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WORKING PAPER NO. 4

EVALUATION OF POLICIES FOR REGULATING ENVIRONMENTAL POLLUTION

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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, An Analysis of the Legal and Administrative Framework for Monitoring and Feedback Systems in Impact Assessment and Management.

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

Dorcey, Anthony H.J., Michael W. McPhee and Sam Sydneysmith, Environmental Regulation of Timber Harvesting and Log Transportation: Salmon and the B.C. Coastal Forest Industry.

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

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University of Texas, LBJ School of Public Affairs, The Toxic Substances Control Act; Overview and Evaluation.

Victor & Burrell, Research & Consulting, Environmental Protection Regulation, Water Pollution, and the Pulp and Paper Industry.

* already published.

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Résumé

Dans cette étude, l'auteur évalue les divers moyens possibles de lutte contre la pollution. Les politiques actuelles de limitation des émissions de polluants au Canada sont parfois critiquées, mais pour deux raisons fort différentes. Premièrement, elles ne sont pas, semble-t-il, suffisamment efficaces. Certains ont prétendu que, le plus souvent, la réglementation directe ne prévoit pas de frais élevés pour les pollueurs qui ne se conforment pas aux directives en matière de lutte contre la pollution, et qu'on ne réussira souvent à les y contraindre qu'en leur imposant de fortes amendes. Des économistes ont proposé divers mécanismes de marché comportant des coûts élevés pour les pollueurs, sous forme d'une taxe et d'un droit d'émission d'effuents. La taxe d'émission serait une sorte d'amende imposée par un gouvernement pour chaque unité rejetée d'un polluant particulier, tandis que le droit d'émission serait un permis vendu par un gouvernement et permettant de rejeter dans la nature un polluant particulier à un rythme spécifique pendant une période donnée.

Deuxièmement, on dit qu'il en coûte plus qu'il ne faut pour la lutte contre la pollution, compte tenu des politiques actuelles. Certains économistes soutiennent que des politiques axées sur le marché donneraient les mêmes résultats à un coût

moindre. Ils recommandent eux aussi le recours à des taxes et à des droits d'émission s'appliquant aux effluents.

Dans la présente étude, l'auteur examine les politiques axées sur les mécanismes du marché qui ont été proposées dans le passé, afin de trouver pourquoi elles n'ont généralement pas été acceptées. Il montre que certains des avantages que les économistes attribuent aux taxes et aux droits d'émission d'effluents sont liés à des conjectures qui n'existent que rarement au Canada, de sorte que ces moyens de contrôle sont un peu moins intéressants que les économistes l'ont prétendu.

L'étude montre, par ailleurs, qu'un certain nombre de difficultés d'ordre pratique ou politique nuisent à l'application de ces taxes et droits d'émission d'effluents que favorisent les économistes. On peut en éliminer quelques-unes en repensant les politiques. D'autres, par contre, peuvent être inhérentes aux politiques elles-mêmes et, par conséquent, extrêmement difficiles à résoudre. L'auteur suggère d'apporter, à certaines propositions pertinentes, des modifications qui pourraient minimiser la résistance que ces politiques rencontrent.

En conclusion, l'auteur estime que les politiques axées sur le marché peuvent présenter d'énormes avantages par rapport aux mesures actuelles, en favorisant un développement et une utilisation plus rapides de moyens efficaces et peu coûteux de

réduire les émissions de polluants. Il paraît possible de mettre au point des politiques qui préserveraient ces avantages, mais élimineraient beaucoup des inconvénients politiques propres aux programmes traditionnels axés sur le marché; il faudrait alors réduire les charges financières trop lourdes pour les entreprises (et parfois pour les travailleurs) que représentent les taxes sur les émissions d'effluents. L'auteur offre ensuite des suggestions pour l'application de ces nouvelles politiques fondées sur les mécanismes du marché.

Summary

This paper evaluates alternative policies for environmental pollution control. Current policies for limiting pollution discharge in Canada are at times criticized on two rather different grounds. First, it is said that current policies are not sufficiently effective in reducing pollution emissions. It has been argued that direct regulation does not impose significant costs, in most cases, on polluters who fail to comply with pollution control orders, and that compliance will only be secured if large penalties can be imposed frequently on those who fail to comply. Economists have proposed various market mechanisms for imposing large costs on polluters, including effluent charges and effluent rights. An effluent charge is a price imposed by a government that must be paid for every unit discharged of a particular pollutant. An effluent right is a permit, sold by a government, to discharge a particular pollutant at a specified rate for a specified period of time.

Second, it is said that the cost of pollution control is greater under existing pollution control policies than it needs to be. Economists have argued that market-oriented policies could achieve the same degree of pollution control at a lower cost. Once again, effluent charges and effluent rights schemes are recommended.

This paper examines proposals that have been made for market-oriented policies to see why they have generally

failed to gain acceptance in the past. It is shown that some of the advantages that economists claim for effluent charges and effluent rights schemes exist only under assumptions that do not often apply in Canada, so that charges and rights schemes are somewhat less attractive than economists have claimed.

It is also shown that a number of practical or political problems hinder the implementation of the effluent rights and effluent charge schemes that are favoured by economists. Some of these objections may be overcome by re-designing the policies. Others may be inherent in the policies and therefore extremely difficult to overcome. The paper suggests some modifications to typical proposals that might minimize resistance to them.

It is concluded that market policies may offer considerable improvements over present policies in inducing more rapid development and use of low cost and effective means of reducing pollution emissions. It seems likely that policies can be designed that preserve these advantages yet overcome many of the political disadvantages of traditional market schemes, by reducing the adverse financial impact on firms (and sometimes on workers) that is associated with effluent charges. Suggestions are made for implementing such modified market policies.

I INTRODUCTION

The purpose of this paper is to evaluate alternative policies for environmental pollution control. Current policies for limiting pollution discharge in Canada are at times criticized on two rather different grounds. First, it is said that current policies are not sufficiently effective in reducing pollution emissions. It is suggested that there are many examples where environmental goals have been in place for many years, and yet actual pollution levels far exceed those goals. In many provinces there are examples of major pollution sources that have been ordered to reduce emissions, or who are in serious violation of existing standards, that show no signs of complying with those regulations. It is sometimes suggested that the policies currently used are not sufficiently powerful to compel compliance with the law by sources that are strongly motivated not to comply.

Economists have endorsed this criticism by pointing out that the direct regulatory policies widely used in Canada do not impose significant costs, in most cases, on polluters who fail to comply with pollution control orders. The argument continues that compliance will only be secured if large penalties can be imposed frequently or continuously on those who fail to comply. In short, expensive pollution control will only be undertaken if failure to control pollution is made still more expensive. Economists have proposed various market mechanisms for imposing large costs on polluters, including effluent charges and effluent rights. An effluent charge is

a price imposed by a government that must be paid for every unit discharged of a particular pollutant. An effluent right is a permit, sold by a government, to discharge a particular pollutant at a specified rate for a specified period of time.

Second, it is said that the cost of pollution control is greater under existing pollution control policies than it needs to be. Economists have argued that market oriented policies could achieve the same degree of pollution control at a lower cost. Once again, effluent charges and effluent rights schemes are recommended.

Despite the enthusiasm of economists for market-oriented pollution control policies, examples of their adoption and implementation are rare in North America. One purpose of this paper is to examine proposals that have been made for market-oriented policies in the past, to examine why they have failed to gain acceptance. This investigation will include evaluations of the economists' arguments in favour of those policies and analysis of the practical, political and other objections that have been raised to them. Evaluation will be made of the relative importance of the various advantages that economists claim for effluent charges and effluent rights schemes. It will be shown that some of these advantages exist only under a set of assumptions that does not often apply in Canada, so that charges and rights schemes may be somewhat less attractive than economists have claimed.

It will also be shown that a number of practical or political problems hinder the implementation of the effluent rights and effluent charge schemes that are favoured by economists. Some of these objections may be overcome by re-designing the policies. Others may be inherent in the policies and therefore extremely difficult to overcome. The paper will suggest some modifications to typical proposals that might minimize resistance to them.

The focus of the paper is the choice between direct regulation and market mechanisms or some combination of the two. It does not evaluate other policy instruments such as private litigation that may be brought to bear upon certain types of environmental problems. The investigation is limited to the discharge of pollution. Urban congestion, the preservation of wilderness areas, the depletion of natural resources, and other environmental problems are not considered.

This paper relies largely upon previously published works by economists and political scientists who have analyzed pollution control policies. Some discussions with individuals in government or industry provide additional information where relevant. Some of the theoretical analysis in this paper is new. There is no new quantitative research.

Section II includes a brief review of current environmental policies and problems. This section does not describe current policies exhaustively, but identifies some major characteristics of those policies which help to explain the success and failure of some reform policies.

Section III analyzes the objectives that are sought by various parties influential in the passage and implementation of environmental policies. These objectives are derived in part from an examination of the attitudes and statements of various groups toward past proposals for policy reform.

Section IV reviews the economic arguments for market-oriented environmental policies and evaluates those arguments briefly. The assumptions made by economists in their assessments are questioned, and some important economic issues not previously discussed are raised. This section then evaluates reform possibilities in light of the objectives of various parties

and the character of existing policies presented in sections II and III. Finally, section V draws some general conclusions about the possibilities for reform. It suggests that there are powerful reasons to favour market-oriented policies for dealing with a wide range of pollution emission problems, and that such policies face serious political problems. It suggests two specific cases where market-oriented policies might appropriately be used. The general outline of reforms that might be adopted is suggested here, along with an indication of the potential problems that these reforms would face.

II CURRENT ENVIRONMENTAL POLICIES AND PROBLEMS

This section sketches the form and substance of environmental policies at the federal and provincial level in Canada. It is not an exhaustive survey of these policies. Rather, it is intended to demonstrate some common features as well as the variety of options and procedures that are employed. It also suggests a few strengths or weaknesses of existing policies. It does not deal in any detail with the role that public participation or the press do or might play in the process of environmental administration.

In principle, environmental regulation begins with setting ambient air or water quality standards, and then deriving emission standards that will achieve those ambient quality goals. In fact, the specification of ambient quality standards is only partial; only a limited number of such standards has been set for a limited number of pollutants. Furthermore, the emission standards that follow do not necessarily achieve the ambient quality goals today, nor is it always clear that they will achieve those goals at any time in the foreseeable future. Thus the relationship between the ambient

goals and the emission standards is at best a flexible one. This section will focus primarily upon the setting of emission standards and their enforcement with little attention paid to the process of setting ambient quality goals.

A. How are the Emission Limits Specified?

The emission limits for individual sources might be specified in any of several different ways. One might limit the maximum rate of discharge from a source, for example 10 tons per day of a pollutant from an individual source. One could require a given degree of pollution control, for example 99% removal of all particulates from the exhaust gas stream. One could require the use of the "best practicable technology" for pollution control. One could limit the density of pollutant in the waste water or air, for example 300 parts per million of BOD in the effluent stream. One could prohibit discharges that cause ambient air or water quality to fall to unsatisfactory levels measured either by pollutant concentration or by observed harm to plants or animals. Finally, one could limit the discharge pollutants in proportion to the use of some input in the production process, or the output of the production process. The above limits could apply to all sources of the pollutant, only to sources within a specified industry, or only to new sources within a specified industry.

In fact, all of the above emission limitations are used in one form or another in Canada. It is common for environmental legislation to contain a general prohibition against discharges which are harmful or may be harmful. For example, the Fisheries Act,[1] Section 33(2) states that "...no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish...". Section 14(1) of the Ontario Environmental Protection Act[2] states that "...no person shall deposit, add, or emit or

discharge a contaminant...into the natural environment that (a) causes or is likely to cause impairment of the quality of the natural environment for any use that can be made of it". While these general provisions appear to provide nearly absolute protection to the environment, in some cases other sections of the legislation allow discharges that comply with specific regulations or orders of the relevant ministry.[3] Thus, many pollution problems would appear to be violations of the general prohibition of some environmental act but are in fact lawful because of an exception provided elsewhere. The general prohibitions relate to the ambient environmental quality resulting from the discharge, with no specific limits set on any individual's discharge.

In addition to the general prohibitions, the regulations promulgated under a number of environmental Acts prohibit discharges that cause ambient concentrations in excess of some specified standard. For example, Section 5 of Regulation 15 under the Ontario Environmental Protection Act prohibits any discharge from a source that causes an ambient concentration of a pollutant greater than that specified in Schedule 1 of the Regulation. This regulation is a cross between an ambient quality standard and emission standard, because it depends upon measurements in the ambient air rather than in the stack, but it can be enforced against an individual source. Under such a regulation, building a taller smoke stack will increase the total quantity of pollutant that can be discharged, because there is more dilution before the pollutant reaches ground level. Owning more land may also be helpful if the increased distance from the stack to the property line reduces the pollution density.

One of the most common pollution limits is a limitation on the pollution density allowed in the waste water or the stack gas. For example, most air pollution regulations prohibit the discharge of smoke with a

density greater than some degree of opacity on the Ringleman Chart, effectively limiting the density of particulates in the stack gas. Regulations made under the Fisheries Act on the discharge of water wastes from mines limit the concentration of arsenic, copper, lead and other heavy metals to a certain concentration of waste water volume.[4] One advantage of limiting effluent density in this way is that it is relatively easy to measure. One only has to take a sample of the waste water or stack gas and determine the pollution concentration in that sample. A disadvantage is that it provides an incentive to dilute the effluent without reducing the quantity discharged.

Another common form of effluent regulation is a limitation of the waste that may be discharged per unit of process input or output. For example, the Chlor-alkali Mercury Effluent Regulations[5] state that mercury discharge may not exceed .0025 kilograms per ton of chlorine produced. Thus, the allowable discharge from a plant depends on its chlorine output, so that larger plants may discharge more mercury. Similarly, the Pulp and Paper Effluent Regulations[6] provide that the suspended solids discharged from a mill may not exceed an amount determined by multiplying a coefficient times the number of tons of wood processed or tons of product produced. Here, the emission coefficient is specified separately for each of twelve in-plant processes. This coefficient is different for new and for existing mills and for different methods of pulp production. The format for petroleum refinery regulations is similar to that for chlor-alkali plants and pulp and paper mills. The maximum allowable discharge of a number of harmful substances is determined by multiplying a coefficient from a table times the rate of crude oil input into the refinery.[7]

Finally, the regulation of effuent discharge from pulp and paper mills has been the subject of continuing activity by the Ontario Ministry

of the Environment for over 15 years. The program that has developed begins with ambient water quality goals and translates these into emission objectives for each mill depending upon its situation and the quality of its receiving waters. The resulting effluent limitations are essentially limits on total waste for each mill, expressed in tons per day.[8]

Several characteristics of the regulations discussed above deserve further mention. First, the federal effluent regulations are designed on an industry by industry basis rather than applying a specific rule to all sources of a given pollutant. This is inefficient in that it does not achieve a given total amount of pollution control at least cost. Even within a single Province, there is usually not a single discharge rule applied to all sources of a given pollutant, but rather, rules are developed separately for each industry that may discharge the pollutant.[9] Thus it would be a major change in policy to adopt a uniform effluent or discharge regulation for all sources of a pollutant, regardless of industry membership.

Second, there is an important distinction between existing sources and new sources. The Pulp and Paper Regulations under the Fisheries Act specify different standards for existing mills and for new mills, allowing 50% more pollution for existing mills.[10] The Petroleum Refinery Regulations apply only to new refineries that began operation after November 1, 1973.[11] More important perhaps is the requirement in most jurisdictions that new potential sources of pollution receive approval from the relevant ministry before commencing operation. A condition of this approval is that the plans for the new source must satisfy strict environmental requirements that generally go far beyond any requirements imposed on existing sources.

Third, pollution regulations vary widely from one Province to

another. Even where federal regulations and standards have been imposed, enforcement is generally left to the Provinces. Since this enforcement has an element of discretion, one finds substantial differences in vigour and enthusiasm with which enforcement is pursued. The legislation and regulations adopted independently in each Province can vary substantially with respect to the degree of pollution control required.

B. When Are Costs and Benefits Balanced?

The economic basis for deciding how much pollution control to demand for a particular pollutant or a particular source is a benefit cost analysis in which the benefits of pollution control are balanced against the costs. While attaching actual dollar values to the benefits of pollution is often impossible in practice, it is still important to perform some balancing of the benefits, expressed in physical or other terms, against costs. In order to evaluate the problems or advantages of alternative pollution control policies, it is important to understand at what point costs and benefits are balanced in the existing regulatory process. This can be assessed in part by examining the formal legislation and regulations, in part by analyzing the approvals and enforcement process, and in part by relying upon the writings and opinions of experts.

Holden (1966) develops a model of the decision-making process as a bargaining process all the way from legislation to final enforcement. In his view, costs and benefits of some sort are evaluated at all stages of this process. He points out, however, that there may be political reasons for adopting seemingly tough legislative standards, in order to satisfy environmental interests, and then to apply much more lenient standards, either through subsequent regulations or through lack of enforcement. Thus

we might expect to find legislation that was concerned primarily with protecting the environment, giving no weight to pollution control costs, and then to discover that the actual pollution control policies are very much concerned with abatement costs. Hartle (1979) and Lerman (1977) echo (but do not approve) the political importance of symbolic actions which could take the form of tough legislative standards which will then be enforced more leniently.

Canadian federal and provincial legislation supports the notion that legislation will tend to place heavy emphasis on the benefits of pollution control and tend to ignore pollution control costs. Section 33(2) of the Fisheries Act, section 14 of the Ontario Environmental Protection Act, and section 32(1) of the Ontario Water Resources Act all fit this model, with outright prohibitions against discharges that are or may be harmful. There is no balancing of costs and benefits in these legislative provisions.

These provisions represent a symbolically tough stand against pollution. Since in many cases they may be unduly strict, from a cost-benefit point of view, it is not surprising that exceptions are created when the relevant agency or ministry deals with specific industries or pollutants, or that many sources that clearly violate the act are not prosecuted.

The process of setting ambient water quality goals or guidelines might or might not involve some balancing of costs and benefits. Often it appears that these guidelines are set primarily with regard to protecting human health or protecting the environment from any significant damage, ignoring the costs of pollution control. Ontario's description of its water quality goals and objectives suggests no concern with costs, while stating that the speed of approaching those goals may be influenced by

cost considerations.[12] This would seem to be an undesirable strategy, since it depends upon an uninformed electorate and deliberately misleads the electorate who may wrongly conclude that the pollution problem has been solved. Just as serious, someone may someday force compliance with the extreme goals at great cost.

It is in setting emmission standards for individual sources or industries that a balancing of costs and benefits is most likely to appear. One can view standards that are more stringent for new sources than for old sources as a balancing of costs and benefits recognizing that control costs for new sources are likely to be far lower than for modifying existing sources. This balancing may be efficient. Alternatively, this may represent a concession to the political fact that existing sources can protest vigorously against tough standards, while future sources will not generally be identified when a regulation is promulgated. It may represent a notion of fairness in that tough standards applied to existing sources represent a change in the rules and may appear confiscatory. In these cases the distinction will be inefficient and cause excessive pollution control costs.

The promulgation of separate regulations for each industry might also be a concession to balancing costs and benefits, although there is no evidence that this is so. While a pound of a pollutant discharged at a particular place should cause the same environmental damage regardless of the industry from which it is emitted, the economic impact of regulations may differ considerably from one industry to another, so that a cost benefit analysis might in fact yield different emission standards for different industries. In addition, firms in some industries (such as pulp and paper) may be located in places that experience significantly different benefits from pollution abatement than firms in other industries discharging similar materials.

Looking at the form of regulation, emission standards that are based primarily upon achieving a specified ambient quality would seem to be pre-occupied with benefits with little regards for costs. This would include the emission standards specified in section 5 of Regulation 15 of the Ontario Environmental Protection Act.

Some balancing of costs and benefits occurs in setting the individual source emissions limits that implement a given program, in determining how much delay will be accepted in meeting the standards set out in the program, and in deciding whether or not to prosecute for violation of those standards. The Ontario Standing Resources Development Committee (1979, section 2) states that in 1970 the Ministry developed a schedule of emission reductions for Inco to reduce sulphur dioxide emissions from 5200 tons per day to 750 tons per day by December 31, 1978. Since that time, the Ministry worked with Inco to move toward that goal, and maintained the ultimate 750 ton limit until July 27, 1978 when a new control order set permissible emission levels at 3600 tons per day effective through June 30, 1982. In this 1978 control order, there was no reference to the 750 ton per day limit, reflecting a Ministry stated belief that further pollution control would be very expensive and would have no beneficial effects on the Ontario environment.[13] The Ministry's postponement of the control order schedule and removal of the 750 ton per day limit might reflect a balancing of the costs and benefits of controlling sulphur dioxide emissions, although this has not been proven. Alternatively it may have been a purely political concession to Inco.

Similarly in its dealing with the pulp and paper industry, the ministry may engage in some rough cost benefit analysis. While the ministry has stated that "this industry must treat the environment so that its operations cause no damage, nuisance or loss of amenities to their neighbouring communities",[14] movement toward this goal has been slow. Donnan and Victor

(1976) point out that while the effluent goals for each mill are designed to achieve water qualities suitable for aquatic life, movement towards these goals has been slow and irregular, with some mills actually increasing their discharges over more than a ten year period. The enforcement strategy appears to involve negotiating and applying moral suasion without imposing serious penalties. This may be consistent with a rough cost benefit analysis if slow progress is allowed at mills where the damage is minor and the costs of control would be major. It is not at all clear that this is in fact the case. Unquestionably however discretion has been applied in designing the compliance program for the various mills and in deciding whether or not to prosecute for delays in compliance.

It should be noted that the data base for cost-benefit analysis is generally weak. It is difficult to assign dollar values to the benefits from pollution control for many of the pollutants of serious concern in Canada. While costs of pollution control can readily be generated by engineering methods, the ministry cannot be certain that the industry is providing cost data for the most efficient control technologies. Furthermore, there is no way to assess reductions in costs that might occur in the future if proper incentives could be generated to stimulate appropriate research and development.

C. How Is Pressure to Abate Applied?

All of the major environmental Acts provide penalties for violations. Penalties under the Fisheries Act may be $100,000 per day.[15] Under the Canada Shipping Act fines may be levied up to $100,000.[16] Fines under the Ontario Water Resources Act[17] and the Ontario Environmental Protection Act[18] are

$5,000 for the first offence and $10,000 per day for subsequent offences. Fines for violating other provincial environmental Acts range from $1,000 to $10,000 per day. Thus heavy penalties could in principle be applied to a persistent violator of most Acts.

In fact, the aggregate fines levied in most jurisdictions have been trivial. Estrin and Swaigen (1978, p. 148) state that from 1959 until 1972, only 11 offenders were fined more than $1,000 apiece under the Federal Fisheries Act in British Columbia and the Maritimes. During the 1970's the fines have increased, and $64,000 was levied in 1977 against one firm for mercury emissions.[19] Donnan and Victor (1976, p. 57) report that the total fines for water pollution levied against the pulp and paper industry in Ontario averaged $812 per conviction, with 12 convictions over a 9 year period. While an exhaustive survey has not been undertaken, it is likely that no Canadian jurisdiction has imposed on any industry fines that represented a significant percentage of costs that would be involved in controlling pollution.

Subsidies to industries have been used in many cases to encourage the installation of pollution control equipment, or at least to lessen resistance to abatement programs. Donnan and Victor (1976, pp. 53-57) identify three sources of provincial subsidy for pollution control including refunds of provincial sales tax, pollution loans of up to $250,000, and accelerated capital cost allowances. More recently, the Ontario Government has promised about one hundred million dollars in direct financial assistance to the Pulp and Paper industry for modernization and pollution control investment over the next five years.[20] The Minister of the Environment told the Standing Committee, "I can and will insist that [time] extensions to control

programs are no longer valid on financial grounds."[21] This subsidy program is thus viewed as removing one argument for delay that has commonly been made by industry.

It is interesting to note that Johnston and Brown (1976, ch 10) state that most European countries use subsidies of a greater or lesser magnitude as an integral part of their pollution control programs. While these authors are not enthusiastic about subsidies they concede that for one reason or another most countries seem to have found them necessary to secure effective action. Most subsidies however are limited to existing firms, and are not available to new sources. This highlights the distinction between the treatment of new and old sources noted above.

It is clear that the primary incentive for pollution control is not fines or subsidies but other forms of pressure. The Ontario Ministry of the Environment regards prosecution and fines as a last resort to be used only in exceptional cases. Holden (1966) describes a process of bargaining for compliance in which the enforcement agency uses formal standards as a starting point for negotiations, and settles for a compromise that is reasonably satisfactory to both parties. The threat of prosecution or of damaging publicity about a recalcitrant polluter are two weapons in an agency's arsenal, but are not likely to be used frequently. Since limited enforcement resources require that the agency secure as much voluntary compliance as possible, it would not choose to undertake actions which alienate a firm or perhaps an entire industry. Given the certainty of a continuing relationship between the agency and major polluters over years and perhaps decades, there is a strong incentive to make the relationship reasonably comfortable. This is natural, but it may be damaging to the pursuit of environmental goals, and it may be inefficient because abatement

requirements will depend not just on costs and benefits but on a host of other factors. While many ministries probably have the power to close down a major source for a substantial or technical violation, they choose not to do this in most circumstances. It is not general policy to use the biggest available club.

D. The Role of Private Remedies

It is difficult to assess the practical value of civil actions by private individuals in controlling pollution discharge in Canada today. Common law actions for riparian rights or private nuisance are possible in most jurisdictions, and have at times led to major victories over significant pollution sources.[22] While legislation has sometimes restricted these common law rights, by granting statutory authority to polluters who are in compliance with specific regulations, or by dissolving injunctions against polluters[23] there is still considerable opportunity for their application. Estrin and Swaigen (1978, part IV) discuss the opportunities for individuals to litigate environmental issues.

Three factors limit the usefulness of private civil litigation for environmental protection. First, a number of environmental acts bar civil suits where the offending act is within the regulations or guidelines or approval of the relevant ministry or agency. Second, some pollution damages the environment without material harm to any individual. Since one can not sue without establishing standing, that is, showing that one has been directly affected in a material way, it is often difficult to find a person who can legitimately sue. Third, many environmental problems impose small costs on a large number of individuals. In these circumstances, it is not worthwhile for an individual to bring an action on his own behalf, since the costs of that action

will frequently far exceed any possible benefits he might reap from its successful completion. Here, a class action, which the plaintiff undertakes on behalf of himself and others similarly situated, might be a useful remedy. However cost and fee rules in Ontario and in some other Canadian jurisdiction seriously limit the attractiveness of class actions for would-be plaintiffs.[24]

E. Summary of Problems With The Present Policies

Several problems emerge from the above description of policies, and from various analyses of those policies. It is frequently stated that the most serious problem facing environmental authorities today is that of securing compliance.[25] The charge is frequently made that the present methods of enforcement, including negotiation and moral suasion, with a minimum of prosecution and conviction simply do not provide sufficient incentives for polluters to undertake capital investments, or even to do research and development on improving control technology. While an extensive survey would be required to ascertain the actual importance of this problem, in some Canadian jurisdictions there has been disappointment with the failure to achieve stated environmental goals. It must be remembered however that achieving all the goals spelled out in environmental legislation may not be desirable from an economic point of view.

The above analysis has suggested that legislation may include symbolic measures intended to generate enthusiasm and approval from environmental advocates. If some environmental legislation and regulations have been drafted without regard to the cost of achieving them, then immediate compliance might not be desirable. In this case, the problem is not that enforcement has been inefficient, but rather that the goals are too ambitious. If the public or environmental groups interpret stated goals as serious

objectives, then this divergence between the goals and what is achieved may be a source of continuing conflict and controversy.

A number of other problems with current policies can be listed. Direct regulation of emissions from various sources within each plant does not achieve a given total amount of pollution control at least cost because the marginal cost of abatement is not equated at each source. Direct regulation, particularly if it is based on best technology provides a disincentive to do research on pollution control technology because what is discovered may have to be installed. More strict control of new sources than of old is inefficient and may discourage the replacement of obsolete plants with more efficient new plants. Capital grants or accelerated depreciation on pollution control facilities will create a bias toward capital intensive methods and tail-end treatment instead of process change.

III - OBJECTIVES FOR ENVIRONMENTAL POLICIES AND CRITERIA FOR EVALUATION

This section will suggest some of the objectives that are pursued by various groups and individuals that influence or are influenced by the pollution control process. The basis for most of the statements about objectives are the published works of other economists or of political scientists, direct interviews, and statements made in hearings regarding environmental policies and legislation. Analyzing the statements and behaviour of interested parties should give some clues as to their underlying objectives, and assist in predicting how they would respond to alternative policy proposals in the future. This section focuses especially on reactions to market oriented pollution control policies since assessing their future is one of the major purposes of this paper.

A. Objectives of Proponents of Environmental Protection

The proponents of environmental policies include organized environmental groups, some academics and professionals in environmentally related fields such as botany, zoology and forestry, and the general public.

Lerman (1977, p. 4-7) argues that an important determinant of the objectives of the public and environmental groups is the perception of pollution as a health related problem. Public statements and discussions about pollution problems tend to emphasize pollution episodes resulting in large numbers of deaths, and the actual or possible deaths from a variety of types of pollution. This association of pollution with health problems causes a tendency to regard pollution control as an absolute goal to be pursued without regard to cost. Thus it is not uncommon to find environmental groups making demands that are couched solely in terms of environmental or health protection, without accepting any desirability of balancing costs and benefits. U.S. Senator Muskie, in debate about the 1970 Clean Act Amendments, specifically stated that the purpose of that Act was to protect public health, without regard to the cost of doing so.[1] Much of the public and many environmental groups would probably agree with Senator Muskie, at least in the abstract.

An outgrowth of this health basis for environmental concern is that when experts are called to public discussions of pollution issues, there is a tendency to call medical and biological experts, rather than economists or engineers. The question addressed is frequently "how bad is this stuff" rather than "how can we balance the control costs and exposure risks?" Furthermore, the traditional method of protecting health is by regulation, as in closing bathing beaches, requiring that sanitary waste be contained in sanitary sewers, and a variety of prohibitions and regulations imposed upon the food processing and restaurant industries. It should therefore

not be surprising to find that public demands for environmental protection take the form of demands for absolute protection, although absolute protection is impossible, and for protection through regulation.

Even when the primary issue is protecting the environment rather than protecting human health, there is a tendency to insist on eliminating damage, if not on eliminating all discharge. Environmental groups may insist that there is a right to a clean environment, and this means either that no environmental damage is to be done, or that no discharge should be allowed even if its harm has not been established. Behind some of these demands for zero discharge seems to be a fear either of a catastrophe of enormous consequence, for example a nuclear power accident, or of some seemingly minor pollution discharge triggering a chain of irreversible and devastating ecological consequences. There is sufficient uncertainty about the long-term environmental effects of many pollutants that serious fears cannot be proven either valid or unfounded. The result of these concerns, particularly among life scientists, is a demand for preservation of the environmental status quo, or for reducing emissions to restore some better environmental condition that previously existed.

Interest group demands for minimizing environmental risks can lead to similar expressions in legislation. In the United States, the water pollution legislation promoted by Senator Muskie promised essentially zero pollution discharge into United States waterways by 1985.[2] While knowledgeable observers do not believe that target will be achieved at that date or in the foreseeable future, the public commitment to the goal was well received by environmental groups and the public at large.

The attitude of environmental groups to particular pollution policies such as effluent charges or pollution rights has been limited in Canada

since few such proposals have come forth. There have been few demands by Canadian environmental groups for market-type pollution policies to replace or supplement regulatory policies. During 1979, several groups endorsed the provisions of Bill 24 then being considered by the Ontario Legislature which would make the owner or possessor of a hazardous material responsible for costs of cleaning up if it should spill. Some environmental groups have supported the pollution control delay penalty analyzed by Donnan and Victor, (1976). In the United States, Anderson (1977, p. 149) reports that until 1971 environmental groups either took no position on market-oriented policies or opposed them. In the early 1970's however this began to change, and several groups formed the Coalition to Tax Pollution. At the time of Nixon's sulphur tax proposal in 1971, and Proxmire's water pollution effluent charge proposal, there was mixed support from environmental groups. Those proposals also had support from academic economists, who had been in part responsible for the reform of benefit-cost analysis in the United States in the 1960's.

The attitude of the general public toward market-oriented pollution control policies is probably not well informed reflecting a similar condition in the press. Holden (1966, pp. 34-35) identifies several "social values and myths" that would shape the public attitude towards such policies. These attitudes include: 1) pollution is a threat to health; 2) pollution control is costly and may destroy jobs; 3) pollution is a form of exploitation by "the spoilers"; and 4) pollution is a desecration of nature, whatever that means. The perception of pollution as a health problem, a desecretion, and an act by "the spoilers" will incline people to demand prohibitions. An effluent tax is not an appealing protection against an activity

that is widely perceived as evil. The popular view is that when you have a health problem or anti-social behaviour you don't tax it, you prohibit it. That this may cause problems for a regulatory agency if many jobs are destroyed by strict prohibitions is simply a reflection of inconsistent or at least conflicting desires of part of the public.

Lerman (1977, p. 4-26) points out that the public, if it is aware of effluent charges, tends to regard them as a licence to pollute. Economists describe this perception as silly and incorrect but it is widespread, and thus influential in limiting the public's faith in the efficacy of effluent charges. Furthermore, testimony on effluent charge proposals and responses by elected officials suggest a widespread lack of faith in the operation of the market system. Many people simply do not believe that if you raise the price of pollution, firms will pollute less.[3] When a tax on lead in gasoline was proposed, there was widespread belief that this would simply allow oil companies to raise the price of all gasolines, and not necessarily change the relative price of leaded and unleaded, and therefore not necessarily reduce the production of leaded gasoline. In fact many people do not believe in general that there is a quantity response to prices. This means that many people will not accept the most elementary arguments in favour of effluent charges.

B. Political and Legislative Objectives

We may suppose that governments in general and environmental ministers in particular would prefer, other things being equal, to provide the public the clean environment that is demanded by some. When the costs of pollution

control are not trivial, however, there will be resistance to policies of strict control, and then tough political decisions must be made. We will consider a few political maxims that have been developed to explain political behaviour, and then examine some environmental examples.

Hartle (1979, pp. 73,87) suggests several political axioms. His first axiom is that "voters will not accept any scheme that explicitly acknowledges that each human life is not infinitely valuable". This points up the importance of the general view that pollution control is a health problem. If it is so perceived, then it is not politically acceptable to engage in cost benefit analysis when drafting pollution control legislation. Thus many provincial and federal pollution control acts include a section which prohibits all harmful discharges of pollution or all potentially harmful discharges.[4] Such "tough" legislation provides a government with evidence that it has taken a no nonsense approach toward pollution control. When one examines the legislation in detail, one finds numerous general and special exceptions to the tough-looking rule.

The "sacredness of human life" axiom presents a very difficult problem for effluent charges or effluent rights schemes. Both of these market-oriented policies explicitly recognize that some pollution should be allowed, and this may be regarded as repugnant in any case where health issues may be involved. Hartle asks, "can the well-to-do be allowed to buy the right to make other people sick?" Few governments may be prepared to risk having their policies so described.

Hartle suggests a second axiom that "voters will not readily accept the decision to allocate what they perceive to be rewards to those whom they

perceive to be 'the bad guys'." (1979, p. 87) Pollution is generally identified as a "bad" activity particularly if it is done by a large corporation, so it may be difficult for a government to make major concessions to that corporation, although Ontario has shown some generosity to its major polluters. If pollution and polluters are regarded as bad, then they must be treated by prohibitions, regulations, and prosecution for violation. It may be unacceptable to sell the right to pollute through an effluent charge or through effluent rights.

Lerman (1977, p. 4-12 to 4-18) emphasizes the importance of symbolic acts in politics. He suggests that a politician will satisfy his environmental constituents by the symbolic act of passing tough-sounding pollution control legislation. He can then satisfy his industry constituents by failing to enforce that legislation vigorously. Most citizens, with many other demands on their time, will only notice the passage of the Act, and not the failure to enforce it. In any event, the failure to enforce will not be obvious for many years, and so it may not weigh very heavily in the political balance. Ingram (1978) also emphasizes the importance of symbolic legislation, as an explanation for the tough standards embodied in the U.S. 1970 Clean Air Act. The general implication of the theory of symbolic legislation for environmental concerns is that we should expect "tough" legislation to satisfy environmental groups and the general public, and weak enforcement with many complex exceptions to provide an accomodation with the pollution sources themselves. This stems in part from the concentrated interest of polluters who will follow closely the implementation of a program, and the diffuse interests of the general public who are individually affected very little and thus have little incentive to follow more than the broad public statements about environmental policy.

The importance of symbolic legislation has particular implications for market-oriented pollution control policies. Lerman concludes that "one quality of effluent tax policies is that they appear not to provide the necessary symbolic reassurance (to the public), especially when compared to standards and penalties[5]. Effluent charges are not a symbol of "getting tough" because they are seen as indirect or ineffective when compared to standards. Furthermore, the public perception of an effluent charge as a licence to pollute would rob such a policy of any symbolic value. Even if legislators or governments generally believe that effluent charges would be more effective than regulations, they might not support such a policy because they will be judged for their position on this issue rather than for the effects which might be achieved.[6] There seems to be a strong concensus that the electorate will perceive simple direct regulatory action as more effective than charges or rights. That this belief may be erroneous will be of little interest to the serious politician.

Finally, market-oriented pollution policies represent an innovation as compared to previous regulatory policies. Ingram (1978) argues that the rewards for innovation in legislation are relatively limited. Especially where the success of the innovation is not apparent to the public, the rewards for innovation may be nil or negative. There are far more risks in pursuing an innovative policy such as an effluent charge than in pursuing traditional remedies, unless the general public is convinced that the traditional remedies are in fact ineffective. Thus it may be necessary to fail using traditional methods before innovation becomes politically acceptable.

C. Objectives of Pollution Control Agencies and Bureaucrats

Other things being equal, most pollution control agencies and the individual staff members of those agencies would be motivated to implement effective policies that eliminate pollution as a matter of significant public concern. Since there would be considerable resistance to such a policy from those who would have to bear its costs, difficult decisions must be made as to how much pressure to put on each of a number of pollution sources and in a variety of industries located in disparate portions of a province or the country. It is in making these choices that the objectives of the agency and its staff will be revealed.

Since the benefits of pollution control generally fall upon a large number of individuals, in a small amount per individual, while the costs of pollution control generally fall upon a small number of firms or sources, with large dollar consequences for each, pressures on the agency from the two sides are quite different. Few of those who benefit from pollution control will appear before the agency, and then only in regard to specific problems that affect them in some substantial way. Major pollution sources will generally be in frequent contact with the agency, particularly if there is an ongoing attempt to affect the behaviour of the polluter. In this situation, we might expect to find one of Hartle's injunctions observed: "never do anything substantial when a symbolic gesture will suffice".[7] If tough legislation has been enacted, that may satisfy the public desire for a strong symbolic stance. There will be every incentive not to enforce the strict standard, so long as this will not become obvious to a concerned segment of the public, since non-enforcement will satisfy the polluters who are in the best position to make strong representations to the Ministry.

Holden (1966) suggests that the interaction between the regulatory agency and the regulated polluter is essentially a bargaining process. In carrying out the legislative mandate to control pollution, the agency proposes ambient quality standards, and receives submissions and arguments from affected parties, including polluters and environmental groups as to the appropriateness of those standards or the desirability of some alternate standard. After ambient quality objectives have been adopted, emissions standards must be set that will move toward the achievement of the ambient quality goals. Again, an information exchange or bargaining takes place between the agency and interested parties and polluters. After emissions standards have been adopted, enforcement decisions must be made. Once more, the agency must make important judgments as to which sources to pursue, how much delay to accept, and what behaviour to deem to be compliance. Again, there will be serious bargaining with the emissions sources, and probably less contact with environmental groups or representatives than in the previous stages.

It would require an active, effective and politically powerful environmental lobby to counterbalance the representations from pollution sources so that the actual enforcement of the Act fulfills its symbolic goals. Such a lobby will rarely exist. In the absence of persistent and powerful input from environmental groups one might expect the continuing bargaining between polluters and the pollution control agency to lead to continual compromise and thus to an environmental result that falls significantly short of that apparently promised in the Act. If the Act established reasonable standards, the bargaining will lead to inefficient pollution control. On the other hand, if the Act was unreasonably "tough" in order to maximize its symbolic value, some compromise may be desirable. This suggests that the success of an environmental agency should not be

measured purely by comparing the degree of pollution control with that promised by the legislation. The legislative goal may be overstated from a cost-benefit point of view, in which case an agency that fell far short of achieving the stated goal of the Act might in fact just reach the efficient degree of pollution control, although this is a fortuitous, not a necessary, result. Holden (1966, p. 29) goes so far as to suggest that much of the activity of a regulatory agency has little to do with achieving an environmental goal and a lot to do with achieving a tolerable working arrangement with the regulated industry.

Holden also suggests that for an agency to be effective it must have some sense of mission and some means to measure its progress toward a goal. If there is little or no solid evidence that a pollutant is in fact harmful, it will be difficult for an agency to sustain a drive to control that pollutant, in the face of vigorous opposition from polluters. When the pollutant is known to be harmful but the magnitude of that harm is subject to great uncertainty, it may be very important to establish ambient quality standards simply to provide a tangible goal for the agency to work toward, since eliminating disease or restoring fish may not be a practicable goal given the environmental uncertainties. It may be important for the agency to be able to demonstrate continual reductions in emissions from one year to the next in order to satisfy itself, and perhaps the public, that it is making progress. The construction of physical waste treatment facilities by polluters may be of great symbolic importance to the agency as another physical demonstration of progress. Thus the agency may be biased toward capital intensive projects that achieve specific abatement goals.

With regard to alternative methods for achieving environmental goals,

agencies should have several obvious preferences. Anderson (1977, p. 155) suggests that like everyone else bureaucrats prefer the familiar to the unfamiliar, and therefore will tend to resist innovations such as effluent charges or pollution right schemes simply because they are different from the direct regulation methods they are familiar with. Most Canadian environmental agencies have been operating for a decade, many of them for much longer, and they have developed complex procedures for handling problems. It would be surprising if an agency were prepared to abandon a large body of familiar procedures in favour of something completely new.

In addition, the preferences of agency staff should depend in part on their own training and background. Environmental agencies in Canada tend to be staffed by engineers, biologists, botanists, lawyers, and other natural and physical scientists. The theoretical appeal of market-oriented policies will not be apparent to individuals without economic training, and even the notion that an effluent charge might lead to pollution reductions would probably be rejected as unlikely by most staff members of environmental agencies. Engineers tend to think in terms of technical solutions, and therefore would prefer policies that specifically require particularly desirable technical solutions. Lawyers tend to think in terms of traditional regulation and enforcement techniques, and not in terms of market incentives. Lerman (1977, p. 4-11) suggests that it would be surprising if the ideas of economists were to find a warm reception in such a situation.

The pollution delay penalty concept was developed in the Ontario Ministry of the Environment by two economists on the Ministry's staff. That idea has been discussed to some extent in the five year since its first publication, but there has been little or no enthusiasm in the Ministry

among the other staff who are generally not economists. A poll of agency staff on the question of replacing direct regulation with economic incentives would probably reveal opposition to the change.

It is interesting to contrast the reception accorded to sewer surcharges in Canada in the various municipalities where they have been adopted. These surcharges are applied as a charge by the municipality for treating extra strength waste discharged into the sewer system by major industrial sources.[8] While the adoption of surcharges is not universal nor growing rapidly they have been adopted with a relative minimum of fuss in a number of Canadian jurisdictions. Here however the motivation has been primarily as a revenue measure rather than as an incentive to reduce pollution. Furthermore, municipal sewage treatment operators are accustomed to levying charges for sewage treatment based upon water use or some other simple measure. It is a logical extension of their normal revenue procedure to apply a surcharge for treating extra strength wastes. The cost of operating the sewage treatment plant provides a straightforward and non-subjective basis for calculating the charge. Thus the engineers who dominate such systems do not find sewer surcharges nearly as alien as they would an effluent charge for discharging wastes directly into the environment. In the latter case, there is no service provided and no cost basis for determining the magnitude of the charge. The sewer surcharge and the effluent charge are therefore perceived quite differently by these agencies.

Finally, Holden (1966) makes the point that the bargaining between the agency and the polluters might not be significantly reduced by replacing direct regulation with an effluent charge. This bargaining results from the complexity of the measurement problem and the tremendous financial incentive

on polluters to delay or avoid compliance. An effluent charge may impose large financial penalties, so one could expect to see intensive bargaining over the timing of application, the level of the charge, the basis on which effluent was to be measured and a host of other technical factors. Economists have been perhaps too optimistic about the extent to which effluent charges will simplify the administeration of pollution control programs.

D. Polluter Objectives

One expert has indicated that firms subject to environmental regulations have two major concerns.[9] First, they want assurances that all of their competitors will be subject to the same environmental regulations that are proposed for them. This is the natural reaction of a firm in a competitive industry wanting to avoid being put at a disadvantage. Second, they want some reduction in uncertainty, including some assurance that the standard promulgated today will not be replaced by an inconsistent one next year after they have already made an irrecoverable investment to comply with the present standard. Pollution regulations often specify particular options or technologies for a variety of sources in a plant, and these have been changed frequently in the past. Since the last decade has seen a rapid evolution in pollution control objectives and standards, it would not be surprising if some polluters felt harrassed by constantly changing demands.

One could add a few other objectives that are less basic. First, an individual firm would certainly prefer no regulation to regulation, and less regulation to more, other things being equal. The expenditure of money and the change in operating procedures implicit in pollution control will undoubtedly be resisted by businessmen. Second, most polluters are probably more compliant when there is a clear benefit from reducing their emissions.

If a pollutant is known to be harmful and is in fact observed to cause harm, the polluter may be concerned about civil liability and thus have an independent incentive to abate. If there is no known damage, or the possibility of damage is highly speculative, the firm may regard the regulation as wasteful, even if it will be applied uniformly to all industry members. Furthermore, a firm might fear that compliance with an apparently pointless regulation may lead to more pointless demands in the future. Better to resist the first than to start fighting after several have been accepted.

Anderson (1977, pp. 157-162) shows that industry has consistently opposed effluent charges when they have been suggested in the United States. Two major arguments were raised in opposition to Senator Proximire's proposed tax on effluent discharge into waterways. First, industry regards an effluent charge as imposing a double burden because firms must pay first for pollution control and second for any remaining discharge. Unless the efficiency gains of the effluent charge are great, or the remaining amount of pollution is minimal, the total financial burden will indeed be greater for an effluent charge than a standard. Second, industry argued that the effluent charges would be especially burdensome to small firms, as compared to large firms. For this to be true, there would have to be economies of scale in pollution control or some particular inefficiency for small firms as compared to large ones. It seems quite plausible that there are economies of scale in pollution control devices to a substantial level, so that this argument might be true for some cases. It is not clear however why an effluent charge would be more burdensome to small firms than effluent regulations which did not give a special break to small firms. A

third, unstated reason may be the fear that effluent charges would work - that they would impose large costs and force abatement expenditures which could be avoided by negotiation and delay in a regulatory regime.

Lerman (1977, pp. 14-19) notes the almost unanimous business opposition to effluent charges in general and in particular to a proposal to impose a tax on leaded gasoline in 1970. Arguments against effluent charges included the suggestion that it was inflationary, that it discriminated against the poor, and that it would discriminate against small refiners. Lerman speculates that the motives behind this opposition might have included fears that the effluent charges would become another revenue source, and the dislike of the symbolic implication that paying an effluent charge would be perceived as admitting to wrongdoing. One steel plant apparently closed when a fine of $2300 per day was levied for pollution violations giving as its reason its refusal to pay "a daily tribute to the government".[10]

Furthermore, if economists are correct that effluent charges will be effective, that in itself is reason for business to oppose them. An effluent charge that works is far more expensive than an effluent standard that does not work and does not lead to significant penalties being levied.

In considering the attitude of polluters it would be a mistake to overlook the attitude of labour. Lerman suggests that labour has been at least as opposed to effluent charges as has business. The public arguments by labour against effluent charges include damage to consumers, the licence to pollute argument, the belief that they would be inflationary, and a clear lack of belief that pricing has any incentive effect. It appears that labour shares the general public view that an effluent charge may simply be passed on with no effect on pollution discharge. In addition, labour

may correctly perceive that effluent charges would succeed in reducing emissions where regulation has failed, and that this would increase dislocations of the work force. In this they are probably correct, but the costs of those dislocations must be balanced against the benefits of pollution control.

E. Economic Criteria for Evaluation

It is interesting to contrast the objectives of the above parties, representing the major forces affecting environmental legislation, with the objectives stated by economists. Economists place primary importance on technical efficiency: achieving a given degree of pollution control at the least cost. It is hard to see this goal in the objectives of any of the major parties discussed above, except if industry is resigned to a massive clean-up program, and if the efficiency gains of one policy are substantial compared to that of another. If industry is reasonably successful in delaying expenditures for pollution control, there is no reason for it to support an efficient method that eliminates this delay.

Economists are also concerned about dynamic efficiency, including the ability of pollution control policies to cause technological progress that improves the efficiency and reduces the cost of pollution controls. A firm or industry that was resigned to a certain degree of pollution control could also favour technological progress. However under direct regulatory regimes industry can frequently postpone compliance on the grounds that technology is not currently available or is too expensive. In this situation technological progress is the last thing that industry wants; if better technology appears it may have to be adopted. Thus there is little reason for industry to prefer policies leading to such progress.

Since environmental groups tend not to consider costs in making their demands, efficiency is not high on their list of priorities. A few environmental groups have endorsed market-oriented policies, motivated by a belief that these will lead to more pollution control, rather than by a concern for minimizing the cost of achieving a given degree of control.

Finally, economists can measure and talk about the income distribution consequences of environmental policies. In general, however, where these are not trivial, it is suggested that other income distribution policies be used to offset any undesirable distributional consequences of environmental policy. Since the distribution of benefits and burdens is a major factor in politics, and of great concern in business, the distributional effects may be paramount for political and business groups, when economists profess little interest in them.

There is not much in common between the motives that have impelled economists to favour effluent charges and the objectives of the major parties in environmental policy issues. It is not therefore surprising that the successful market-oriented policies have been those which promised not efficiency but action. The Connecticut plan which imposes penalties for delaying compliance equal to the cost of compliance is not a true effluent charge, but an effective penalty to force compliance. The compliance penalties written into the 1977 Clean Air Act Amendments of the United States are very similar to the Connecticut plan. The sewer surcharges in use in Canada are essentially revenue measures and do not behave like ideal effluent charges.

One conclusion from this is that the failure of the economists to sell their charges and rights schemes should not be surprising since their major argument is a matter of little interest to potential buyers. The challenge

is to search for policies which will both achieve some of the efficiency objectives sought by economists and satisfy a reasonable number of the objectives of the other parties listed above so that there is some chance of implementation. This will be discussed in Section V of this paper.

IV COMPARISON OF CURRENT AND ALTERNATIVE ENVIRONMENTAL POLICIES

A. Definitions of Alternatives

We will consider three alternatives to traditional regulatory policies. The first is the effluent charge in which a price is set for each unit of pollution discharged from each source. A charge might be used for a single pollutant or many, but the rate would be specified separately for each pollutant. An effluent charge might be uniform across a province or the country, or it might vary from one region to another. The charge might be constant over time, or it might be higher during some periods and lower at other periods. The charge rate might be established in legislation, set by regulation or triggered by some specified variables such as ambient air or water quality. Finally, an effluent charge might apply to all units of pollution discharged from each source, or it might apply only to discharges in excess of some specified rate, density, or quantity. In the latter case, the effluent charge behaves like a means for enforcing an effluent standard.

The second alternative is a mixed approach in which a polluter who fails to comply with an emission regulation or abatement program may be subject to a specified charge related to the extent by which he exceeds the standard. The penalty could be the cost the polluter would have incurred in complying with the discharge regulation or a fixed charge rate.

This plan is designed to eliminate the profit from postponing or avoiding pollution control.

The third alternative to existing policies is the use of effluent rights, described by Dales (1968). Under an effluent rights program, the environmental agency specifies the maximum total rate of pollution emission for all sources in a region, province, or the entire country. The agency then issues rights to discharge pollution at a limited rate such that the total discharge under all rights is the desired total discharge of that pollutant. The rights may be sold to polluters by auction, distributed to existing polluters in proportion to recent emissions, or distributed by any other method. Discharge of pollution in excess of the amount allowed by one's pollution rights is strictly prohibited and severely penalized. Once issued, the pollution rights may be bought and sold at whatever price they command. The pollution rights scheme creates a market for the right to discharge pollution, with the market price established not directly by government but by the interaction of the total quantity of rights distributed and the demand for those rights by polluters.

B. The Economic Arguments for Alternate Policies

Economists have identified a number of advantages that effluent charges or effluent rights schemes might have over the traditional approach of setting emission standards and imposing fines on violators. These arguments are well presented in Baumol and Oates (1979, chapter 16), Anderson (1977, chapter 2), and Kneese and Schultze (1975, chapter 7). The economic arguments in favour of charges and rights are that they equate marginal costs and marginal benefits, that they achieve a given degree of pollution control

at least cost, that they provide incentives for technological process, that they reduce incentives for polluters to delay in compliance, and that they reduce the excess burden of other taxes. We will assess these arguments briefly below.

1. Equating marginal costs and marginal benefits

Kneese and Bower (1968, Chapters 6 and 7) suggest that the ideal basis for determining an effluent charge is to set the charge per unit of waste equal to the marginal damage per unit of waste discharge, which is the same as the marginal benefit of pollution control. Polluters will reduce emissions until the marginal cost and the marginal benefit of abatement are equated. This result will be more efficient than setting effluent standards unless the standards are set to equate marginal costs and marginal benefits.

Precise estimation of marginal benefits is difficult or impossible, however so the choice between standards and charges may depend on the shape of the marginal cost and benefit curves, and the nature of the uncertainty about them. If marginal benefits are not constant over different levels of environmental quality, the agency must either know the marginal cost functions beforehand or must adjust the effluent charge as pollution control occurs in order that in equilibrium the charge represents the marginal benefits at that level of pollution control. When benefit data are limited charges may be more efficient if the marginal benefit schedule is thought to be horizontal, while specifying the desired environmental quality may be more efficient if marginal damages are thought to be steeply rising in the vicinity of the desired environmental quality.[1]

2. Least Cost

Effluent charges or effluent rights achieve a given total amount of pollution control from a number of sources at the least possible cost by equating the marginal cost of abatement at all sources. A set of effluent standards that is uniform for all firms will lead to marginal abatement costs that are different among those firms, if their abatement cost functions are not identical, and therefore to a higher total cost of abatement.[2] Empirical studies of pollution control costs have shown that traditional regulatory approaches may lead to costs twice as great as those incurred under an effluent charge.[3] Even if discharge standards are set individually for each source, the pollution control agency would require accurate cost information to set the standards such that marginal costs of abatement were in fact equated.

One limitation of this argument is that minimizing the total cost of abatement from a number of sources is of interest only if the effect of a unit of pollution discharge from one source is identical to that of a unit of discharge from the other sources. This would be true in a perfectly mixed environment such as a short section of a river, a small turbulent lake, or a compact urban air shed. Where the environment is not perfectly mixed, the marginal damage from one unit of pollution discharge by firm A will generally be different from the marginal damage caused by one unit of pollution discharged by firm B. Equating marginal abatement costs will minimize the total cost of a given total pollution reduction, but will no longer equate marginal costs and marginal benefits at all sources. In short, with an unmixed environment, minimizing the total cost of abatement may conflict with the goal of equating for each source the marginal cost and marginal

benefit of abatement. Ackerman and Ackerman (1975) identify this as a major problem with the effluent charge scheme proposed for the Delaware River; proper application of that scheme might have meant significant changes in the charge from one reach of the river to the next, requiring a complex charge scheme with information requirements not significantly less than an efficient scheme of effluent standards. Cost minimization may also conflict with fairness. It may be thought unfair that firm A must abate by 90 percent while firm B abates by 10 percent just because firm A can abate at lower cost.

There is another aspect to minimizing the cost of pollution control. A single polluter will have a variety of alternative means for pollution control including treating the wastes once they have been generated, changing the production process to produce less wastes, or changing the product mix or output to generate less waste. An efficient pollution control policy must encourage the polluter to select the least cost combination of these techniques. In principle, charges, standards and rights should all provide the same incentive for the polluter to minimize his pollution control costs, given a set of available technology. If there are specific incentives, such as tax breaks or grants for capital equipment, then the polluter will use this method of control more intensively, and therefore no longer minimize the total cost of abatement. Furthermore, standards are often specified for various processes within a plant or mill, which will not necessarily equate the marginal cost for each process. Thus charges and rights may often have further advantages with respect to least cost.

Should an effluent charge be uniform across Canada, or should it be high in large cities where pollution is severe and many people are exposed

and low in the country which is clean and little populated? It is often assumed that marginal benefits will be low in clean areas, and that charges should be lower there. Dales (1968, pp. 88-92) argues that the price of pollution should be uniform over urban and rural areas because there is some value in preserving diversity in the environment. Low charges in clean areas would create an incentive for dirty industry to move there, leading in the long run to uniform pollution densities. Yet some people prefer to live in clean areas, and many people may prefer that clean areas exist for recreation. Thus the benefits of pollution control in clean areas may be just as great as in dirty areas. This argument would justify effluent charges that were uniform over large areas: perhaps entire provinces or even the entire country. It would also mean that the goal of equating marginal costs and marginal benefits would coincide with minimizing the total cost of pollution control within the appropriate area.

3. Technological Progress

In the long run pollution control costs may be determined primarily by technological progress. There is continuing debate among economists and others whether effluent standards or effluent charges would lead to more rapid technological progress to develop efficient technology that would achieve the same degree of pollution control.[4] While this debate is still unresolved, economists have argued further that effluent charges or effluent rights will create incentives to develop technology that goes beyond any specific set of standards. Under a fixed effluent standard, there is no reason to develop technology that achieves more than the standard, while under the effluent charge or effluent rights there is an incentive to develop technology up to the point

where emissions are completely eliminated since this is the only way to eliminate paying the charge or the cost of owing the rights. In fact, with effluent standards there are incentives not to develop more effective technology since the agency may then require that it be adopted. Thus the charges and rights schemes offer greater incentives for technological progress than do fixed standards. Penalty charges for violating standards should provide an incentive similar to an effluent charge for developing technology that meets the standard, but no incentive to develop technology that goes beyond it. If one admits that standards may be modified to apply continual pressure for technological progress, the advantage of charges and rights is less obvious. Flexible standards over time however cause problems with the incentives created for the polluters themselves, as discussed below.

4. Proper Incentives

Russell (1979) articulates the economic argument that has gained the most widespread acceptance; that effluent charges and rights create incentives for polluters to reduce their emissions and develop new technology, while effluent standards create incentives to delay pollution control and to suppress new technology. Anderson (1977, pp. 12-18) points out that a system of effluent standards leads immediately to strategic bargaining between the polluter and the control agency. Since large fines are rarely imposed on polluters, in Canada or the United States, there is every reason for the polluter to debate the wisdom of a standard once adopted, complain about the difficulties of compliance, and take no actual steps to comply, so long as an appearance of a good faith attempt to comply can be maintained.

Furthermore, it is common for pollution standards to be flexible over time, either explicitly or implicitly. Explicit flexibility occurs in standards requiring the use of the best available technology or best

practical technology. Implicit flexibility occurs when an agency is prepared to make its standard more stringent if it discovers that the more stringent standard can be met.[5] In either case, the industry has every incentive to conceal new developments in pollution control, and not to look for such developments. Unless a breakthrough is achieved which renders pollution control costs trivial, the development of more effective control technology is likely only to mean that this more effective technology will have to be installed. In many regulatory situations the worst possible outcome of a pollution control research program for an industry would be the discovery of a highly effective but very expensive method of pollution control where none had existed previously, since the agency may force its adoption.

An effluent charge, it is argued, would reverse these incentives. If the charge is levied at a specified rate regardless of technological opportunities, then polluters can save money by developing improved technology. The profit incentive leads not to delay but to rapid progress with research and development to achieve greater control and less expensive control. Thus the charges and rights will in the long run be far more efficient than standards because they create desirable rather than perverse incentives.

This argument assumes that the agency will be prepared to impose an effluent charge regardless of the availability of control technology. This would be a major departure from the past control philosophy in which major enforcement actions are rarely undertaken where there is no foreseeable hope of the polluter complying other than by shutting down. While economists may be right that charging 15¢ per pound of sulfur oxide emissions will spur industry across North America to develop technology for controlling such emissions, there is a real question whether the implementation of an effluent charge would be in this form. It is possible that while the format

of an effluent charge might be adopted, its incentives would be crippled by postponing the application of the charge until technology had been developed. Thus the clear advantage of the effluent charge in this regard depends upon a rigorous implementation, and a willingness to impose heavy charges on polluters when it may not be apparent how they could reduce their emissions.

Penalty charges may behave somewhat like an effluent charge, but not identically. A penalty charge may be based on the cost saving to the firm from non-compliance, which assumes that the technology of abatement is known, proven, and can be costed accurately. Where this assumption holds, the penalty charge should create proper incentives. Where the technology of abatement is unknown or unproven however, it is not clear how a penalty charge would be implemented. There the effluent charge has a clear advantage.

Suppose that effluent rights were issued to allow current emissions, with the quantity of rights to be reduced in the future to force reduced emissions. Would each firm resist a reduction in the total rights issue with the same vigour that it resists reductions in its effluent standard? Clearly not, because of the public good problem. If firm x's discharge standard is reduced, firm x is affected directly in a measurable way. If the total rights issue is reduced, then the value of all rights rises along with their cost. The wealth effect partly offsets the cost effect, and the effect is spread over all firms. No one firm will have a great interest in resisting this move.

5. Revenues Reduce Excess Tax Burden

Most taxes, such as income taxes and excise taxes, generate "excess burden", a form of economic inefficiency, by causing a divergence between the value of labour or a commodity to the buyer and to the seller. Effluent charges or effluent rights schemes which generated substantial government revenues would allow the reduction of other forms of taxation. Since the effluent charge is welfare improving rather than welfare reducing, the net effect of substituting effluent charge revenues for other forms of tax revenue would be to reduce the total excess burden in the economy, and therefore to improve its efficiency.

There are problems however in treating effluent charges as revenue measures. If the charge is successful in reducing emissions, then its revenue potential is far less than would be estimated by multiplying current emissions times the proposed charge rate. If economists are right about the efficiency and technological progress advantages of charges, one should expect in the long run that their revenue potential would be much less than current emission rates would suggest. Alternatively, governments may seize upon the charge as a revenue device and set its level to maximize revenue rather than to control emissions. Maximum revenue might be derived by a high charge, or by a low one that failed to induce pollution abatement.

While the former outcome might be applauded by environmentalists, they would receive the latter with horror. Thus while there are indeed fiscal benefits from effluent charge schemes heavy reliance on this factor might risk subverting the purpose of the program itself.

The above discussion is focused primarily upon effluent charges and effluent rights. Schemes such as the Connecticut plan clearly do not fulfill the first two objectives, nor the fifth since that plan is primarily a means of enforcing a traditional set of effluent standards. The Connecticut plan does however create proper incentives, by eliminating the financial benefits of delay, and may induce technological progress as a result. The PCDP comes closer than the Connecticut plan to fulfilling the "least cost" objective because it would allow a high cost polluter to continue polluting. Thus the choice between rights, charges or something like the Connecticut plan may depend upon one's belief as to the relative importance of creating proper incentives for enforcing standards, versus equating marginal costs among a number of pollution sources.

C. Fate of Previous Proposals

1. Pollution Control Delay Penalty

Donnan and Victor (1976) identified several alternatives that the Ontario Ministry of Environment might pursue in seeking compliance with its objectives for the pulp and paper industry in Ontario. One of these options was a "pollution control delay penalty" (PCDP). The PCDP was designed to encourage compliance with pollution control regulations, and not as a revenue source nor as a means of allocating the burden of pollution control among a number of sources.

The PCDP requires a schedule of effluent reduction that may be uniform for all sources or determined individually for each source and specifies allowable emission rates that diminish over time to some ultimate goal. This is an element in most current programs for pollution reduction. If the polluter fails to comply with the schedule he is not subject to prosecution or administrative proceedings, but automatically owes a penalty based upon the extent to which his emissions exceed the scheduled discharge applicable at that time. A polluter who complies with his abatement program will pay no penalty at any time. A polluter who fails to comply will automatically be liable for payments which can be easily determined by comparing his actual emission rate with the allowable emission rate and multiplying the difference by the penalty rate. This is similar to using an effluent charge to enforce a standard. It differs from present enforcement procedures in that the magnitude of the charge is easily computed, while the magnitude of a fine is difficult to predict. The total charge would be far greater than any fines levied court in Canada if the violation was serious. Donnan and Victor suggested that the PCDP might be applied to the discharge of BOD and suspended solids from pulp and paper mills in Ontario. While they did not specifically advocate the PCDP, their evaluation suggested that it would solve the enforcement problem better than other policies.

The PCDP has not been adopted by the Ontario Ministry of Environment for dealing with the pulp and paper industry, nor for any other industry in the Province. Recently, the PCDP was discussed in a report to the Ontario Legislature.[6] That report quotes the current minister of the environment, Dr. Parott, as stating that the ministry has considered the PCDP at considerable length but does not believe it is what the industry needs. (Nobody had suggested that the industry would favour it). The report goes on to recommend

that prosecutions under the existing system should be pursued more vigorously, and that the PCDP alternative should be studied carefully and reported on during 1979.[7]

Because the PCDP has not been publically debated, there is not a clear record of the reasons for favouring or opposing it. The Ontario Ministry of the Environment expressed concern that collecting the PCDP would contribute to government revenue rather than benefiting northern communities depending on the pulp and paper industry.[8] Of course, if each mill meets its discharge schedule, no payments would be made, and northern communities would benefit from a cleaner environment. The Committee itself apparently found the PCDP idea attractive as a means of enforcing standards which the ministry has had difficulty enforcing in the past, and did not discuss issues of economic efficiency or achieving abatement at least cost. It seems likely that this proposal will be discussed in the future with respect to the pulp and paper industry and perhaps other problem polluters in the province of Ontario, but it is impossible at this time to predict whether it might ever be adopted.

2. The United States Sulfur Oxide Tax

In 1971 and 1972 the Nixon administration proposed a tax on sulfur oxide emission into the atmosphere as an incentive to reduce those emissions.[9] The Nixon proposal levied a charge on the discharge of sulfur oxides of 15¢ per pound of sulfur in areas with severe air pollution problems, 10¢ per pound in areas with modest air pollution problems, and no charge in areas that do not exceed any ambient air quality standard. The 15¢ per pound rate was intended to approximate the cost of the pollution control technology that was available then. At the same time, The Coalition to Tax Pollution developed a proposal for a tax starting at 5¢ per pound of sulfur in the fuel in 1972

and rising in 5¢ increments each year to 20¢ per pound in 1975 and thereafter. A 20¢ per pound tax on the sulfur content of fuels is equal to a 10¢ per pound tax on sulfur oxide emissions. A bill similar to the Coalition proposal was introduced as Senate Bill 3057 by Senator Proxmire on January 24, 1972. There was no geographical variation in the tax rate under the Coalition/Proxmire proposal, a feature applauded by Dales (1968).

Neither of the above proposals was adopted, although they generated considerable debate. The Nixon proposal was attacked because it would encourage polluters to move from dirty areas to clean areas thus reducing the entire country to what environmentalists regarded as an unacceptably low level of environmental quality. Congressman Aspin complained that the Nixon proposal left no incentive for polluters to clean up beyond the standards specified in the legislation. He also suggested that the maximum rate of 15¢ per pound was not high enough.[10] All three of these objections were met by the Aspin and Proxmire bills.

Several reasons have been given for the complete defeat of all proposals. At the time these bills were introduced Senator Muskie was regarded as the leading environmental member of congress. Senator Muskie was, and still is, fully committed to the direct regulatory approach.[11] His opposition to effluent charges of any kind created a political problem for these bills in the Senate. Because the proposals took the form of amendments to the U.S. Internal Revenue Code, they had to pass through the House Ways and Means Committee, chaired by Congressman Wilbur Mills. Mills was hostile to the concept of effluent charges, and his opposition in that crucial committee created similar political problems for the bills in the House of Representatives. Anderson (1977, p. 154) suggests that with

Mills as chairman of this committee industry had a virtual veto over effluent charges, and industry was not enthusiastic about those charges. Industry's opposition arose from a correct belief that the effluent charge would require not only expenditures for pollution control, but also payments for any remaining emissions. In addition, there may have been a sensible fear that an effluent charge would work whereas regulations can be circumvented.[12] The U.S. Department of Commerce, representing industry views, opposed the bill.

Elsewhere in the government, there was little support. The Treasury department whose staff includes many economists supported the effluent charge. Some environmental groups represented by the Coalition to Tax Pollution supported the charges but other groups did not. The bureaucracy at the National Air Pollution Control Administration opposed effluent charges in part because its staff included few if any economists, and because the staff was accustomed to working with direct regulatory procedures and unaccustomed to working with effluent charges.[13]

Further opposition came from the Senate Finance Committee, chaired by Senator Russell Long of Louisana.[14] Louisana is a major sulfur producing state. It was clear that if the sulfur tax worked and if the method of control recovered large volumes of elemental sulfur, the market for this Louisana industry's product would be diminished, or destroyed. One would expect Senator Long to oppose sulfur charges wholeheartedly, and with his opposition, it would be impossible to get the bills through his Committee and thus through the Senate. This opposition combined with the other factors discussed above was so crippling that the administration could not find a Senate sponsor for its bill, and none of the bills received serious debate in the Senate.

The institutional arrangements of the United States Congress, especially the power of specific Senate and House committees are not replicated in Canada and those probl might not occur here. One would however have to consider the non-institutional problems of the size and importance of various groups likely to support or oppose the tax.

3. U.S. Water Pollution Effluent Charges

In November, 1971 Senator Proxmire introduced amendments to the Federal Water Pollution Control Act in 1971 which would enable the administrator of the Environmental Protection Agency and the secretary of the Treasury Department to promulgate regulations implementing effluent charges. These charges were to be imposed on water pollutants including but not limited to BOD, suspended solids, heat, and toxic wastes.[15] Like the sulfur tax, the Proxmire bill was unsuccessful, but its failure is interesting because of the more extensive debate which it received in the U.S. Senate. Senator Proxmire promoted the amendment as a means of enforcing standards, that is, as an incentive for polluters actually to engage in pollution control. He emphasized that his bill was not a substitute for the traditional regulatory approach, but would complement it by providing a further incentive for pollution control. Senator Proxmire's statements in supporting his amendment are a clear recitation of the arguments that would be made by economists in its favour.

The primary opponent of the Proxmire amendment was Senator Muskie. Muskie regarded the effluent charge as redundant given the "tough" regulatory approach that he was promoting. He attacked the charges on the grounds that they were for effluent reduction and not effluent control, a distinction

that remains unclear.[16] Muskie stated that his legislation, which required virtually no discharge of waste by 1985, had rendered effluent charges unnecessary. He claimed, and perhaps believed, that tough regulatory legislation would solve the water pollution problem and avoid the necessity for effluent charges. The Muskie solution to the previous failure of the regulatory approach was to apply more of the same medicine.

An interesting objection raised by both Senator Muskie and other Senators was that the Proxmire proposal was too simple. They pointed out the vast variations in water quality and in the economic and physical conditions of polluters across the country, noting that present environmental policies were designed to recognize and cope with these variations. They suggested that a simple uniform effluent charge would fail to deal with these myriad variations, and therefore would fail to achieve the desired water quality goals in the way that they could be achieved by direct regulation. We have already referred to the debate among economists over whether a uniform national charge would be more or less efficient than a charge varying from one region to another. While a uniform effluent charge across either Canada or the United States will not necessarily balance costs and benefits in each watershed within the country, the present regulatory system does not necessarily do this either. One might compare the social cost of the uniform charge policy which may be too strict in many areas with the social cost of a regulatory policy that is inefficient in failing to equate marginal costs in all areas. It is quite possible that an effluent charge that was uniform over substantial geographical areas would be more efficient than a traditional regulatory approach, assuming reasonable compliance with the regulations. A uniform charge would certainly save enormous administrative costs.

4. Sewer Surcharges in Canada

A number of municipalities in Canada levy sewer surcharges which bear some resemblance to effluent charges. The surcharge is levied against firms discharging wastes into municipal sewage systems, when those wastes exceed some specified normal strength.// For example, in London, Ontario the surcharge by-law provides for charges imposed on firms discharging waste with BOD concentrations in excess of 300 parts per million and suspended solids concentrations in excess of 350 parts per million.[17]// The charge is based on the concentration in excess of the "normal" concentration and the total volume of waste discharged.

The rationale of the charge is that it is a payment to the municipality for treating the extra strength waste discharged by the firm. The magnitude of the charge is therefore based on the portion of the operating costs of the municipal sewage treatment plant that is attributable to the "extra strength" waste. The by-law specifies the method for calculating the surcharge, and this calculation is tied directly to easily verified expenditures by the municipality. The polluter thus has some assurance that the charge will not be set arbitrarily nor used as a general revenue device. Canadian jurisdictions imposing sewer surcharges include Winnipeg, Edmonton, Calgary, London, Kitchener and Toronto. Most of these use a formula similar to that first devised in Winnipeg. A complete description of each surcharge formula is contained in Sims (1977, chapter 2).

Sewer surcharges are not imposed on all pollution sources within a city. Typically a jurisdiction will start with the largest sources and test other industrial firms adding a few sources a year as the staff and financial

ability of the municipality allow. Because the program requires some expenditure for monitoring and enforcement, it is not extended to small sources even though they might discharge extra strength waste.

The sewer surcharge programs seem to be successful in that they are accepted both by industries and municipalities as a reasonable way to deal with heavy pollution loads. The municipalities appear to have worked out monitoring arrangements that because they are sufficiently accurate, or sufficiently understate actual discharges, are accepted by the sources themselves. Studies have demonstrated that some pollution reduction does occur as a result of the imposition of surcharges, although the magnitude of this reduction varies widely from one source to another.[18]

It is interesting that the municipalities themselves tend not to view a surcharge either as a means to induce pollution control or as a source of general revenue. It is regarded primarily as a mechanism for the municipality to collect a fee for providing waste treatment services. This is a philosophy that would be congenial to the engineers who dominate municipal sanitation agencies, and would not be repugnant to industrial polluters. Although an effective surcharge might reduce industrial wastes entering the municipal system and thereby reduce the waste discharge by the municipal sewage treatment plant, environmentalists have taken little interest in these charges. Neither have they attracted major political attention.

We can speculate on the main factor which leads to the acceptance of sewer surcharges and the rejection of effluent charges. The surcharge is analogous to paying for sewage treatment services performed by the city, while charges for using a stream to carry off wastes may seem more like any

other tax. An interesting test would be for a city to impose a sewer surcharge on firms discharging wastes into a sewer when that sewage is not treated before being discharged into a waterway. Here the rationale of paying for treatment would not be available, and one might expect considerable opposition from industry. Not only would the concept appear different, but the operating cost basis for calculating the charge would be lost, leading to fear that it would be used as a revenue device.

5. Effluent Charges in Europe

A number of European countries use effluent charges, sewer surcharges like those used in Canada, or some other means of imposing prices on those who discharge waterborne wastes. Johnson and Brown (1976) carefully review the European experience. We will only summarize a few points from that review here.

Johnson and Brown conclude that the effluent charge is an important factor in pollution control in France, the Netherlands, Hungary, and the Ruhr area of Germany. Other countries have rejected charges or are contemplating them. Where charges are used, they are not based upon estimates of damage because accurate dollar estimates are not available. They are based in part on estimates of the charge necessary to induce some degree of pollution control. In addition, polluters do not pay the full cost of pollution abatement in any case because all countries with charge programs also have extensive subsidy programs. While the European countries have claimed to embrace the concept that the polluter should pay, subsidies are in fact widely used and greatly undercut this principle. It is ironic that eastern European countries seem more enthusiastic about direct effluent charges than the capitalist regimes of western Europe.

Interestingly, Johnson and Brown found they could not reach definite conclusions about the efficiency of actual effluent standards systems, in part because the actual effluent charge systems deviate so much from the theoretical systems that economists analyze. This suggests that enthusiasm for effluent charges may be based on comparisons of ideal charges with actual standards, and must be tempered if consideration is restricted to feasible charge systems that may be implemented. While Europe has had considerable experience with effluent charges of one sort or another, this experience does not suggest the kind of ideal solution that economists might be looking for.

6. Canada Water Act Effluent Charge Provisions

The Canada Water Act[19] provides for the use of effluent charges when circumstances warrant. In section 11(1) of the Act, the governor in council is authorized to designate an area as a water quality management area and authorize a crown corporation to undertake programs in that area if the area represents interjurisdictional waters where water quality management has become an urgent matter of national concern and provincial cooperation has failed to solve the problem. Section 13(1) of the Act provides that the agency established in section 11(1) shall apply and initiate and carry out programs of various types including the development and recommendation of a water quality management plan which could include "...recommendations as to the appropriate effluent discharge fees to be paid by persons for the deposit of wastes in those waters..."

One might first consider why this effluent discharge provision was included in the Canada Water Act at all. We have not discovered the origin of the provision but it is included in a section with a variety of other policy tools, and

may have been added to provide the maximum number of enforcement mechanisms. The effluent charge provisions of the Canada Water Act have never been used. This is probably because no interjurisdictional waters have suffered pollution problems that qualified for action under section 11(1).

7. Connecticut Plan

Pollution control agencies that are committed to a direct regulatory approach frequently experience difficulty in securing compliance with regulations. The Connecticut Department of Environmental Protection, concerned about difficulties it would face in enforcing its environmental legislation, requested additional enforcement tools, which were granted in the Connecticut Environmental Enforcement Act in 1973.[20] The Connecticut plan, unlike an effluent charge or effluent rights plan, does not replace a regulatory system with a market system. Instead, it retains all the features of a regulatory system, including specifying the allowable emission rate from each pollution source, but adds a powerful enforcement tool. The enforcement tool is described as having two parts: "economic remedies and a series of gradually escalating responses to non-compliance that have economic bite but do not require going to court."[21]

The economic remedy used in Connecticut is to impose on firms that are not in compliance with an emission regulation a charge equal to the cost that would have been incurred in complying with the regulation. When a polluter is discovered not to be in compliance, an estimate is made of the capital and operating costs that would be required to bring him into compliance. The capital costs are amortized over the life of the equipment and added to the operating costs to yield a monthly cost of pollution control. During every month when he is not in compliance, the polluter becomes liable for

this amount. Thus the polluter earns no more profit, and spends no less by avoiding pollution control than by pursuing it. The normal economic incentive to delay and avoid pollution control is destroyed by consistent application of this economic penalty. The penalty payments are set aside to be returned when compliance is achieved.

The Connecticut plan avoids the difficult problem of estimating the marginal benefit of pollution control that is necessary to establish an optimal effluent charge. It ignores benefits completely, assuming that the regulatory emission standard was adopted with a sensible regard for costs and benefits of pollution control. The only calculation needed to impose the penalty is the cost of pollution control for each source. The Department of Environmental Protection concluded that they could make sufficiently accurate estimates of the cost of compliance for a wide variety of sources with one to sixteen man-hours of work.[22] Subsequently, many of the cost calculations have been reduced to computer programs and tables, so that frequently it is necessary only to look up a number in a table or to make a quick computer calculation.

A second aspect of the Connecticut plan is that the economic penalty can be bought into play with little delay. The usual procedure for prosecuting the violator of an effluent standard may require years before administrative proceedings are completed and all appeals and remedies are exhausted. During these years, no cost is imposed on the polluter except for his legal fees. In contrast, the administrative remedies provided in Connecticut allow economic costs to be imposed approximately four months after the polluter has been detected to be not in compliance with the regulation, and within six or seven months after he is detected in violation he may be paying a monthly charge up to the full cost of pollution control. In most cases, if the polluter appeals the cost estimate or his non-compliance, the assessment of the economic

penalty continues during the appeal. In all cases, the economic assessment is paid into a fund which will be returned to the polluter when he comes into compliance. Since the money will be returned, the inability of the polluter to avoid payment pending an appeal is less offensive to due process. Furthermore, the objection to effluent charges that they require "paying twice" does not apply because the economic penalty is returned once pollution controls have been installed.

During the first two years of operation of the Connecticut plan, it is reported to have greatly reduced non-compliance and administrative costs.[23] At that time however it was recognized that this plan might be successful in causing the installation of capital equipment, but might face greater difficulty in inducing proper operation and maintenance of that equipment.

The Connecticut plan is designed to solve the enforcement problem. Experience and economic theories suggest that using such a plan to remove all profit from delaying pollution control should provide a powerful boost to pollution control activities, in contrast with the negligible incentives provided by small fines under court enforcement. Such a plan does not have the economically desirable attribute of equating marginal costs at various sources, and it does not provide the same incentives for long run technological progress as a market type system. Nor is it clear that it can lead

to adequate operation and maintenance as opposed to mere capital investment. Still, it has the ability to make pollution expensive rather than virtually free as under traditional enforcement techniques, and this should both accelerate pollution control activities and lead to more realistic and less symbolic effluent standards.

Recently an amended version of the Connecticut plan has been adopted in Washington. The 1977 U.S. Clean Air Act Amendments include a "delayed compliance penalty" which is a quarterly charge imposed on polluters who delay in compliance with effluent regulations. Previously under the Clean Air Act, the EPA could issue an administrative order requiring that the source comply with the applicable statutes and regulations, it could sue for an injunction, or it could bring a criminal action for fines and imprisonment.[24] The 1977 Clean Air Act Amendments authorize the EPA to bring civil actions to recover money penalties,[25] and require the EPA to impose an administrative penalty on major sources that are in violation of Clean Air Act Limitations.[26]

While other US Federal laws authorize the collection of civil penalties, the Clean Air Act noncompliance penalties are unique in that they are not discretionary with the EPA, but must be levied against every major violator. They also differ from other Federal laws in that the amount of the penalty is equal to the economic benefit to the violator of failing to comply with the Act.

The procedure under the non-compliance penalty programme is straightforward. The EPA must send a notice to every major source that is in violation of the Act or regulations. The source upon receiving such a notice may calculate the appropriate penalty, and submit within 45 days a proposed payment schedule. The other choice open to the source is to submit a petition alleging that it is not in violation or that it is entitled to an exemption. The list of reasons for exemption is quite limited, including situations where the pollution arises from a government order regarding fuel switching to conserve oil or gas, a formal energy emergency, the use of new technology which specifically authorizes an exemption, or the inability of the polluter to comply for reasons entirely beyond its control. Orloff (1979) anticipates that few sources will manage to qualify for exemption under these provisions. Once a petition has been received by the EPA, it must hold a hearing, after which it either allows the petition or denies it and assesses the penalty.

The amount of the penalty is to be calculated according to a simple computer programme provided by the EPA. The calculation is designed to determine what it would have cost the source to comply with the relevant law, and to impose upon the source a penalty equal to that amount. Thus once the payments begin, the source in principle saves no money by failing to comply as compared with actually complying. The first payment is due 6 months after the notice of noncompliance was issued, and subsequent payments must be made on a quarterly basis until the source comes into compliance. The payments may be made either to the EPA, or to a state if the state issued the notice of violation. This provides a powerful financial incentive for states to enforce vigorously their anti-pollution programmes.

Once a source comes into compliance, the penalty is not refunded, in contrast to the Connecticut Plan. There is a "evening-up" calculation in which the actual costs of compliance are substituted for the estimated costs of compliance, and the amount of the penalty adjusted. This should however cause modest increases or decreases in the total amount of the penalty, and will not cause a total refund.

This plan went into operation during the summer of 1979 so its effect cannot be clearly determined yet. Ruff (1978, page 329) expressed concern that the plan still requires detailed case by case consideration by the regulatory agency unlike an effluent charge. Orloff (1979) expressed the opposite fear that the programme was too inflexible and too rigid and would therefore impose undue hardships upon polluting sources. Clearly this plan warrants close examination as a test of the efficacy of a vigorous attempt to enforce compliance with a regulatory pollution control scheme.

8. Pollution Rights

Dales (1968) recommended that pollution be brought into the market system by establishing pollution rights and auctioning them off to polluters. The total amount of pollution would be limited by the quantity of rights allowed, and the cost of pollution control would determine the demand for rights and therefore their price. Those who emit pollutants without adequate rights would be severely punished.

While no jurisdictions has yet adopted a complete effluent rights programme such as that suggested by Dales, two developments in the United States move in this direction. The first is the "Offsets" policy under the Clean Air Act, and the second is the allocation of "prevention of significant deterioration increments" also under the Clean Air Act.

Under the 1970 Clean Air Act, EPA regulations prohibited the construction of a new source of pollution in an area which had not attained compliance with the applicable national air quality standards.[27] Since many major American cities were in non-attainment areas, this combination of law and regulation appeared to impose economic stagnation on many cities. This led to an interpretative ruling in 1976 which was incorporated into the 1977 Amendments for the Clean Air Act which introduced some flexibility while still moving toward achievement of the national ambient air quality standards.[28] Under this offsets policy, a state may issue a permit for the construction of a new major source, or modification of an existing major source in a non-attainment region, so long as the expected emissions from the new or modified source would be more than offset by reductions in emissions from existing sources.

Several conditions must be fulfilled before an offset will be allowed. The offset must result in reasonable further progress towards the attainment of national ambient standards. The new source must achieve the lowest achievable emission rate (which is not necessarily the same as the new source performance standards). All pollution sources owned by the owner or operator of the new source within the state must be in

compliance with existing emission limitations. The pollutant must be of the same kind.

This offsets policy provides for the operation of something like a pollution rights market, whereby a new source can agree with an existing source to compensate the existing source for reducing its emissions if that will allow the new source to be constructed. It is not a perfect rights market because there must be an overall reduction in emissions, and because of the variety of conditions imposed on the transaction.

It is reported that such offsets have been used about 115 times since 1976, although most involved reductions at other locations by the same firm rather than exchanges between firms.[29] The Volkswagon plant in New Stanton Pennyslvania was allowed to operate only because the Pennyslvania Transportation Department reduced hydrocarbon emissions from its road surfacing operations. A new General Motors plant in Oklahoma City was allowed to operate only after oil companies within an 85 mile radius reduced emissions from their petroleum storage tanks.

The other possibility for pollution rights markets has occurred with respect to the prevention of significant deterioration (PSD) policy under the Clean Air Act. While offsets arose in areas that did not attain ambient quality standards, it was feared that areas that were cleaner

than those standards would deteriorate in quality. The EPA therefore developed a policy which would not allow new sources in clean areas if they would significantly deteriorate the air quality.[30] Limited increments in emissions would be allowed. In 1977 the Clean Air Act Amendments changed the PSD policies somewhat, and in 1978 the EPA amended its PSD regulations to conform with these amendments.[31]

The 1978 PSD regulations addressed the issue of how states should distribute any allowable increase in total emissions in an attainment area. The EPA suggested that states could allocate PSD increments on a first come, first served basis or through the use of economic incentives such as marketable permits, emission fees, and emission density zoning. The EPA also suggested that an offset policy would be appropriate to the allocation of PSD increments.

The PSD policy clearly opens the door for a form of pollution rights market to emerge. The rights may exist for new increments to pollution, and may be augmented by offsets from reduced emissions from existing sources. Once again, it will be interesting to observe whether markets for these rights actually emerge, and how they behave. This may provide a test of pollution rights policies in very limited circumstances.

It appears that the U.S. policies have stopped somewhat short of creating a complete market for pollution rights in particular areas. However the offsets and PSD policies come close to creating such markets,

and in fact we may expect some limited markets to emerge in the near future.[32] It is interesting that these steps towards pollution rights have been considerably more successful than attempts to impose effluent charges. One reason for this no doubt is the fact that as compared to a direct regulatory policy, pollution rights generated under an offsets or PSD policy do not impose new costs on existing firms. On the contrary, they may yield additional revenue to existing firms as those firms sell off valuable rights to newcomers, at a price that more than covers the cost of reducing their own emissions. Thus as compared to a rigid set of standards, an offsets or PSD policy should appear attractive to a major political force, namely, existing firms in an area. It is unfortunate that the policies in the U.S. are circumscribed with a variety of limitations and qualifications, but they may provide some preliminary test of the workability of pollution rights schemes.

9. The Bubble

One argument for effluent charges, effluent rights or other economic policies for pollution control is that they minimize the cost of achieving a given degree of pollution control. This efficiency argument is generally put forth with regard to minimizing the cost for several sources to achieve a given total degree of abatement. It is equally applicable however to minimizing the cost of achieving a given degree of abatement from a single source. If one plant emits a pollutant from several different processes, through several different pipes or stacks, any regulatory policy that controls the emissions from each of

the outlets must be tested to see whether it achieves the total reduction in emissions at the least possible cost within that plant. Both in Canada and the United States, pollution control policies frequently are directed at a particular pipe or stack, and therefore the opportunity for inefficient regulation arises. The bubble concept is a means of achieving in-plant efficiency by lumping together all sources within a given plant and treating that plant as if a bubble were placed over it with only one outlet. The controls are than applied to this hypothetical outlet.

The advantage of the bubble concept is that within the bubble the plant manager decides what rate of emission he will permit from each internal source, while outside the bubble the EPA or state regulatory agency set emission standards for the total emissions for the whole plant for each pollutant. The bubble concept was announced by EPA administrator Costle on December 21, 1978 and was published as a proposed policy statement in the Federal Register on January 18, 1979.[33] Under the bubble concept, the EPA continues to set standards in the conventional fashion, and monitoring of pollution discharge continues as usual. Any standards that are set under the bubble concept must at least be the equivalent of the existing standards for the plant under the relevant state implementation plan. There are a number of limitations on application of the bubble. It cannot be used to delay compliance dates or enforcement actions, and it is only available to firms that are in compliance with air quality standards, an EPA approved compliance

schedule or a court decree. It cannot be applied to newly constructed sources to allow a lower decree of control than is permitted by the new source performance standards. There is no opportunity for trading off one pollutant against any other.

Clark (1979) reports a number of applications of the bubble concept. An electric utility at Tampa Florida used the bubble concept for its control of sulfur oxides and cut its costs of pollution control by 20 million dollars. E.I. DuPont de Nemours has also applied to use the concept at its New Jersey works, where it was estimated that it will save 15 million dollars.

The bubble concept provides an opportunity to achieve a given decree of pollution control at a specific plant at a lower cost than would be required under strict regulation at each point of emission. While adding it to the existing complex set of regulations on individual sources may actually increase pollution control agency workloads, these increases should be modest if the concept is applied primarily to major sources. A sensible further step would be to allow the bubble to replace existing regulations for each specific point of discharge within a plant with a single plant standard thereby allowing a net reduction in agency workload. There seems to be considerable enthusiasm for the bubble concept in industry, and the U.S. experience provides some valuable guidance as to its possibilities for easing the burden of compliance for pollution regulations.

D. Some Further Issues

1. The Measurement Problem

An often voiced objection to effluent charges is that we cannot measure pollution discharge with sufficient accuracy to levy an effluent charge fairly. Drayton (1978, p. 234) put this point most colourfully:

> Neither EPA nor its regulatees know or can prove how much of what pollutants are emitted. Continuous monitors exist for only a token few percent of all sources. (Furthermore, emissions factors...expressed in terms of product volume-for example, the number of square inches an electroplater plates or the average number of ducks owned by a duck farmer...-are likely to be unenforceable for different but closely analogous reasons: How can an EPA inspector prove that an electroplater's estimate of the square inches of forks, cleats, atomic submarine parts, and so on that he has treated in the last year is too high? Or that a duck farmer usually has fewer ducks in residence than he now does?)
>
> ...Imagine the conversation between the state environmental inspector attempting to assess this tax and a plant manager (neither of whom knows what the plant's emissions have been). Imagine the chronic but unequal underestimating that would result. Imagine the legal fights. Imagine the impact on the state agency's staff's morale."

One must wonder, however, how it is possible to enforce effluent regulations when little or no information exists about rates of discharge. If poor measurement precludes charging, does it not also preclude any method of enforcement? If this is so, then a program of effluent standards involves less expenditure for monitoring than a program of effluent charges only because the choice is made to administer the standards loosely. An effluent charge or effluent rights program that collected substantial fees would require substantial monitoring to be fair and effective, but it would also have a considerable impact. In short, the objection that accurate monitoring for an effluent charge or effluent rights would be terribly expensive may really be an objection to any vigorous program of pollution regulation.

A substantial amount of compliance monitoring under regulatory programs is done by simply inspecting to see whether the appropriate capital equipment has been installed, and whether the approved inputs (low sulfur fuel, non toxic chemicals) are being used. But if this method can be used for effluent regulations, it can also be used for estimating an effluent charge or rights. If monitoring actual effluent is too expensive, one can estimate the effluent discharge rate from product output and capital equipment, fuel type, and other easily measured parameters. This is not a perfect method of measurement, but it is better than none. Furthermore, it can preserve the incentive to reduce emissions efficiently if it allows an estimate to be reduced by actual proof that emissions are lower than those used in the estimating procedure. Thus the polluter who discovers control technology that is not reflected in the estimation method can receive credit for using this technology so long as he can prove that it works and reduces his emissions.

Finally, it makes sense to consider innovative environmental regulations such as effluent charge or effluent rights schemes first for situations where emissions can be measured reasonably accurately at a reasonable cost. Emissions of sulfur oxide can be estimated accurately not by stack sampling but by analyzing the fuel burned and knowing the proportion of fuel sulfur that is usually discharged through the stack. While BOD measurement is subject to considerable error, it is relatively inexpensive, so that a sufficient number of samples can be taken to yield estimates of sufficient accuracy at moderate cost, at least for large sources. It should be noted that the sewer surcharge programs in Canada manage to measure suspended solids and BOD with sufficient accuracy to avoid serious complaints. The higher the rate of effluent charge, the more accurate the measurement would

have to be to avoid disputes.

2. Financial Impact

While economists have provided dozens of proofs of the efficiency characteristics of effluent charges and effluent rights schemes there have been few analyses of their financial impacts on individual firms.[34] It is generally acknowledged that an effluent charge will impose higher costs on an industry than effluent regulation, because effluent payments must be made in addition to paying for pollution control equipment. The efficiency advantages of an effluent charge reduce this additional cost, and if the charge induces sufficient technological progress over time, the excess financial impact might vanish. Still, in the short run, the effluent charge will impose a higher cost on polluters than effluent standards. Much of this cost can be passed on to consumers in the form of higher product prices and this is desirable because it raises the relative price of pollution-intensive goods. Still, industry has vigorously resisted effluent charges, and if we put aside the long run assumption that all firms and industries earn a normal rate of return, it is not difficult to see why they resist. Furthermore, it is possible to explain industry acceptance of present regulatory approaches, and to identify some market-type approaches that might be no less attractive.

Consider a competitive industry composed of identical firms. All factors of production are supplied at constant cost, and the industry elasticity of demand for the product is -1. Assume further that the capital-labour ratio for pollution control is identical to that for productive activities. Pollution control is achieved by adding treatment facilities

(tail-end treatment) and not by changing the production process. We will examine the effect on the value of shares held by shareholders of firms in this industry of imposing alternative pollution control policies.

Suppose that an effluent standard is applied identically to all firms in the industry. This standard requires some expenditure for pollution control, which will raise total costs and therefore the long run equilibrium selling price in the industry. If pollution controls raise costs by 10 per cent, then output will be reduced by 10 per cent for the entire industry. Some firms may exit, or all may reduce their scale of output, depending on the shape of individual firm cost curves.

The impact of this pollution control standard on the share values of the industry depends upon the malleability and mobility of the capital equipment of the industry. Suppose that it is perfectly malleable and mobile, so that it can be transformed from production to pollution control at no cost, or can be shifted from this industry to some other industry at no cost. In this case, imposing effluent standards imposes no loss of value to the original shareholders in the industry, because the same total capital will be required to produce fewer units of output but more pollution control, and the capital will be costlessly transformed. If on the other hand capital is non-malleable, then 10 per cent of the productive capital of the industry will be lost, and the aggregate value of shares in the hands of the original shareholders will be reduced by 10 per cent.

Now consider an effluent charge designed to achieve the same degree of pollution control as the effluent standard. Under the effluent charge, the industry must bear costs for pollution control, and must also expend money for the effluent charge, assuming that one hundred per cent pollution

control is not economic. While revenues are unchanged because of the unitary elasticity of demand, revenues are no longer divided only between capital and labour. Some revenue is syphoned off by the effluent charge, so that the total capital stock in the industry shrinks, and the productive capital (as opposed to pollution control capital) stock shrinks more than in the effluent standard case. Once again, if capital is perfectly malleable, it will shift from production to pollution control and from production in this industry to production in other industries, with no loss of value to the original shareholders. If capital is not malleable then any reduction in productive capital will be reflected in a destruction of value for the original shareholders. Since costs will increase more in the effluent charge case than in the effluent standard case, because of the charge expenditure, output will decrease more, and therefore the shareholders will suffer a greater loss in value with non-malleable capital under an effluent charge. Thus we should expect firms to resist more vigorously an effluent charge than effluent standard. The former has a more detrimental impact on the value of shares in the industry than does the latter. This is true assuming non-malleable capital, even though long run rates of return in the industry must be unaffected by pollution control.

Suppose that an effluent rights system were used instead of an effluent charge. If the effluent rights are sold by the government to polluting firms, and achieve the same pollution control as the effluent charge, the economic impact should be identical. Presumably firms will have to pay an annual amount or shadow price for pollution rights just equal to the annual cost of an effluent charge that would achieve the same degree of pollution reduction. In steady state, the effluent rights sale should have the same effect as an effluent charge, and thus be equally distasteful to industry.

Suppose alternatively that the effluent rights are distributed to

existing members of the industry at no charge, in proportion to their current emission rates. After distribution, the rights are marketable, and they achieve the same degree of pollution control as the previously contemplated effluent charge. The long run effects of the rights are identical to those of the charge with respect to product price and pollution control. The big difference however is a wealth effect: there is no lump sum payment by the firms for the rights. Instead, they receive a valuable marketable right for free. Because the pollution rights have a market value, they become an asset of the firm, and their value tends to offset the decrease in share value resulting from the pollution controls and the cost of holding the rights. Clearly shareholders are better off with pollution rights distributed to firms than they are with an auction of pollution rights or with effluent charges. Furthermore it can be demonstrated that under some assumptions shareholders may be better off with a pollution rights scheme than no pollution control program at all.[35] The distribution of pollution rights to existing firms thus provides a program with all the desireable efficiency consequences of an effluent charge program but reducing or avoiding the resistance from industry based on the harmful effects on shareholders of effluent charge programs. The "offset" policy of the U.S. EPA is similar to a free distribution of pollution rights to existing firms, in that new entrants must buy rights from existing firms.

If rights are distributed to existing firms in proportion to their current emissions, an equity problem may arise. Firms that have not complied with control orders or abatement programs will be rewarded with a large issue of rights, while firms that have invested heavily in pollution control and have reduced their emissions will receive few rights. This

may seem unfair. Yet the purpose of a free distribution of rights is precisely to recognize a historic right to pollute, and to award some compensation for changing the rules. It is impossible to award compensation without recognizing some measure of past performance. The problem might be solved in part, however, by awarding rights in proportion to product output (in a homogeneous industry) or to established emission standards, or some other measure that was less directly related to past compliance with pollution control pressures.

Although it seems paradoxical that the pollution rights system could actually make existing firms better off than they would be with no pollution control system, this effect can also be achieved by a discriminatory application of effluent standards. If one imposed environmental requirements that were far more strict for new firms than for existing firms, an artificial barrier to entering into the industry would be erected, and conceivably existing firms could be better off.[36] In section II of this paper, we noted that it is common for pollution control policies across Canada to impose standards that are more strict for new firms than for existing firms in an industry. This may be economically efficient since new firms can control emissions at lower cost than existing firms but it is inefficient in that it maintains

obsolete plants in the industry. It makes political sense, since existing firms will have some political influence while potential entrants to the industry are generally not identified, and not likely to exert any political influence. It may be regarded as fair since existing firms invested at a time when pollution was allowed. Weaker standards for existing firms than new firms may be the political price that must be paid to obtain some industry cooperation for this environmental legislation. This characteristic of existing legislation has been completely ignored in most effluent charge proposals, and in pollution rights proposals which do not offer to distribute rights free to existing firms.

Examining the interests of shareholders of existing firms in polluting industries provides three insights. First, it helps explain existing pollution control legislation. Second, it suggests that simple effluent charges may suffer a serious political disadvantage as compared to traditional regulatory approaches. Third, it suggests that effluent rights schemes can be tailored to reduce the political disadvantage of effluent charges, and to be as attractive, if not more attractive to existing firms in an industry than a system of effluent standards.

E. Assessment of Objections to Market Policies

The above review of proposals for market policies for pollution control has identified a number of objections that are typically raised when effluent charges or effluent rights are proposed. We will summarize here the major objections and our own assessment of them, drawn from other sections of this paper.

(1) "Market policies require polluters to pay twice, and therefore impose a greater financial burden on industry."

It is true that the sum of payments for pollution control equipment plus payments for effluent charges or effluent rights will generally be greater than the payment for pollution control under an effluent standard system that achieves the same environmental quality. However, the idea of paying twice is identical to the notion of paying for capital equipment to reduce labour requirements and then paying for the remaining labour that must still be hired after the equipment is installed. Thus an effluent charge treats pollution just like all other productive inputs.

There are several other responses to the "paying twice" argument. Firstly, the efficiency gains from an effluent charge will reduce the cost of pollution control under this system below the cost under a regulatory system that achieves the same reduction in emissions. Secondly, effluent rights may be distributed free rather than being sold, in which case existing firms do not pay twice. Thirdly, an effluent charge generates government revenues which can be recycled to the industry without reducing the incentive to control pollution, so long as the basis for

repayment does not depend upon pollution emissions. Thus a policy designed to compensate existing firms can reduce or eliminate the added financial burden.

(2) "There is no basis for setting an effluent charge, so it would be purely arbitrary."

It is difficult to estimate the marginal benefit of pollution control accurately in monetary terms, so that in general effluent charges will have to be set on some basis other than a precise estimate of marginal benefits. The corollary of this is that it is very difficult to set discharge standards or environmental quality standards accurately in any case where benefit measurement is difficult or impossible. Thus the degree of arbitriness in setting an effluent charge is only moderately greater, or perhaps the same as the degree of arbitrariness involved in setting ambient environmental quality standards.

In cases where there is believed to be a solid scientific basis for establishing ambient quality standards, one can use information about the cost of pollution control to estimate an effluent charge that will lead to approximately achieving the desired ambient quality standard. Alternatively, one can employ pollution rights, which because they specify total emissions, should be just as successful as effluent standards in achieving a given degree of environmental quality.

(3) "An effluent charge does not guarantee that environmental quality standards would be met".

This is true, because without perfect information about costs

of pollution control, we cannot estimate precisely how polluters will respond to a given level of effluent charge. It is important to recognize however that effluent standards have been in use for a considerable period of time and their record proves that they too do not guarantee the achievement of the desired level of ambient quality. Our frequent inability to secure compliance with emission standards renders them suspect as a means for insuring a specific level of ambient quality. The ability of market policies to encourage research and development, technical progress, and action toward pollution control should make them more effective in improving environmental quality. In cases where there is a solid basis for desiring a particular level of environmental quality, effluent rights would be probably be superior to effluent charges as a mechanism for moving towards that quality level.

(4) "Market mechanisms are unnecessary because direct regulation will solve current environmental problems."

The record of the last decade provides little evidence that difficult environmental problems will be solved in the near future by traditional methods. One of the strongest arguments for market mechanisms is that they are more likely than direct regulation to achieve some progress towards environmental goals.

(5) "Polluters will simply pay an effluent charge instead of cleaning up."

If the charge is set so low that is cheaper to pollute and pay than to clean up, this will be true. If however the charge is

set equal to the marginal cost of abatement at a high level of pollution control, it is nonsense to suggest that any substantial number of firms will simply pay the charge rather than cleaning up. It flies in the face of all economics and of good business practice to suggest that businessmen will intentionally choose the more costly of two means of producing their products. If pollution control is cheaper than paying the effluent charge, firms which continue to pollute will find themselves at a cost disadvantage compared with firms that abate. It is true that the effluent charge gives the polluter the option of paying rather than cleaning up. One would expect this option to be exercised only where there was a reasonable expectation that more effective or more economical technology would be available in the near future, so that in the long run it was cheaper to postpone installing control until better technology had arrived. The effluent charge provides a perfect incentive for each polluter to weigh these possibilities and resolve them in the most efficient manner. This is not an opportunity for needless delay, since all the time he is waiting the polluter is paying heavily for his discharge.

(6) "Geographically differentiated charges will cause undesirable industrial relocation."

If effluent charges are set at different levels in different parts of the country reflecting varying levels of marginal benefits of pollution control, then they will indeed lead to incentives for firms to locate in low charge areas rather than in high charge areas. This is exactly the same incentive that is created if pollution control standards or regulations are more stringent in one area than in another.

So long as the charge differential accurately reflects differing marginal benefits of pollution control, such relocation is not harmful but instead is desireable and efficient. If it is thought that such relocation will impose unbearably high social costs on the economy, one can adopt a uniform charge and eliminate that incentive. A national uniform charge gives up some efficiency by treating all areas equally, but also minimizes incentives to relocate. There is no inherent difference between effluent charges and direct regulation with respect to the incentive to cause industrial relocation.

(7) "It is impossible to measure emissions with sufficient accuracy to levy an effluent charge"

If we cannot measure emissions accurately, how can a regulatory programme operate? There is no evidence that an effluent charge programme requires more information than a fair and vigorously enforced system of effluent standards. If there are many small polluters who are believed not to exceed existing effluent standards and therefore need not be monitored at all, one could exempt them from the effluent charge on the grounds that no policy is needed to deal with them. If all sources are believed to have the potential for violating standards and therefore must be checked under an effluent standard programme, the monitoring requirements for an effluent charge should be no greater. In many cases where agencies argue that they cannot afford the monitoring needed for an effluent charge, one finds that they do not have the information necessary to enforce a system of effluent standards either.

V. CONCLUSIONS

A. Economic Assessment of Market Policies

Market policies for pollution control including effluent charges and effluent rights have three primary advantages over traditional regulatory approaches. First, the market policies avoid the perverse incentives problem. A charge that is independent of the economic or technical problems of the polluter provides a clear incentive to work on pollution control rather than debating and delaying. It makes it more economical to reduce pollution emissions than to continue polluting. Once such a system is in place, each polluter has a powerful incentive to put all his efforts into pollution control rather than into delay, debate and resistance to the programme.

Second, the market policies provide superior incentives for long run technological progress in pollution control. Because in the long run technological progress may enormously reduce the costs of pollution control and greatly expand the feasible degree of pollution control, providing proper incentives here is absolutely essential. Traditional regulatory policies create incentives not to engage in research and development into pollution technology. Under market systems, the incentives are just the opposite; there is every advantage from pursuing an energetic and successful research and development programme into pollution control technology.

Finally, the market systems achieve a given degree of pollution control at less cost even in the short run than do traditional regulatory policies. This is achieved by equating the marginal cost of pollution control at all sources within the control area and at all points within each plant. Repeated economic analysis has demonstrated that the short run efficiency gains of market policies can reduce pollution control costs by one third, one half or even two thirds of the costs experienced under direct regulatory regimes. These enormous savings are short run only, and do not count the additional benefits from the two categories of advantage listed above.

The only economic liability of market systems is that they may cause more short run dislocations than effluent standards. Part of this increased dislocation occurs because the market systems will work whereas direct regulation frequently does not. However if the benefits of pollution control exceed the costs, the cost of the dislocation may be justified. Market systems may raise product prices in polluting industries somewhat more than direct regulation would even assuming similar degrees of pollution abatement. This too increases the short run dislocation costs, but once again if the cost benefit analysis has been done properly and the programme is justified, these costs are outweighed by the benefits of pollution control. In short, any cost benefit analysis of pollution control policies including market policies should consider not just the long run equilibrium but also the short run transitional costs. It will be rare that such an analysis will justify a regulatory regime and not also justify the market systems.

B. Political Assessment of Market Policies

While market systems have tremendous economic advantages, they also have considerable political liabilities. Industry and labour have both opposed effluent charges in the past because they correctly perceive that the short run financial impact on existing firms may be greater than under traditional regulatory policies. Part of this greater impact arises from the probability that effluent charges will be effective whereas traditional regulation is often ineffective. Part of it comes from the payments that must be made for pollution discharge that is not controlled. The first objection is in fact a tribute to the desirability of market systems. The second objection

can be met in part or in whole by distributing effluent rights free of charge to existing industry members rather than selling effluent rights or by using the revenue from an effluent charge to compensate firms. While there has been little formal industry reaction to effluent rights proposals, a free distribution of effluent rights might be far more acceptable than effluent charges without compensation.

Industry has also opposed effluent charges because they look like a new form of taxation without a clear basis for computation. Unlike sewer surcharges which can be seen as a fee for service, and which are calculated on the basis of treatment plant operating costs, effluent charges are a fee for a service provided by nature, and historically provided for free. Industry sometimes fears that an effluent charge would be adjusted to maximize revenues and not to control pollution. A system of effluent rights would appear not to raise these problems. It is not clear how the resistance to a new form of taxation can be lessened within the framework of an effluent charge scheme.

A third political problem is that the general public and environmental groups are not particularly enthusiastic about market schemes. This may be a result of misperceptions about the effectiveness of direct regulation, misunderstanding of the operation of markets, or other factors. The clear failure of direct regulatory policies and a careful programme of public information may be needed to change this attitude.

Finally, there is little enthusiasm for market policies in most government agencies currently responsible for environmental protection. The lack of enthusiasm springs in part from misunderstanding and in part from the differences between market policies and the traditional regulatory methods with which agency personnel are familiar. A more subtle and serious problem is that the market systems would eliminate much of the discretion and therefore power currently wielded by regulatory agencies. Replacing complex

regulations with a faceless market system would probably reduce civil service manpower requirements, and would certainly erode the power and authority of those currently responsible for administering case by case regulations.

Most of the problems identified above have arisen specifically with respect to effluent charges. Effluent rights have not seriously been tested, although they appear to be springing up in some situations in the United States. Theoretical analysis suggest that effluent rights might if properly designed carry considerably smaller political liabilities than effluent charges, and the emergence of limited rights schemes in the U.S. seems to confirm this.

C. General Recommendations

Canada is not so wealthy that we can afford to waste money and resources on inefficient control policies. We can not afford to spend two or three times the amount that is necessary on pollution control in the short run, and more than that in the long run. We face environmental problems of sufficient concern that we can not afford to indulge in policies that do not work or work slowly. From an environmental point of view we cannot afford to rely primarily on policies that reward and encourage delay and debate rather than abatement. In the long run, we cannot afford to rely on policies that discourage innovation and research into the development of more effective and more economical pollution control technology.

It is therefore imperative that market policies be applied to the most serious environmental problems: those which raise serious environmental concern and which will be costly to solve. While market policies may also be best for many lesser problems, the greatest gains will come from applying them to the largest problems first.

What characteristics identify problems that are appropriate for the application of market policies? First, the pollutant should be a clear cause of environmental harm, to ensure that there is a reasonable basis for imposing an effective control policy. There must be a reasonable though not perfect method of estimating the discharge rate, and a limited number of sources discharging the preponderance of the pollution, so that measurement costs are not excessive. Market policies will have the greatest advantage in cases where pollution control is expensive or polluters are recalcitrant since these are the cases where traditional policies are most likely to fail to achieve substantial reductions in emissions.

The extent to which market policies can displace existing control procedures will vary from case to case. Sometimes, some traditional controls must be retained to deal with a high local concentration of a pollutant, or with the manner of discharge. For example, an effluent charge might be an excellent way to reduce total sulfur dioxide emissions, but one still might need some minimum stack height and other regulations to avoid short term locally high concentrations of pollutant near a source. In other cases, the effluent charge can be used to induce technical progress and movement toward considerable pollution control, with effluent standards employed to specify final emissions levels. In such cases the effluent charge removes most of the incentive to disregard emission standards since savings on pollution control will be approximately offset by charge payments. In general, however the market policy is intended in part to get government agencies out of detailed business decisions, and therefore some reduction in traditional regulatory activity should accompany the adoption of market policies. The next section will suggest some specific applications for which market policies may be appropriate.

There may be some problems which for some reason seem inappropriate for either an effluent charge or an effluent rights system, yet traditional

policies have failed to secure compliance with adopted standards. In these cases the enforcement problem may be attacked with quasi-market policies such as a charge for exceeding the standard, a pollution control delay penalty, or a Connecticut approach. Any of these should create desirable incentives for compliance and for technology development that are absent under traditional procedures.

D. Specific Recommendations

The same reasons that led the Nixon Administration and Senator Proxmire to propose a tax on sulfur oxide emissions in the early 1970's makes sulfur oxides a good candidate for effluent charges or pollution rights policies now. It is relatively easy to measure or estimate emissions from fuel burning sources, and only moderately more difficult to measure them from metal smelters. The number of sources in Canada that account for 80 or 90 percent of total Canadian emissions is quite small, so that the cost of measurement would be relatively modest. The problem has proven relatively intractable under traditional regulatory procedures, and with current technology the costs of pollution control will be enormous. Thus one would predict continued failure of the direct regulatory approach. In addition, the benefits of a market policy would be great. The technology for controlling sulfur oxides is relatively primitive, with high costs and difficult operating problems. A serious research and development programme into alternative control technologies and into process changes might yield great reductions in cost and increases in effectiveness simply because there is so much room for improvement. Because industry can forcefully argue that the current control technology is both expensive and unsatisfactory, there is little incentive for technological progress under a direct regulatory system. Thus

the long run benefits from a market policy would be to improve the incentives for technological development, and therefore to reduce the cost of control in the future.

Most of the institutional barriers which haunted the Nixon sulfur taxes do not exist in Canada today. A sulfur tax or rights scheme at the provincial or federal level would not have to pass through Committees dominated by individuals known to be hostile to the concept of effluent charges or rights. It is not apparent that any key political hurdle is dominated by an individual with a strong constituency in the sulfur industry. The leading environmental politicians have not taken a strong position in opposition to effluent charges.

It is beyond the scope of this paper to design a sulfur oxide effluent charge programme in detail. It would make sense to phase the charge in over period of years to allow industry time to conduct research and to make capital investments. It would make sense to exempt the smallest sources where it could be shown that the cost of monitoring emissions would exceed any possible benefits from pollution reduction. If the charge is to be specified in dollar terms, the rate schedule should be tied to some inflation index such as the wholesale price index or a capital equipment index so that time does not erode the force of the charge.

An effluent charge would be preferred to effluent rights for sulfur oxides because the harm caused does not seem to involve any particular thresholds and because the pace of technological progress over the next decade or so is very difficult to anticipate. If the effluent charge were resisted because of its financial impact on firms, one could design a rebate scheme which repaid the total charge collected to all polluting firms. The rebate must be independent of actual emissions in order not to reduce the incentive to reduce emissions. Ideally it should depend upon facts that pre-date announcement of the policy, such as the previously allowed emission rate, product output, gross revenues, or some other measure.

If an effluent charge were out of the question politically, effluent rights might be issued, initially in an amount equal to current or recent discharges but with the total issue to decline at a specified rate over a period of years. One problem with this approach is that a small number of sources discharge a large proportion of Canadian sulfur oxides, so a competitive market cannot be ensured. Another problem with this approach is that in the absence of any information about the expected rate of technological progress, setting the reduction in allowable emissions over time would be quite arbitrary. If technology does not progress for five years and the rights allotment is considerably reduced, the price of rights might soar to great heights. Alternatively, if technology moves swiftly the price of rights might plummet, and the original schedule of rights reductions would prove to have been too slow. Still, an effluent rights scheme while less desirable than an effluent charge would be far superior to a continuation of direct regulation.

The other clear candidate for market pollution control policies is the discharge of traditional pollutants such as BOD and suspended solids into the water. One might levy an effluent charge on all major sources of BOD and suspended solids directly into lakes and rivers in Canada by applying a uniform rate across the country. Arguments have been presented above for both the uniform and the regionally differentiated approaches. It is suggested that a uniform charge be adopted across the country in part in order to avoid the danger of polluting currently clean areas, and in part to avoid the regional disputes that would arise from a regionally differentiated plan. When effluent charges were discussed in the U.S. Congress there was more support for uniform than for regionally differentiated policies. The charge should not apply to sources discharging wastes into a municipal sewage treatment system, since there the municipality has the option of levying a charge or surcharge if it wishes.

The program should begin by identifying the largest sources of water pollution and applying the charge to them, working down to smaller and smaller sources as warranted by measurement costs and apparent benefits. It is not desirable to attack a single industry at a time, since the pollution from one industry is no more harmful pound for pound in a given location than the pollution from another. Non-point sources of BOD and suspended solids may be more difficult to deal with than point sources, but could be included in the programme where monitoring with reasonable accuracy is feasible. Because it is difficult to estimate the dollar value of marginal benefits from pollution control, an appropriate basis for the effluent charge would be the average marginal cost of abatement required under current pollution control programmes. If the specified rate is tied to an index, so that it is not automatically reduced by inflation, then over time technological progress should lead to greater and greater degrees of pollution control.

We have had considerable experience with controlling BOD and suspended solids emissions so the technology and costs are relatively well known to date. Thus if an effluent charge were politically infeasible because of the resistance of the industry and labour, it would be equally satisfactory to adopt an effluent rights system. A national system would establish effluent rights in an amount approximately equal to the average total discharge over the last few years. The rights would be designed to depreciate over time, so that total allowable emissions would be reduced by a specified amount in each year. This would allow for gradual pollution control and environmental improvement over time. Because the technology is well known, and the charge would be set at approximately current marginal cost levels, there is no danger that a planned reduction in allowable emissions would cause the price of rights to skyrocket. Rights should be given to existing sources of pollution

in proportion to their rate of discharge in recent years, but should be marketable so that new industries can purchase them at any time.

Two specific cases are recommended for treatment with market oriented pollution control policies. This is not an exhaustive list, but a pair of examples. Any difficult pollution problem satisfying the criteria outlined in the preceding subsection should be seriously considered.

E. Conclusions Regarding Regulation Reference Issues

How is Cost/Benefit Assessment Addressed Under the Existing System?

At both the Federal and Provincial levels in Canada, environmental objectives, especially ambient quality objectives, are often set to avoid any damage, or to minimize the risk of harm without regard to the cost of controlling emissions to this level. The policies designed to implement these goals, however often allow for some balancing of costs and benefits, at least implicitly. Granting approvals for the construction of new sources involves a process of negotiation in which costs and benefits may be balanced. Preparing programs for reducing emissions from existing sources involves bargaining between the agency and source concerning the ultimate emission target and the pace of movement toward that target, and some balancing of costs and benefits may take place. Decisions about the vigour with which policies are enforced, and about which violators to prosecute involve considerable discretion, and may thus allow some cost/benefit balancing. There is no guarantee in any part of this process that the balancing of costs and benefits be formal or careful, nor that all interests be represented. Since the benefits are sometimes unknown, and can rarely be reduced to dollar terms, and since control costs can change radically over time with technological progress, it is rarely possible to prove that

even very strict environmental goals are uneconomical in the long run. The more interesting area of debate is whether the pace and timing of the control program is appropriate, that is, whether it is appropriate to proceed slowly to allow control technology to improve in capability and decline in cost, and whether the policies used provide adequate incentives for technological progress.

How Does the Enforcement System Work?

Most environmental legislation provides that substantial fines may be levied for continuing violations, up to $100,000 for some Federal Acts, and often up to $10,000 per day for Provincial statutes. In practice, however, violators are rarely charged, and the fines levied are usually small. The aggregate financial penalties levied on polluters in Canada are trivial, and cannot exert significant pressure to reduce emissions. Often prosecution is regarded as a last resort, and agencies use negotiation, threats and compromise to get results. There are many cases when this approach has produced failure, in that polluters remain in gross violation of stated goals for years. Some such "failures" may actually reflect an unconscious balancing of short-run costs and benefits, although there is no evidence that this is generally true.

Footnotes

Section II

1. R.S.C. 1970 C. F-14 as amended by S.C. 1977, ch 35.
2. S.O. 1971, ch. 86
3. For example Section 102(2) of the EPA prohibits prosecutions under the EPA when the person is in compliance with a control order. Section 14(2) of the EPA exempts animal wastes disposed of in accordance with normal farming practices from the application of Section 14(1)(a).
4. Metal Mining Liquid Effluent Regulations, S.O.R./77-178, Section 5.
5. S.O.R./72-92, s. 5.
6. S.O.R./71-578.
7. S.O.R./73-679, s. 7, 8.
8. Donnan and Victor (1976, Ch. 2).
9. In Ontario, the basis for water pollution control is ambient water quality goals that are not related to any particular industry. The implementation of these goals has involved regulations imposed on one industry at a time. In principle, when (if) the ambient goals and objectives are achieved, the effluent regulations for a source will depend only on the character of the receiving waters and the effluent, and not on what industry the firm is in. Ontario Ministry of the Environment, "Water Management Goals, Policies and Implementation Procedures" Nov. 1978.
10. S.O.R./72-92, Schedule 1.
11. S.O.R./73-679, s. 3.
12. Ontario MOE (1978)
13. Ontario Standing Resources Development Committee (1979, p. 2-4).
14. Ibid (p. 3-4).
15. R.S.C. 1970 Ch. F-10, s. 33(5).
16. R.S.C. 1970 2nd supp. ch. 27, s. 754.
17. R.S.O. 1970 Ch. 332 s. 32.
18. S.O. 1971 Vol. 2 C. 86.

19. Estrin and Swaigen (1978, p. 149)

20. Ontario Standing Resources Development Committee (1979, p. 3-4(a))

21. Ibid p. 3-7.

22. The KVP Company v. McKie [1949] SCR 698.

23. The KVP Company Limited Act, 1950 S.O. 1950 c. 33.

24. Dewees, Prichard and Trebilcock (1980)

25. Donnan and Victor (1976)

Section III

1. Lerman (1977, p. 4-8)

2. "For 1985 we want to end all discharges into all of our waterways" Senator E. Muskie, Congressional Record, Senate, 92nd Congress, 2nd Session, Vol. 117 part 30 p. 38829, Nov. 2, 1971.

3. Lerman (1977, p. 4-26, 27)

4. See Section II, supra

5. Lerman (1977, p. 4-14)

6. Lerman (1977, p. 4-17)

7. Hartle (1979, p. 73)

8. Sims (1977, Ch 2)

9. Jack Knetsch, private conversation, Sept. 1979.

10. Lerman (1977, p. 4-20)

Section IV

1. Dewees, Everson and Sims (1975, Ch. 6); Spence and Weitzman (1978)

2. Kneese and Bower (1968, Ch. 7)

3. Ibid. Ch. 8; Maloney and Yandle (1979); Baumol and Oates (1979, Ch. 18)

4. Mills and White (1978)

5. Estrin and Swaigen (1978, p. 143) state that "[a]s a matter of policy, Ottawa periodically reviews the regulations and as technology improves, imposes stricter standards."

6. Ontario Standing Resources Development Committee (1979, p. 3-23)

7. Ibid pp. 95-96

8. Ibid p. 3-23.

9. Anderson (1977, pp. 51-53); Kneese and Schulze (1975, pp. 99-101)

10. Congressional Record, House, 92nd Congress, 2nd Session, Vol. 118, Part 4, p. 4250.

11. Anderson (1977, p. 154)

12. Ibid. p. 158.

13. Ibid p. 155.

14. Discussions with Jack Knetsch, October, 1979.

15. Congressional Record, Senate, 92nd Congress, 2nd Session, Vol. 117, Part 30, p. 38826, Nov. 2, 1971.

16. Ibid. p. 38828

17. Sims (1977, p. 8)

18. Ibid.

19. R.S.C. 1970 (1st Supp.), ch. 5.

20. Connecticut Enforcement Project (1975, p. i)

21. Ibid. p. 3

22. Ibid. p. 7

23. Drayton (1978, p. 232)

24. 42 U.S.C. § 1857c - 8(a), (b), (c) (1976)

25. 42 U.S.C.A. § 7413 (Supp 1978)

26. 42 U.S.C.A. § 7420 (Supp 1978)

27. 40 C.F.R. § 51.18(b)

28. 42 U.S.C.§7410(a)(2)(I) and

    42 U.S.C.§7501-7503

29. Clark (1979)

30. 40 C.F.R.§52.21

31. 43 Fed. Reg. June 19, 1978, pp. 26388-26410

32. Yandle (1978)

33. 44 Fed. Register No. 13 Jan. 18, 1979, pp. 3740-3744

34. Buchanan and Tullock (1975) performed one such analysis.

35. Dewees (1980)

36. Buchanan and Tullock (1975).

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