the one described above for the Spanish River. The same cannot be said of water quality indices such as the SFBI which have been examined by the Ministry, but have not been incorporated into its regulatory program. This is unfortunate. The examples presented in this chapter and in the paper by Dewees, Everson and Pickett show the contribution that these indices could make to a more informed approach to environmental management in general and, in particular, to regulating the pulp and paper industry. They might be useful for deciding a number of regulatory issues:

- what should the mill specific discharge objectives be?
- should the mill objectives be differentiated according to time?

- which receiving waters and locations offer the greatest potential for benefits from pollution abatement, and hence how should the regulatory authority allocate its time and resources to monitoring and enforcement?

In conclusion, this chapter has reviewed, with examples, several analytical techniques the use of which could substantially improve the information base for regulating waste discharges from the pulp and paper industry.

FOOTNOTES

CHAPTER 7

1. Although the computer program described in this section was written by staff of the Ontario Ministry of the Environment prior to the commencement of the study it had not been made completely operational. Those who did the original programming are no longer in the employment of the Ministry and some effort was devoted, in the course of the study, to debugging and reprogramming.

2. These comments on the nature of the environmental problems at these mills and the expected benefits from abatement are based on the following sources: Control Orders for the mills; Ontario Ministry of the Environment, Alternative Policies for Pollution Abatement, October 1974 and discussions with Ministry staff. Note that the effluent from both mills is toxic to fish (see Table 5.4.).

3. Ontario Ministry of Industry and Tourism, Industrial Survey, 1973.

4. All of the information in this and the following sections was provided by the Ontario Ministry of the Environment. Some of the information originates with the companies but all of it is considered by the Ministry to be in the public domain.

5. When air pollution abatement options for the Eddy mill were analysed with WATAP, the number of feasible treatment plans exceeded 380.

6. Any of these assumptions can be changed when running WATAP.

7. Ontario Ministry of the Environment, Water Management, op cit, 1977.

8. Ontario Ministry of the Environment, Water Quality Study of the Lower Spanish River, 1972.

FOOTNOTES - CHAPTER 7 cont'd.

9. The selection of 7Q20 for this purpose is currently under review in the Ministry.

10. Ontario Ministry of the Environment, News Release, Feb. 20, 1980.

11. Ibid.

12. This part of the study was greatly aided by assistance from The Water Resources Branch of the Ministry.

13. Ministry of the Environment, Low-Flow Characteristics of Streams in Northeastern Ontario, Water Resources Map 3005-4, 1979.

14. Water Quality Study of the Lower Spanish River, op. cit.

15. Everson, C.K., and Braune, B., "A Sports Fishery Benefit Index" University of Toronto, Institute for Environmental Studies, Discussion Paper W-5, 1977.

16. Dewees, D.N., Everson, C.K., Pickett, E.E., "Analysis of Water Quality Management Policies: A Case Study of the Thames River" submitted for publication to the Journal of Economics and Environmental Management.

17. Dewees, Everson and Pickett, op. cit. p.54.

18. Dewees, Everson and Pickett, op. cit. p.53.

19. Everson and Braune, op. cit.

20. Pollution of the Spanish River, op. cit.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

The discussion and analysis in this study has been conducted at several levels. It has included an overview of the legislation most relevant to controlling pollution from the pulp and paper industry. The mechanics of the federal regulatory process were reviewed and that of Ontario was examined in considerable detail. With the use of rather aggregated data, the compliance record of the industry in each region over the past decade was considered. It was shown that progress towards meeting the federal requirements has been achieved though at a lower rate than expected by the federal authorities. A more detailed consideration of the situation in Ontario revealed that this improvement at the aggregate level did not reflect a uniform pattern among the individual mills. Some mills have done better than the average, others far worse, including some which have shown absolute increases in BOD and suspended solids discharges. To gain a fuller understanding of the issues at the level of specific mills, a close look was taken of the technical abatement options of two in particular. For one of these, the results of the technical and economic analysis were used with a river quality simulation model to highlight yet more detailed aspects of the regulatory process. It also showed some of what could be learned through technical, economic and biological analysis that might be useful in regulating pulp and paper mills.

Proceeding in this way, the comprehensive but somewhat shallow treatment of national and regional issues has been complemented by the much more focussed account of the situation of individual mills. By virtue of the often inadequate data, and the rather selective way with which much of them have been used in this study, the conclusions that flow from the analysis are necessarily tentative. Nevertheless, in comparison with what was known about the industry and its problems when the existing regulatory systems were developed, the content of the previous chapters, taken in conjunction with other studies that have dealt with similar

issues, offers a reasonable basis for formulating recommendations to improve the regulation of the pulp and paper industry to protect the environment.

8.1 Conclusions About the Regulatory Process

The picture that emerges of the way in which the pulp and paper industry is regulated in Canada, and especially in Ontario, has the following characteristics:

i) Ultimate, long-term objectives are set by a process from which affected groups are excluded. Industry participates when federal objectives are established. In Ontario only civil servants are involved. In B.C. the process is more open. (See Chapters 3 and 6.) At the federal level these objectives are defined in terms of the "best practicable technology." In Ontario they are ambient water quality objectives, intended to ensure suitable conditions for aquatic life and recreation.

No attention is given in setting these objectives, to balancing costs and benefits. Cost considerations do enter, implicitly, in the technology based federal objectives, but they are not compared with benefits. Clearly, two mills of the same size, with the same output, using the same production processes will not damage the environment to the same extent if they are located on receiving waters of different assimilative capacities and/or where competing uses of the water differ. Hence, maximum net benefits from pollution abatement will not be achieved if both mills are limited to the same level of wastewater discharges, yet this is how the federal objectives apply.

ii) Individual compliance programs are negotiated for each existing mill, again with little or no public input. (In B.C. the issuing of a Discharge Permit can become the subject of a public hearing and in Ontario, Amendments to Control Orders are now approved only after a public meeting.) The benefits to be obtained from compliance with the long-term discharge objectives for each mill are not evaluated systematically, though some documentation of current impacts may be prepared by the companies or by the regulators, and used in justifying Control Orders or other similar instruments. The costs of abatement and what the companies say they can afford, appear to be very important factors in determining the rate of compliance that finally is approved. (See Chapters 3 and 6.)

iii) Most of the emphasis in the regulation of the industry has been placed on securing reductions in suspended solids and BOD. (See Chapters 3 and 6.) Substances which cause fish tainting have also received attention. More recently the control of toxic discharges has been given prominence and in future this may become the primary or only concern of Environment Canada with respect to wastewater discharges from the pulp and paper industry. It is also possible that the federal government's focus on toxic discharges will be extended from the present concern with acute toxicity to fish to broader and more remote impacts of toxic discharges on the environment.

iv) Despite some considerable reductions in suspended solids and BOD discharges, the expectations of the regulatory authorities regarding future reductions have been consistently too high. (See Chapters 2 and 5.) The availability from 1979, of federal and provincial subsidies for abatement in Ontario and Quebec is used, by those involved in regulating the industry, to support the view that, from now on, the expected compliance rates will be achieved. Some skepticism seems justified, however, if only because companies which do not spend funds on the approved expenditures for pollution abatement only forfeit a prorated portion of the grant. In other words, the penalty for non-compliance is no different from what it was before the grants were introduced.

v) By introducing these subsidy programs the principle of 'polluter pays', espoused by federal and provincial governments, has been compromised. Furthermore, the administration of these subsidies has further increased the discretionary powers of civil servants in regulating the industry to the exclusion of any public input.

vi) Considerable reliance for effluent data is placed by the regulators on the results of the mills' self-monitoring programs. Monitoring of the receiving waters in Ontario by the Ministry of the Environment (usually considered to be the most comprehensive of all the provinces) has produced results which are often incomplete and unsuitable for establishing trends in water quality (See Chapter 5). Hence, there is little direct evidence of improvements in the surface water quality in the province where the pulp and paper mills are located.

vii) On the relatively few occasions that pulp and paper companies have been prosecuted for causing water pollution, the courts have imposed fines well below the maximum specified in the legislation. (See Chapters 3 and 6.) From a company's viewpoint the expected value of such a fine must be extremely small in that it reflects the combined probabilities of being detected, being prosecuted, being convicted, and the likelihood of a small fine. From this perspective, pollution is often a cheaper option than pollution abatement. In the case of pulp and paper companies, the potential loss of sales due to a poor public image is minimized by the fact that most of the industry's output is not sold to final consumers under the name of the producing company. Even if some consumers wanted to favour companies having good abatement records, they would seldom have the information to discriminate in this fashion.

Inadequacies in the regulatory process have led to many changes, some of which are still being implemented. In Ontario, for example, there is:

-- an increasing effort to enforce Ontario's environmental protection legislation with the establishment, in 1980, of a Special Investigation Unit. This unit consists of 13 full-time staff trained in enforcement procedures, distributed among the Ministry of Environment's regional offices. A police officer has been seconded for one year to the Ministry to support this activity;

-- an increasing involvement of the public in amending Control Orders;

-- an increasing requirement for the regional offices to provide documentation in support of Control Orders, Amendments to Control Orders and proposals to prosecute offending companies. This documentation should include material on social and economic factors as well as environmental ones, (though little progress has been made by the Ministry in specifying appropriate methodologies and content).

Increasing the opportunities for public involvement may introduce into Ontario's regulatory process information that is relevant to identifying and evaluating the benefits and costs of pollution abatement by the pulp and paper mills. It may also increase the credibility of the process itself in the eyes of the public and the industry. An effect of the requirement for improved documentation on benefits and costs, especially if it is made public, will likely be to improve the information on which the Ministry can base the design and enforcement of its mill specific compliance programs. It will also help reduce the uncertainty about whether the costs of abatement measures are justified in terms of their benefits from improved water quality and enhanced water uses.

Environment Canada is also reviewing its approach to environmental protection regulation. The main thrust of the changes being considered involves a concentration of effort on the regulation of toxic substances. If implemented, possibly by means of new legislation, it will mean that the provinces will be left to themselves to regulate BOD and suspended solids. In British Columbia, where some friction is reported between the regional office of Environment Canada and the provincial Ministry of the Environment, this may be seen as an improvement. In other regions where relations between the provincial and federal offices seem unproblematic, and do not involve a duplication of effort, this specialization of the federal level will not necessarily be an improvement. Unless some other provision is made by Environment Canada to assist the Atlantic provinces in regulating the pulp and paper industry, it may turn out to be a retrograde step in the Atlantic region.

These changes in the regulatory process both in Ontario and at the federal level will go some way to reducing the deficiencies summarized in Section 8.1. However, there are several other aspects of the regulatory process, again focussing on Ontario, that seem ripe for improvement and these may be related to the major components of the process as it presently exists:

-- setting ambient water quality objectives
-- setting individual compliance programs
-- monitoring receiving waters
-- monitoring effluent discharges
-- enforcement
-- providing financial assistance

The recommendations that are stated below are based on the findings reported in the previous chapters. Their overall thrust is that mill specific discharge objectives should be established through an open process and compliance with these objectives should be assured through

an open process and compliance with these objectives should be assured through the deployment of a powerful, non-negotiable economic incentive. Such an approach stands in marked contrast to the system which has prevailed to date in which compliance programs are negotiated between the Ontario Ministry of the Environment and the pulp and paper companies. These programs are revised periodically with the result that the regulatory objectives of more than fifteen years ago have yet to be achieved by many mills. (See Chapter 6.)

8.2 Recommendations

The recommendations which follow (R.1 - R.6) for improving the regulatory process (specifically in Ontario, though relevant to other jurisdictions with similar problems), have not been developed in sufficient detail to indicate precisely how they would be implemented if accepted. A discussion of administrative procedures and details would not only be tedious but would divert attention from the crux of the problems being addressed and the basic rationale for the recommendations.

8.2.1 Setting Ambient Water Quality Objectives

With the publication of the Blue Book in 1978, the Ontario Ministry of the Environment set out its "goals, policies, objectives and implementation procedures" for water management. Details of the Provincial Water Quality Objectives, from which mill specific discharge objectives, are derived (see Chapter 6) are provided in the Blue Book. All waterbodies are to be brought to the level as specified in these water quality objectives. However, it is recognized that "where public hearings into proposals for new or expanded discharges are held ... such hearings may be utilized to consider" whether deviations from this policy should be allowed.

This raises the larger question of whether the Provincial Water Quality Objectives themselves, and the policies of which they form a part, i.e. the Blue Book, should be the subject of a public inquiry. An important

argument against such an inquiry derives from the fact that the background documentation is rather technical,[1] and would not be readily understood by the public at large. Looked at from a different standpoint, it is precisely the emphasis that seems to have been given to technical issues that suggests a public inquiry would be appropriate. Any water quality objective reflects value judgments regarding tradeoffs among competing actual and potential water uses. Such judgments are not necessarily best made by experts in the employ of the regulatory authority. Consequently:

R.1 *a public review of the Provincial Water Quality Objectives is recommended.*

Issues which might be addressed at such an inquiry include:

-- the desirability of uniform ambient water quality objectives versus objectives specific to location and desired water uses;

-- the level of the ambient water objectives;

-- the probability that an objective will not be achieved (i.e. should a 7Q20 river flow be assumed, or some other low flow probability? see Chapter 7);

-- whether failure to meet a water quality objective should automatically trigger some form of regulatory action or continue to be at the discretion of the regulatory authority.

A public inquiry into these issues might usefully be conducted in Ontario under the Environmental Assessment Act, in which case the Ministry of the Environment would be the proponent of the Provincial Water Quality Objectives. Alternative levels of objectives would be considered in terms of their environmental, social and economic implications. It would be the

responsibility of the Ministry to document these implications to a far greater extent than at any time previously, and to submit this documentation to public scrutiny.

The arguments in favour of public involvement in setting ambient water quality objectives are not restricted to the question of democratic rights in the abstract. Ambient water quality objectives cannot be based exclusively on "objective" scientific and technical information. The attitudes and preferences of those affected by the objectives are also important, and information on these is presently unavailable to the government except in a partial and ad hoc fashion. In addition, a more open process for setting ambient water quality objectives may add to the credibility of the objectives and provide a firmer basis for taking the necessary regulatory action to achieve them.[2]

8.2.2 Setting Individual Compliance Programs

Individual mill specific compliance programs permit a flexible regulatory approach, one which allows for important variations in mill size, age, technology and location. Until recently, these programs were established in Ontario by means of negotiations between the Ministry of the Environment and the companies. Now amendments to Control Orders for pulp and paper mills are considered at public meetings, and this procedure may be extended to new Control Orders as well.

As mentioned in Section 8.2.1 this initiative could have the effect of both introducing information relevant to the assessment of benefits and costs of pollution abatement and increasing the credibility of the process. The public meetings that have been held to consider amendments to Control Orders for several mills have been regarded favourably by the pulp and paper industry. They give companies, and the Ministry, the opportunity to inform the public and to gain support for whatever is being proposed. Insofar as there are trade-offs between environmental and socio-economic objectives, they can be considered and discussed openly.

The fact that the nature of trade-offs in specific circumstances may be difficult to determine precisely should not be taken as an argument against opening up the regulatory process. It is the uncertainty about the relation among discharges, ambient receiving water conditions, ambient concentrations of contaminants, impacts on potential uses and costs and consequences of abatement, that provides the fundamental challenge to rational regulatory decisions. The stance of the authorities towards this uncertainty should reflect the interests and concerns of the public, including industry. This can best be achieved through an open process in which all relevant documentation is available to all parties and ample opportunity is provided for discussion and critical commentary. It is in this context that such analytical tools as WATAP and the Sports Fishing Benefit Index make a useful contribution in conjunction with mill specific and industry wide financial and economic assessments. (See Chapters 4 and 7.)

R.2 *It is recommended that public involvement in setting compliance programs be increased. The following specific initiatives should be adopted:*

-- the Ministry should gazette and publicize in local newspapers all proposals for "notices of intent, program approvals, control orders, requirements and directions, certificates of approval and amendments and extensions to these".[3]

-- the public should be allowed 60 days to make representations to the Minister of the Environment on these proposals and should be given access to all relevant documentation (excluding trade secrets).

-- a public inquiry should be held when the public's concerns cannot be adequately dealt with by considering written submissions.

- a public inquiry should be held at the discretion of the Minister.

For such inquiries to be successful, further consideration would have to be given to procedural questions: who should conduct them and according to what rules; who should the inquiry report to; what, if anything, can the inquiry decide?

Though it need hardly be said, there is no reason to believe that a more open process for setting mill compliance programs will lead to more stringent requirements than have been developed in the past. It is quite possible that there will be the opposite result, especially if the companies can convince the public that pollution abatement expenditures inhibit their ability to modernize and expand employment opportunities and that the benefits from the abatement expenditures are not commensurate with this impact. Once again, more complete documentation than hitherto required by the regulatory authorities will be called for. Some of it will come from the companies and some from the regulators. Most important of all, the compliance programs that are finally adopted and imposed on the mills will have an enhanced stature as compared with the frequently amended programs that have characterized the regulatory process in the past (see Chapters 2 and 5).

8.2.3 Monitoring Receiving Waters

The introduction to Water Quality Data: Ontario Lakes and Streams states that the published data,

> "result from a routine sampling program designed to provide a long-term record of water quality information at specific points on rivers and inland lakes in Ontario.
>
> Sampling station locations have been selected to meet one or more of the following requirements:

1. to measure quantitatively and qualitatively, the materials discharged from tributary streams to the terminal basins;

2. to monitor the effects of wastewater discharges on a watercourse;

3. to provide data that can be considered generally representative of water quality conditions in a certain area.

The information is used by the Ontario Ministry of the Environment to maintain surveillance over water quality and to provide supporting data used in the analysis and prediction of water quality for planning and other purposes".[4]

In the course of this study the water quality data for points proximate to Ontario's pulp and paper mills during the summer months since 1970 were examined. For all but 5 mills the data proved insufficient for performing simple time series analysis of the differences in upstream and downstream measures (see Chapter 3). Clearly, the conspicuous gaps in the data for those locations close to some of Ontario's most important industrial point sources suggest that the data may be unsatisfactory for the intended purposes.

Even if the data were more complete, it is questionable whether information gathered from routine monitoring programs are suitable "for identifying subtle changes in aquatic environmental conditions resulting from changes in loadings of substances such as suspended solids or BOD. Surveillance stations to monitor relatively minor changes in environmental quality resulting from small scale loading changes at a mill can be established but they would have to be far more sophisticated, costly and manpower consuming than the routine monitoring network stations".[5]

In light of this comment one can only wonder how useful the monitoring data really are to the Ministry of the Environment or to anyone else. The pulp and paper mills are commonly major sources of BOD and suspended solids and Ministry policy has called for very significant reductions in waste loadings, some of which have been achieved. If the water quality monitoring data are inadequate for detecting the extent of improvement

in these cases, then it is doubtful under what other circumstances and for what other purposes they can be used in their present form. Therefore:

R.3 *It is recommended that the Ontario Ministry of the Environment review the purposes, costs and adequacy of its routine water quality monitoring program.*

8.2.4 Monitoring Effluent Discharges

Pulp and paper mills are responsible for monitoring their own effluent discharges. The results are submitted to the Ministry of the Environment which also conducts a spot check monitoring program.

This arrangement is reasonable since it places most of the burden of the costs of discharge monitoring on those responsible for the discharges. What is lacking, however, is a systematic record of these discharges readily accessible to Ministry staff and the public. An attempt was made some years ago by the Ministry to store discharge data on a computer but this work has not been pursued, despite the importance of up-to-date, retrievable, complete data on discharges for monitoring abatement efforts.

R.4 *It is recommended that the Ministry review this data-processing effort and consider the costs and benefits of its further development.*

This will become especially important if steps are taken to open up the regulatory process further, since it will facilitate public access to these important data.

8.2.5 Enforcement

This study has shown a preference among the regulatory authorities in Ontario and throughout Canada for negotiation and compromise rather than for prosecution on a routine basis (see Chapters 5 and 6). Since 1977

in Ontario, the Ministry of the Environment has adopted a somewhat different approach with respect to the pulp and paper industry. Most mills have been placed on Control Orders and a few companies have been prosecuted. With the announcement in 1979 of the federal/provincial funding program for modernization and pollution abatement in the pulp and paper industry Ontario officials believe that the terms of the Control Orders now in force will be adhered to. As noted in section 8.1 the possibility should not be ignored that companies will continue to apply for Control Order Amendments and some may not spend all of the portion of the grants received for pollution abatement. It may be cheaper for them merely to forfeit some of the grant and to resume negotiations with the Ministry of the Environment. Much depends on how the possibility and consequences of prosecution for non-compliance with the Control Orders is perceived by the companies.

An alternative approach to enforcement has been discussed in the economics literature for some years, involving the use of an automatic financial penalty for pollution.[6] Some aspects of a simple effluent charge were discussed earlier (see Chapter 7). Variants of an effluent charge have been in use for years in several European countries,[7] and in Canada sewer surcharges have proved to be effective for inducing reductions in waste loadings.[8] The Canada Water Act, 1971 makes provision for an effluent charge but the federal government has not taken steps to implement a charge scheme in Canada.

There are numerous arguments for and against an effluent charge and many types of charge schemes have been proposed and implemented. The view adopted in this study is that for dealing specifically with a small number of major industrial waste dischargers that have failed to meet compliance targets, a type of charge scheme sometimes referred to as a pollution control delay penalty is most appropriate.

A pollution control delay penalty is intended to provide an incentive for a company to comply with a schedule of pollution abatement. An example of the scheme would be as follows. Each mill would be given a schedule specifying the maximum allowable 30 day average of, say, BOD and suspended solids. This allowance would decline over time, at a prescribed rate, until the objective for the mill was achieved. The schedule, possibly written as a Control Order, would state the initial allowable discharge, the rate of reduction and the ultimate objective for the mill. If a mill deviates from its schedule, so that its wastewater discharge exceeds the allowed amount in any period, an automatic penalty is imposed. The size of the penalty would be based on the amount of the excess discharge, multiplied by a rate per unit of BOD or suspended solids. Thus, large excess discharges would be penalized proportionately more than smaller ones.[9]

The size of the penalty rate should be high enough to make compliance with the schedule more costly than delay. This is the essence of the scheme. It would make pollution abatement cheaper than pollution, which is the opposite of the prevailing situation. (A model such as WATAP would be useful for estimating effective penalty rates; see Chapter 7).

For a pollution control delay penalty to work, wastewater measurement techniques would have to be approved, such as in the Federal Pulp and Paper Effluent Regulations.[10] Disagreements over the wastes discharged would, no doubt, arise but these could be resolved by a tribunal or in court if necessary. Unlike the present situation, the tribunal or court would not have to decide whether actual environmental damage had occurred, nor would it be required to impose a fine. (False reporting of test data is another matter of course.)

Another feature of the penalty scheme is, that to the extent it works, it will not generate revenue for the government. If large revenues do begin to accrue then it will be a direct signal that the penalty rate is too low to avoid delay in pollution abatement and should be raised. Provision for adjusting the rate periodically should be built into the scheme.

Difficulties may arise if it is found, through further work, that the costs of abatement vary so much from mill to mill that the same penalty rate is not suitable for all mills. Rather than set different rates for each mill or group of mills, the rate estimated to be necessary to secure compliance at the mill where abatement costs are highest could be imposed on all mills. Alternatively, unless there were compelling environmental reasons for requiring some mills to spend far more per unit of abatement than others, large differences in abatement costs among mills should lead to revisions in the proposed compliance schedules and the abatement objectives themselves.

It may be thought unfair to impose a pollution control delay penalties a single industry. A more acceptable approach in all respects would be to include all industrial (and municipal?) sources that exceed some qualifying level of discharge. This would eliminate some of the small pulp and paper mills from the scheme and bring in a modest number of plants in such industries as iron and steel, chemical and petrochemicals, food processing and metallurgical.

A scheme of this sort would reduce the discretionary power of the regulatory authority to renegotiate abatement agreements. In part this is what the scheme is intended to do. What this will mean, however, is that the compliance schedules will take on added significance for the companies: the costs of non-compliance will be obvious, unavoidable and high. Companies may feel they cannot afford what the Ministry is proposing by way

of abatement, and the social and economic consequences of an error in this matter could be serious for the company and the towns in which the mills are located. For this reason, the introduction of a delay penalty complements the recommendation to open up the regulatory process to public input. Those likely to be affected by efforts to achieve too much abatement, as well as those concerned about too little, should be involved in setting the long term abatement objective for a mill and the rate at which it is to be achieved. Once decided, there are good reasons to believe that a pollution control delay penalty will be successful in securing a compliance rate far superior to that which has been achieved in the past.

The case for a pollution control delay penalty in Ontario appears compelling given the existing regulatory context. Control Orders are already used to establish abatement schedules. It is only the penalty for non-compliance that would be affected. Even the emphasis on wastes discharged rather than on technology employed is in line with the direction in which the Ontario Ministry of the Environment has been moving.

For all of these reasons:

R.5 *It is recommended that a pollution control delay penalty be introduced for ensuring compliance with mill specific pollution abatement schedules.*

8.2.6 Providing Financial and Other Assistance

The provision of financial assistance to pulp and paper companies for pollution abatement compromises the "polluter pays principle" subscribed to by provincial and federal governments, and endorsed by Canada as a member country of the Organization for Economic Cooperation and Development.

Even if financial assistance were to be provided ostensibly for modernization purposes alone, it could not be effectively restricted to that purpose. Modernization expenditures frequently result in pollution abatement. In addition, some of the expenditures for modernization would in all likelihood, have been undertaken without government assistance. Thus any inflow of funds to the industry, even if earmarked for particular (non-abatement investments, improve the industry's capacity to fund other abatement expenditures.

From a somewhat different perspective, financial assistance for pollution abatement combined with a determined effort to enforce abatement requirements, represents the substitution of one form of subsidy for another. In the past, abatement requirements for some mills have been lower than they would have been had the industry been more prosperous. Environmental objectives were traded off against economic and social ones. At least, this is what the regulatory authorities believed they were doing. To allow companies to make excessive use of receiving waters for waste disposal constitutes a form of subsidy: an environmental subsidy. Though difficult to measure, the cost of the subsidy is the extra damages from the pollution of the receiving waters.

One clear advantage of providing financial assistance in place of relaxed environmental requirements is that the extent of the assistance can be easily determined. Another advantage is that the relationship between the policy to assist companies and the reason for the assistance becomes more obvious. There are several ways in which a community can be aided by the government; providing assistance to a pulp and paper company is only one. And there are several ways in which pulp and paper companies can be assisted; reduced pollution abatement requirements is only one. Consequently,

R.6 *It is recommended that any decision to exempt a company from meeting abatement requirements be seen as an instrument of social and economic policy and compared with others that might be more appropriate.*

In many respects, the joint federal/provincial funding programs are not only consistent with this recommendation but anticipate it. Funds are being provided in the belief that the modernization and abatement that will be encouraged will confer benefits on society as a whole. Moreover the information required by the governments from those companies applying for assistance is an example of the kind of detail that can reasonably be expected from companies objecting to compliance schedules on the grounds that they are too costly. Considerations of confidentiality may prevent data of this sort from being publicly available though this should not be assumed without further discussion.

This brings to a close the conclusions and recommendations of this study regarding the regulation of the pulp and paper industry in Ontario. Many of them also apply to other jurisdictions in other industries, discharging other kinds of pollutants. More could be offered by way of recommendations, about the importance of improving communications within and among the regulatory authorities (see Chapter 7). The need for greater monitoring of successes and failures, both for self-management and public review, is also apparent from the findings of this study. (Once more the progress that is being made in Ontario in this as in other areas must be noted. The Ministry of the Environment's adoption of "management by results" represents a moye in this direction.)

It is to be hoped that all of the problems of environmental regulation that have been addressed in this study, and the recommendations for dealing with them, will provide some assistance in regulating the pulp and paper industry in a balanced way.

CHAPTER 8

FOOTNOTES

1. See for example, Rationale for the Establishment of Ontario's Provincial Water Quality Objectives, Ontario Ministry of the Environment, September 1979.

2. Recommendations for greater public participation in environmental decision making were made at a Workshop on Public Participation sponsored by the Standing Committee on Social Sciences, Economics and Legal Aspects of the International Joint Commission's Research Advisory Board. See Proceedings of a Workshop on Public Participation, P. Bonner and R. Shimizu (eds.) June 1975. Similar recommendations were also made by the Ontario Royal Commission on Electric Power Planning, Final Report Volume 1, February 1980. The Commission also recommended that funding be provided for public interest groups to enable them to participate.

3. This was proposed in the Final Report on Acidic Precipitation, Abatement of Emissions from the International Nickel Company Operations at Sudbury, Pollution Control in the Pulp and Paper Industry, and Pollution Abatement at the Reed Paper Mill in Dryden, October 1979; Legislature of the Province of Ontario, Standing Committee on Resources Development.

4. Ontario Ministry of the Environment Water Quality Data for Ontario Lakes and Streams, 1978 Vol. XIV, p.v.

5. Communication from the Ontario Ministry of the Environment.

6. This literature is examined by D.N. Dewees in Evaluation of Policies for Regulating Environmental Pollution, a report to the Economic Council of Canada Regulation Reference, February 1980.

7. R.W. Johnson and G. Brown Jr. Cleaning Up Europe's Waters Praeger Publishing Co. 1976.

8. A. Penman "The Experience with the Effluent Charge Scheme of the City of Winnipeg" paper presented to the Department of the Environment, February 14, 1974.

9. A more detailed account of a pollution control delay penalty may be found in Alternative Policies for Pollution Abatement: The Ontario Pulp and Paper Industry, Ontario Ministry of the Environment 1974. See also the discussion in D.N. Dewees op. cit.

10. Environment Canada, Pulp and Paper Effluent Regulations, Report EPSI-W-72-1, Water Pollution Control Directorate, November, 197.

APPENDIX A

Water Pollution Abatement Technologies

for the Pulp and Paper Industry

WATER POLLUTION CONTROL TECHNOLOGIES IN THE
PULP AND PAPER INDUSTRY

PROCESS	APPLICATION	EFFECTIVENESS *	COST *	REMARKS
INTERNAL				
1. Air Stripping	Stripping of sulfur and organic compound from evaporator and turpentine underflow condensates.	BOD - 15-40% Total reduceable sulfur compounds - 95%		. Stripping efficiencies are Ph and mixing ratio dependant, (Low) . Multi-effect condensing units can be installed to isolate specific condensates for special treatment thereby reducing the flow through those units.
2. Steam Stripping	Same as above.	BOD - 40-90% Ethanol - 75% Total reduceable sulfur compounds - 99%	Capital - $850,000 O & M - 11.21/1,000 gals. wastewater All costs are U.S. for 200 gpm system	. Can be operated in conjunction with turpentine decanter with recovery of up to 95%. . Effluents from this process can be sewered or returned to chemical recovery system for incineration and process heat.
3. Dry Barking	Removal of bark in the woodroom	BOD - reduced by 2.5 lb/ton Flow reduced by 300-500/gal/ton		. As bark is relatively dry upon leaving this plant it will not need further pressing before incineration.

TABLE 6 (continued)

WATER POLLUTION CONTROL TECHNOLOGIES IN THE PULP AND PAPER INDUSTRY

PROCESS	APPLICATION	EFFECTIVENESS *	COST *	REMARKS
4. Oxygen Bleaching	Replacement of chlorination stage of bleach process.	BOD - 80-90% TDS or colour - 80-90%		. Oxygenation processes can also be applied during pulping process with similar effluent reductions and greater total yield. . As this cuts out chlorinations the corrosiveness of bleach plant effluent is reduced and it can enter normal kraft recovery systems. . Up to 95% BOD and TDS reduction can be achieved through a complex separate bleach plant effluent treatment.
5. Pulp Washing and Thickening	Use of more effective filtration devices with extensive water reuse in cleaning of pulp.	TSS - 20-80% TDS - 70-80% BOD - 70-80% FLOW - 80-90%		. Use of vacuum filters instead of Decker gravity filters gives 5 times efficiency increase in water separation and also cuts down on fibre loss. . Efficiency of these operations is dependant on the process used, i.e. low yield bleachable kraft pulp has a high suspended solids content and as a result it is more difficult to clean and thicken.

TABLE 6 (Continued) WATER POLLUTION CONTROL TECHNOLOGIES IN THE PULP AND PAPER INDUSTRY

PROCESS	APPLICATION	EFFECTIVENESS *	COST *	REMARKS
EXTERNAL				
6. Primary Treatment	Use of clarifier and/or settling basin to remove suspended solids by sedimentation.	TSS - 65-95% BOD - 20-90%		. Efficiency is dependant on pulping process and de-inking mills with low TSS show poor reduction percentage because of fine graine nature. . BOD reduction is proportional to amount of BOD containing in suspended solids, (high for coarse paper and board mills). . Coagulating or flocculating chemicals can be added to increase settling efficiency. . Units either have mechanical sludge collection devices or are periodically cleaned, which imposes extra costs and a solid waste disposal problem.
7. Secondary Treatment	Reduction in BOD by: (1) Activated Sludge	BOD - 70-90% Colour - 10-15%	10-40¢/1,000 gal.	. Reaction rate is temperature dependant and waste waters have to be cooled if above 110' . Process is vulnerable to shock loads and requires approximately 1.0 acre/mgd for normal use. . Secondary clarifiers extract up to 98% of TSS giving extra loadings at the end of the process.

TABLE 6 (continued)

WATER POLLUTION CONTROL TECHNOLOGIES IN THE PULP AND PAPER INDUSTRY

PROCESS	APPLICATION	EFFECTIVENESS *	COST *	REMARKS
	(2) Aerated Stabilization Basin	BOD - 60-90%	10-30¢/1,000 gals.	. Is subject to some temperature, solid waste and nutritional constraints as the activate sludge method. . Rotating biological contactors can be adde to improve efficient/organism contact and BOD reduction. . Process is very land intensive needing up to 90 acres/mgd depending on effluent strength.
	(3) Trickling Filter	BOD - 50-85%	10-30¢/1,000 gals.	. Is subject to temperature and nutritional constraints as in other biological treatme but it is relatively amenable to shock loa . Is useful in conjunction with activated sludge of aerated basins as it acts as a cooling and flow stabilization mechanism as well as BOD reducer.
	(4) Waste Stabilization Ponds	BOD - 50-90%	5-15¢/1,000 gals.	. Also subject to temperature and nutrition constraints. . Very sensitive to high TSS loadings. . Only recommended as a final stage at BOD reduction in areas where land is readily available. . Maximum loading is suggested at 100-300 lb. BOD/acre/day.

WATER POLLUTION CONTROL TECHNOLOGIES IN THE PULP AND PAPER INDUSTRY

TABLE 6 (continued)

PROCESS	APPLICATION	EFFECTIVENESS *	COST *	REMARKS
8. Tertiary Treatment	Colour removal by: (1) Lime precipitation.	Color - 85-95% BOD - 25-35% Organic Carbon - 50-75%		. Lime slurries of varying concentration can be added to mixed final effluents or specific high color discharges, (bleach plant) giving varying cost-effective results. . Solid wastes from this process can be introduced into kraft recovery process. . Internal measures related to pulping and bleaching processes also can reduce color.
	(2) Alum coagulation and precipitation.	Colour - 85-95% BOD - 95+ %		. Produces a solid waste disposal problem and chemicals are more expensive than lime treatment.
	(3) Hyperfiltration and Ultrafiltration	Colour - 99% Water recovery - 99% BOD - 70-95%		. Menbrane stability is temperature and Ph dependant and is also subject to cloggi
	(4) Polymeric Resins and Absorbents	Colour - 90% BOD - 35%		. Color removal efficiency is strongly Ph dependant.

TABLE 6 (continued) WATER POLLUTION CONTROL TECHNOLOGIES IN THE PULP AND PAPER INDUSTRY

PROCESS	APPLICATION	EFFECTIVENESS *	COST *	REMARKS
	(5) Ion Exchange	Colour - 95%		. Concentrated waste resin can be burned in recovery furnace.
	(6) Activated Carbon	Colour - 60-100% BOD - 35-70% TSS - 36%		. Colour and BOD reduction efficiency depends on nature of previous treatment.
9) Solid Waste Disposal	Dewatering of primary and secondary sludge	(1) Gravity tickening - 3% (product total solid %) (2) Vacuum filtration - 20% (3) Centrifugation - 25% (4) Filter Press - 30%		. The greater the concentration of solids the less disposal area and handling costs. . Addition of certain chemicals allows greate concentrations. . Solid wastes are finally sent to landfills or incinerated with subsequent air pollution loadings.
10) Mercury Removal				

TABLE 6 Addendum CAPITAL AND OPERATING COSTS OF POLLUTION CONTROL EQUIPMENT MODULES, PULP AND PAPER INDUSTRY

	Systems	Capital Cost	Operation Cost	Maintenance Cost	Depreciation Rate	Lifetime (Years)
1.	Aeration basin	. $90,000 for 1 MGD basin with 10.5 hours retention time. . Approximate flow dependance . = 4-5¢/G in this range	-	0.5 - 1.5% of Capital Cost	.016 - .040%	25 - 60 yr
2.	Condensor or Heat Exchanger	. ≈ $12,000 for 100 GPM unit . $25 - 67 /gal. in this range	-	.75 - .90% of Capital Cost	.063 %	16 yrs.
3.	Centrifugal Extractor	. ≈ $120,000 for 10 GPM Unit . ≈ $4,000-7,000/GPM in this range	.10 - .25 operators per shift	≈ 2.0% of Capital Cost	.063 - .100%	10 - 16 yr
4.	Low Pressure Fluidized Bed Reactor	. ≈ $420,000 for a 10 ft. diameter 1 stage reactor . ≈ $30,000-$40,000/ft. of variable capacity.	.25 operators per shift	≈ 2.47% of Capital Cost	.063 - .100%	10 - 16 yr

TABLE 6 Addendum CAPITAL AND OPERATING COSTS OF POLLUTION CONTROL EQUIPMENT MODULES, PULP AND PAPER INDUSTRY

	Systems	Capital Cost	Operation Cost	Maintenance Cost	Depreciation Rate	Lifetime (Years)
8.	Floatation Machine	. ≈ $6,500 for 10 ft.^{3} capacity unit . Variable costs ≈ $120/ft.^{3} in this range	0.25 operators per shift	≈ 2.0% of Capital Cost	.056 - .100 %	10 - 18 yr
9.	Recovery Furnace	. ≈ $150,000 for a unit producing 10 mm btu/hr. . $10,000/mmbtu in this range . Design adjustment factors of -35% to +25% are applicable depending on the type of furnace and pressure of combustion	0.25 operators per shift	≈ 1.7% of Capital Cost	.063 %	16 yrs.
10.	Incinerator	. ≈ $40,000 for unit with 1000 lbs/hr. capacity . Variable costs ≈ $20/(lb/hr) extra capacity	-	≈ 1.4% of Capital Cost	.063 - .100 %	10 - 16 yr

TABLE 6 Addendum CAPITAL AND OPERATING COSTS OF POLLUTION CONTROL EQUIPMENT MODULES, PULP AND PAPER INDUSTRY

	Systems	Capital Cost	Operation Cost	Maintenance Cost	Depreciation Rate	Lifetime (Years)
5.	Drum Dryer	. ≈ $80,000 for 100 sq. ft. area dryer . ≈ $200-$300/sq. ft. in this range . for vacuum drum dryers use adjustment factor of ≈ 2.7 x	0.2 - 0.5 operators per shift	.46 - .55% of Capital Cost	.063 - .100%	10 - 16 yr
6.	Equalization System	. ≈ $200,000 for 1 MGPD unit . ≈ 10-16¢/gal. in this range	-	.25 - .75% of Capital Cost	.016 - .040%	25 - 60 yr
7.	Filters	. ≈ $60,000 for 100 sq. ft. for normal sewage filter . $200 - $300/sq. ft. in this range . For rotary drum or disc filters add 25% . For simple plate and frame, wet or dry leaf filters subtract 65-75%	0.25 - 0.5 operators per shift	3.4 - 5.6% depending on nature of effluent and operating characteristics	.063 - .100%	10 - 16 yrs

TABLE 6 Addendum CAPITAL AND OPERATING COSTS OF POLLUTION CONTROL EQUIPMENT MODULES, PULP AND PAPER INDUSTRY

	Systems	Capital Cost	Operation Cost	Maintenance Cost	Depreciation Rate	Lifetime (Years)
11.	Aerated Lagoon System	. ≈ $220,000 for a 2.0 MGD system . ≈ $70,000/MGD extra capacity in this range	-	≈ 3.89% of Capital cost	.040 %	40 yrs.
12.	Reverse Osmosis System	. ≈ $2000 for a 1.0 GPM Unit . ≈ $1000/GPM extra capacity in this range	-	≈ 10% of Capital cost will vary greatly depending on application and membrance life	.045 %	22 yrs.
13.	Sedimentation System	. ≈ $60,000 for a 1.0 MGD capacity system . ≈ $50,000/1.0 MGD extra capacity in this range	-	5 - 16% of installed Capital Cost	.016 - .040 %	25 - 60 yrs
14.	Stack	. $5,500 for a 50 ft. stack . ≈ $100/ft. of extra height in this range	-	0.2 - 1.0% of Capital Cost.	.045 %	22 yrs.

TABLE 6 Addendum CAPITAL AND OPERATING COSTS OF POLLUTION CONTROL EQUIPMENT MODULES, PULP AND PAPER INDUSTRY

	Systems	Capital Cost	Operation Cost	Maintenance Cost	Depreciation Rate	Lifetime (Years)
15.	Thickener	. ≈ $250,000 for a 100 ft. diameter unit . ≈ $2,000 - $4,000/ft. of diameter in this range	-	≈ 1.0% of Capital Cost	.016 - .040 %	25 - 60 yrs
16.	Trickling Filter	. ≈ $750,000 for a 1,000 GPM unit . $5,000 - $7,000/GPM of capacity in this range	-	≈ 3.3% of Capital Cost	.025 - .050 %	20 - 40 yrs
17.	Cooling Towers	. ≈ $100,000 for a 10,000 GPM unit . ≈ $10/GPM of variable capacity in this range	-	≈ 3.0% of Capital Cost	.063 %	16 yrs.
18.	Ultrafiltration System	. ≈ $1,750 for a 1.0 GPM capacity unit . ≈ $700/GPM of variable capacity in this range	-	1.0 - 3.0% of Capital Cost	.045 %	22 yrs.

TABLE 6 Addendum CAPITAL AND OPERATING COSTS OF POLLUTION CONTROL EQUIPMENT MODULES, PULP AND PAPER INDUSTRY

	Systems	Capital Cost	Operation Cost	Maintenance Cost	Depreciation Rate	Lifetime (Years)
19.	Vibrating Screen	. ≈ $8,000 for a 10 ft.^{2} area screen . ≈ $3,000/sq. ft. of variable capacity in this range . For multi-layer screens increase by ≈ 20% per layer	-	≈ 1.9% of Capital Cost	.063 - .100 %	10 -16 yr
20.	Electrodialysis Chemical Recovery System	. ≈ $700,000 for a 1,000 GPM Unit . ≈ $3,000/GPM of variable capacity in this range	0.25 - 1.0 operators per shift	≈ 5% of Capital Cost with variation in operating conditions and membrane life	.063 - .100 %	1- - 16 yrs
21.	Ion Exchange Chemical Recovery System	. ≈ $80,000 for a 100 cu.ft. capacity unit . ≈ $400/cu. ft. of variable capacity in this range	.25 operators per shift	. ≈ 3% of Capital Cost . Variations with fluid and operating characteristics	.063 - .100 %	10 - 16 yrs

TABLE 6 ADDENDUM

NOTE:

- All data is taken from H. Blecker, Capital and Operating Costs of Pollution Control Equipment Modules, Washington, D.C., U.S., Government Printing Office, 1973.

- Cost data was crudely estimated from graphs but should be ± 10 - 15%.

- Variable materials charges were neglected as were regional adjustment factors.

- Exact nature of condensors or strippers used in Pulp and Paper could not be discerned.

- All costs are $1972 U.S.

- Operation cost excludes fuel cost.

APPENDIX B

A Description of the Waste Treatment Analysis Program (WATAP)

As described in Chapter 8, the Waste Treatment Analysis Program (WATAP) was developed by the Ontario Ministry of the Environment. Table b.1 is a sample of the summary output provided by WATAP, Table B.2 a sample of the detailed output. The following is a brief definition of the parameters listed in Table B.2.

Annual Capital Repayment: This figure represents the amount of borrowed capital (borrowed at year end) that is paid off from the loan in that year as calculated through the following equation:

$$KRP_k = ICC_k * \left[i(1+i)^{k-j} / ((1+i)^L - 1)\right] \qquad (7.1)$$

Where:

KRP_k = Annual capital repayment

ICC_k = Inflated capital cost (i.e., original principal of the loan)

i = interest rate on borrowed funds

j = year of installation and initial year of the loan

k = year that KRP is calculated for

L = Maturity period of the loan

Annual Interest Payment: This figure represents the amount of interest paid on the loan annually at year end. Note that the loan is assumed to be taken out in the year of installation and that the interest rate in that year prevails throughout the period of the load:

$$IP_k = ICC_k * \left[\frac{i((1+i)^L - (1+i)^{k-j}}{((1+i)^L - 1}\right] \qquad (7.2)$$

Inflated Capital Cost and Operation and Maintenance Cost: Both of these parameters are calculated through the same general cost function. These figures are initially calculated in constant dollars, as viewed from the beginning of the planning period, and then converted to inflated dollars through the use of an inflation factor.

$$UOM \text{ or } UCC = a_0 + (a_1 + b_1 W_1^{c_1})^{d_1} \qquad (7.3)$$

Table B.1

WATAP SUMMARY OUTPUT

Alternative Number	Description*	Present Value	Biochemical Oxygen Demand	Total Suspended Solids	Total Dissolved Solids
1	--	0.0	39.09	12.45	168.60
2	DSC	0.028	39.09	10.63	168.60
3	SGL	0.016	39.09	11.73	168.60
4	DSC/ SGL	0.043	39.09	10.02	168.60
5	WRI	0.858	37.72	11.09	168.60
6	DSC/ WRI	0.885	37.72	9.47	168.60
7	SGL/ WRI	0.873	37.72	10.45	168.60
8	DSC/ SGL/ WRI	0.901	37.72	8.92	168.60
9	SNCF	0.210	39.09	10.63	168.60
10	DSC/ SNCF	0.237	39.09	9.08	168.60
11	SGL/ SNCF	0.226	39.09	10.02	168.60

* These refer to the technologies employed.

Table B.2

WATAP DETAILED OUTPUT

Year	ANNUAL									AMOUNT OF WASTE IN THE EFFLUENT		
	Capital Repayment	Interest Payment	Inflated Capital Cost	Inflated Operating/ Maintenance Cost	Depreciation Allow-ance	Sales Tax	Inflated Additional Revenue	Profits/Tax Avoided	Effluent Charge	BOD: Tonnes/Day	TSS: Tonnes/Day	TDS: Tonnes/Day
1978	0.000	0.002	0.015	0.001	0.008	0.0	0.0	0.005	0.0	39.09	11.73	168.60
1979	0.003	0.015	0.108	0.086	0.066	0.0	0.0	0.082	0.0	37.72	10.45	168.60
1980	0.003	0.014	0.0	0.093	0.058	0.0	0.0	0.081	0.0	37.72	10.45	168.60
1981	0.004	0.014	0.0	0.101	0.0	0.0	0.0	0.056	0.0	37.72	10.45	168.60
1982	0.004	0.014	0.0	0.109	0,0	0,0	0,0	0.060	0,0	37,72	10,45	168.60
1983	0.972	4.975	41.350	1.570	22.122	0.0	0.0	14.047	0.0	20,18	9,55	103,69
1984	1.088	4.859	0.0	1.680	22.122	0,0	0,0	14.044	0,0	20,18	9,55	103,69
1985	1.219	4.728	0.0	1.797	0.0	0.0	0.0	3.197	0.0	20.18	9.55	103,69
1986	1.365	4.582	0.0	1.923	0.0	0.0	0.0	3.187	0.0	20.18	9.55	103.69
1987	1.529	4.418	0.0	2.058	0.0	0.0	0.0	3.173	0,0	20,18	9,55	103.69
1988	1.713	4.234	0.0	2,202	0.0	0.0	0.0	3.154	0,0	20.18	9.55	103.69
1989	1.918	4,029	0.0	2.356	0.0	0.0	0.0	3,128	0.0	20.18	9,55	103.69
1990	2.148	3.799	0.0	2.521	0.0	0.0	0.0	3.096	0,0	20.18	9.55	103.69
1991	2.406	3.541	0.0	2.697	0.0	0.0	0.0	3.057	0,0	20,18	9.55	103.69
1992	2.695	3.252	0,0	2.886	0.0	0.0	0.0	3,008	0,0	20.18	9.55	103.69
1993	3.018	2.929	0.0	3.088	0.0	0.0	0.0	2.948	0,0	20.18	9.55	103.69
1994	3.379	2.572	0.047	3.304	0.025	0,0	0.0	2.892	0.0	20,18	9.55	103.69
1995	3.777	2.207	0.339	3.535	0,207	0,0	0,0	2.915	0.0	20,18	9.55	103.69
1996	4,231	1.754	0.0	3.783	0,181	0.0	0.0	2,802	0.0	20.18	9.55	103.69
1997	4.738	1.246	0.0	4.048	0.0	0.0	0.0	2.594	0,0	20.18	9.55	103.69

Where:

UOM = Uninflated operation and maintenance cost

UCC = Uninflated capital cost

a_0, a_1, b_1, c_1, d_1,
= constants entered for each treatment's cost function

W_1 = Effluent loading as measured by parameter W_1 in that year of installation or operation

$$ICC_k = UCC_k * \left[1+(ST_k*(1-STR_k))\right]*\left[(1+r_k)*(1+r_{k-1})\right] \qquad (7.4)$$

Where:

ST_k = Percentage sales tax in year k

STR_k = Percentage sales tax rebate in year k

r_k = Inflation rate in year k

r_{k-1} = Calculated total inflation for period 0 to year k-1

The equation for the inflated operation and maintenance cost (IOM_k) is the same as equation (7.4) except that the sales tax variables are excluded. A similar form of inflation variable $\left[IV_k=(1+r_k)*(1+r_{k-1})\right]$ is calculated for any additional revenues, waste disposal costs (WD_k), the depreciation allowance and the economic disincentives for pollution.

Annual Capital Cost Allowance: Capital cost calculations can be done through diminishing balance and/or straight line depreciation modes. Within each run, any number of asset classes with varying percentages of applicable capital costs and depreciation rates may be identified. It is the total of these calculations that is presented in Table B.7. The general equation for one class of asset in either method is presented below:

$$AKA_k = \left[\%\ UKDB_c*IV_k*(1+ST)*DBDR_c\right] + \left[\%\ UDSL_d*IV_k*(1+ST)*SLDR_d\right] \qquad (7.5)$$

Where:

ADA_k = Capital cost allowance in year k

$\%UKDB_c$ = % of UCC available to class c of the diminishing balance method

$DBDR_c$ = % depreciation rate in class c of the diminishing balance method

$\%UKSL_d$ = % of UCC available to class d of the straight line depreciation method

$SLDR_d$ = % depreciation rate in class d of the straight line depreciation method

The straight line method is applied only at the year of installation with the yearly depreciation allowances calculated by multiplying $SLDR_d$ by the total applicable capital costs and assigning them to the following years until the total amount is depreciated. The diminishing balance method is calculated yearly with $DBDR_c$ applied to the net outstanding capital cost as it is reduced from year to year.

Note that the total amount of sales tax paid is depreciated regardless of any sales tax rebates.

Annual Sales Tax: This column in Table B.2 gives the net annual sales tax as computed from the following equation.

$$AST_k = ICC_k * \left[\frac{ST*(1-STR)}{(100+(ST*(1-STR))} \right] \qquad (7.6)$$

Where:

ST = Percentage sales tax rate in year of purchase

STR = Percentage of sales tax rebate offered in the year of purchase

AST_k = Net annual sales tax in year k

Annual Inflated Additional Revenue: This factor gives the total additional revenue accruing from the treatment options.

$$AIAR_k = \sum_{i=1}^{N} AR_i * IV_k$$

Where:

$AIAR_k$ = Annual inflated additional revenue in year k

AR_i = Uninflated additional revenue (or loss of revenue) generated by treatment technology i

N = Number of treatment options

Annual Effluent Charge: The equation for computing effluent charges is sufficiently general to allow a variety of schemes to be considered including, in particular, a conventional effluent charge and a pollution control delay penalty:

$$P_k = \sum_{e=1}^{z} \left[M^e * \frac{O^e}{D_k^e} * (D_k^e - (B^e * r_k^e) * IV_k \right] \qquad (7.7)$$

Where:

P_k = The effluent charge on all effluents e in year k

M^e = The penalty rate for an effluent e

O^e = The objective for effluent e

D_k^e = The discharge of effluent e in year k

B^e = The discharge of effluent e in the base year

r_k^e = The proportion of the base year discharge by which the effluent loading must be reduced by year k for a mill to avoid paying a delay penalty

(With $\frac{O^e}{D_k^e} = 1$ and r_k^e = zero, equation (7.7) is the formula for a conventional effluent charge adjusted for inflation.)

Annual Profits Tax Avoided: Options exist in the program to defer tax savings to years of high taxable income if a suitable projection of the mill's financial outlook is available. The inclusion of the effluent charge in these calculations is optional and is dependent on the tax regime. One tax case treats these charges as tax deductible, the other treats them as non-deductible. The annual profit tax avoided is calculated by the following equation:

$$APTA_k = TTAXD_k * TR_k \qquad (7.8)$$

Where:

$APTA_k$ = Annual profit tax avoided in year k

$TTAXD_k$ = (Deferred pollution related expenditures from the years preceding k) + (inflated interest payments) + (inflated O + M and Capital Costs) - (inflated additional revenue) + (inflated waste disposal costs), all in year k. (The pollution control delay penalty or effluent charge are not considered tax deductible.)

TR_k = Corporation profits tax rate in year k.

Net Present Value: This figure results from discounting the total annual net costs at varying yearly discount rates and summing these figures for the whole planning period:

$$NPV = \sum_{k=1}^{N} \frac{\text{Total Annual Net Cost in Year k}}{(1+d_k)^k} \qquad (7.9)$$

Where:

Total Annual Net Cost in year k $= KRP_k + IP_k + IOM_k + WD_k + P_k - AIAR - APTA_k$

d_k = Discount rate for year k

N = Number of years in the planning period.

APPENDIX C

SOME DETAILS OF THE ONTARIO MINISTRY OF THE ENVIRONMENT'S WATER QUALITY SIMULATION MODEL AS APPLIED TO THE LOWER SPANISH RIVER

The Ontario Ministry of the Environment completed a study of water quality in the Spanish River.* A major portion of the report deals with the model used by the Ministry to relate BOD discharges from the mill to the DO level in the Spanish River, downstream from the mill.

$$D = \frac{k_d \cdot L_o}{k_2 - k_r} (e^{-k_r t} - e^{-k_2 t}) + D_o e^{-k_2 t} + \frac{S}{k_2} (1 - e^{-k_2 t}) \qquad (7.10)$$

Where:

D_o = dissolved oxygen deficit (pounds/day) at the point of reference [usually the point of waste discharge (t=o)]

D = dissolved oxygen deficit (pounds/day) at any point, time t, from the point of reference

L_o = ultimate BOD loading (pounds/day) at the point of reference

t = time of travel (days)

k_r = the coefficient of BOD removal in the watercourse by physical removal (sedimentation) and volatilization (per day base e)

k_d = the coefficient of deoxygeneration (per day, base e)

k_2 = the coefficient of reoxygeneration in the watercourse (per day base e)

S = the rate of oxygen utilization by benthic deposits

$S = swv$, where

s = oxygen uptake rate (pounds/sq. ft./day)

w = average width of deposit (feet)

v = average velocity over deposit (ft./day)

This equation relates the BOD discharges from the source (L_o) to the DO level at any point downstream. (The mill is 51.4 kilometres upstream from the mouth of the Spanish River, which flows into the North Channel of Georgian Bay.) The model used by the Ministry in the study allows for BOD removal through physical means (k_r), deoxygenation (k_d), and oxygen utilization by benthic organisms. It also allows for reoxygenation through natural processes (k_2).

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* Ontario Ministry of the Environment, Water Quality Study of the Lower Spanish River, 1972.

To determine an acceptable level of BOD loading into the river it is necessary to specify the conditions under which the DO objective of 5 mg/L must be met. (This was the DO objective used by the Ministry in 1972.) For this purpose the Ministry specified a river flow of 35,400 litres/second (1250 cfs) at the mill, and a water temperature of 22°C. A statistical analysis of the daily flows from 1947 - 1970 indicated that a 7-day flow of this level had a 5% likelihood in any year. (A flow of this frequency is referred to as 7Q20.) Although the Ministry has never specified an acceptable probability level for achievement of the Provincial Water Quality Objectives, the selection of the 7-day low flow that occurs, on average, once in 20 years, has become the norm.*

Tables C.1 and C.2 displays results obtained in this study with the Ministry's water quality simulation model. Tables C.1 presents figures for the "with sludge" case, Table C.2 does the same for the "without sludge" case. The top 4 rows of each table show the values assumed for:

- river temperature
- 100% saturation DO (this is a function of river temperature)
- average upstream DO
- initial flow of river at the mill (a tributary enters 26.6 kilometres downstream from the mill)

The first 2 columns of the tables identify 13 reaches of the river downstream from the mill. Each of the other columns shows the DO at the end of each reach. These values were estimated from the model using the BOD loadings shown at the top of each column in conjunction with the values for the variables in the top 4 rows. (The bottom 2 rows of Table C.2 are discussed in Section 7.4.2 of the main text.)

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*The selection of 7Q20 for this purpose is currently under review in the Ministry.

Table C.1

WATER QUALITY MODELLING RESULTS FOR THE SPANISH RIVER
(With Sludge)

Initial Flow in (litres/s)		72,216*		35,400**						24,355**					
Mill Loading BOD_5 (tonnes/day)		26.7		3.6	5.4	6.6	10.9	12.2	15.8	3.6	5.4	6.6	10.9	12.2	15.8
River Reaches Downstream of Mill Outflow	Reach Length & Distance From Outflow (Km)	Dissolved Oxygen at End of Reach (Mg/L) MOE	STD	Dissolved Oxygen at Reach End (Mg/L)						Dissolved Oxygen at Reach End (Mg/L)					
1	0- 4.4	6.60	6.61	6.64	6.41	6.25	5.69	5.52	5.05	6.19	5.74	5.43	4.34	4.01	3.10
2	4.4-11.4	5.56	5.57	5.95	5.39	5.01	3.66	3.25	2.12	5.02	4.03	3.34	0.94	0.22	0
3	11.4-18.5	4.82	4.81	5.60	4.89	4.39	2.66	2.13	0.68	4.63	3.48	2.68	0	0	0
4	18.5-25.6	4.30	4.29	5.47	4.70	4.16	2.29	1.73	0.16	4.62	3.49	2.70	0	0	0
5	25.6-26.6	4.50	4.50	5.78	5.12	4.65	3.03	2.55	1.19	5.23	4.32	3.68	1.47	0.80	0
6	26.6-30.0	4.43	4.43	5.84	5.17	4.70	3.08	2.60	1.24	5.29	4.39	3.76	1.57	0.91	0
7	30.0-31.4	4.37	4.35	5.94	5.28	4.82	3.22	2.73	1.39	5.49	4.63	4.03	1.94	1.31	0
8	31.4-33.0	4.34	4.34	5.96	5.30	4.84	3.23	2.75	1.41	5.51	4.65	4.05	1.97	1.34	0
9	33.0-36.7	4.29	4.29	6.04	5.39	4.94	3.36	2.88	1.55	5.67	4.85	4.28	2.29	1.69	.02
10	36.7-40.7	4.25	4.26	6.15	5.51	5.06	3.51	3.05	1.75	5.85	5.08	4.53	2.64	2.07	.49
11	40.7-44.1	4.22	4.25	6.23	5.61	5.17	3.65	3.20	1.93	6.01	5.26	4.74	2.94	2.40	.89
12	44.1-47.8	4.21	4.24	6.34	5.73	5.31	3.84	3.39	2.16	6.19	5.49	5.00	3.30	2.79	1.37
13	47.8-51.5	4.21	4.25	6.43	5.84	5.43	4.00	3.57	2.37	6.33	5.67	5.21	3.60	3.12	1.77

Input Values -

	*	**
- River Temperature in ^{o}C	20	22
- 100% Saturation Dissolved Oxygen (Mg/L)	9.17	8.83
- Average Upstream Dissolved Oxygen (Mg/L)	7.30	7.06

Table C.2

WATER QUALITY MODELLING RESULTS FOR THE SPANISH RIVER

(Without Sludge)

Initial Flow in (litres/s)		35,400*						24,355*					
Mill Loading BOD_5 (tonnes/day)		3.6	5.4	6.6	10.9	12.2	15.8	3.6	5.4	6.6	10.9	12.2	15.8
River Reaches Downstream of Mill Outflow	Reach Length & Distance From Outflow (Km)	Dissolved Oxygen at Reach End (Mg/L)						Dissolved Oxygen at Reach End (Mg/L)					
1	0- 4.4	6.78	6.55	6.38	5.82	5.65	5.18	6.38	5.93	5.62	4.53	4.21	3.29
2	4.4-11.4	6.32	5.76	5.37	4.02	3.62	2.48	5.53	4.54	3.85	1.44	0.73	0
3	11.4-18.5	6.17	5.46	4.96	3.22	2.70	1.25	5.41	4.26	3.46	0.66	0	0
4	18.5-25.6	6.21	5.44	4.90	3.03	2.47	0.90	5.63	4.49	3.70	0.95	0.12	0
5	25.6-26.6	6.44	5.77	5.31	3.69	3.20	1.84	6.07	5.15	4.52	2.30	1.64	0
6	26.6-30.0	6.47	5.80	5.34	3.72	3.23	1.87	6.10	5.20	4.57	2.39	1.73	0
7	30.0-31.4	6.53	5.87	5.41	3.81	3.32	1.98	6.24	5.38	4.78	2.69	2.06	0.31
8	31.4-33.0	6.54	5.88	5.42	3.82	3.34	1.99	6.25	5.39	4.79	2.71	2.08	0.34
9	33.0-36.7	6.60	5.95	5.49	3.91	3.43	2.11	6.36	5.54	4.97	2.98	2.38	0.70
10	36.7-40.7	6.67	6.03	5.59	4.04	3.57	2.27	6.49	5.71	5.17	3.29	2.71	1.12
11	40.7-44.1	6.73	6.11	5.67	4.15	3.70	2.42	6.61	5.86	5.34	3.54	3.00	1.47
12	44.1-47.8	6.81	6.20	5.78	4.31	3.86	2.62	6.74	6.04	5.55	3.86	3.35	1.93
13	47.8-51.5	6.89	6.29	5.88	4.45	4.02	2.82	6.85	6.19	5.73	4.12	3.64	2.29
Survival Factor		1	1	1	1	1	.76	1	1	1	.68	.55	.23
% population surviving after 7 days		100	100	100	100	100	15.0	100	100	100	6.7	1.5	<0.1

*Input Values - River Temperature in ^{o}C = 22
- 100% Saturation Dissolved Oxygen (Mg/L) = 8.83
- Average Upstream Dissolved Oxygen (Mg/L) = 7.06

APPENDIX D

THE SPORTS FISHERY BENEFIT INDEX

The Sports Fishery Benefit Index (SFBI) which is described in this appendix was developed by Everson and Braune at the University of Toronto.* The index relates the quality of a river to its potential as a sports fishery. It does not estimate the value of sports fishing benefits in dollars. Instead it attempts to measure the proportion of the maximum potential benefits from sports fishing that could be obtained from a river for varying levels in its quality. In particular, the index treats DO as the critical variable for determining the survival rates and growth rates of numerous fish species. The index incorporates a simple ecological model which relates these rates to the expected level of DO in the river.

A relationship between the stock of a fish species and time under ideal conditions is postulated:

$$S_t = S^* - (S^* - S_{t-1})e^{-g} \qquad (7.11)$$

Where:

S_t = the stock in period t

g = a growth rate

S^* = the maximum stock under ideal conditions

Under less than ideal conditions, yet where some fish still survive, the long run equilibrium stock is assumed to fall to a fraction, X, of the value under ideal conditions. Further, in less than ideal conditions only some fraction of the stock, K_t will survive day t. At the end of day t:

$$S_t = K_t (X_t S^* - (X_t S^* - S_{t-1})e^{-g}) \qquad (7.12)$$

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* Everson, C.K., and B. Braune, "A Sports Fishery Benefit Index", university of Toronto, Institute for Environmental Studies, Discussion Paper W-5, 1977.

Under assumptions about the independence of K and X, the equilibrium stock of a species as a fraction of the stock under ideal conditions is given by:

$$S = \frac{\bar{K}\bar{X}(1-e^{-g})}{(1-\bar{K}e^{-g})} \qquad (7.13)$$

Where:

$\bar{K}$ is the expected value of K (function of DO)

$\bar{X}$ is the expected value of X (function of DO)

This species suitability index is calculated for each reach and each species.

The individual indices are then aggregated into the SFBI by using weights to account for: the natural presence of each species in the water, their desirability as sports fish, and the accessibility of each reach. These weights are normalized to ensure that the value of the SFBI lies between zero and one.

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