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Can Water Quality Trading Help to Address Agricultural Sources of Pollution in Canada?

Project Report

PRI Project
Sustainable Development

Project Partners
Agriculture and Agri-food Canada
Environment Canada
Canadian Water Network

Canada

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About This Report

The PRI contributes to the Government of Canada's medium-term policy planning by conducting cross-cutting research projects, and by harnessing knowledge and expertise from within the federal government and from universities and research organizations. However, conclusions and proposals contained in PRI reports do not necessarily represent the views of the Government of Canada or participating departments and agencies.

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Preface

This report concludes the second phase of the Policy Research Initiative's (PRI) project on economic instruments for water management. (We generally refer to market-based instruments in the document.) While in the first phase we investigated the use of several economic instruments proposed to control the demand for water, the second phase focuses on only one specific instrument – water quality trading (WQT) – developed to address water pollution issues. Even more specifically, we examine the potential for reducing agricultural sources of water pollution using this tool.

This choice allowed us to examine issues of instrument design more closely, and to consider the social context in which implementation takes place. In doing so, however, we do not claim to have answered all relevant research questions. Much remains to be learned, in particular about how policy instruments interact with each other, and how those interactions can be made more effective.

It is important to note that the goal of this report and of the project more generally is not to promote any specific instrument or class of instruments, but to better understand how they can be used, in what context, and to identify conditions for success. By looking in as much detail as possible into how a specific instrument can be implemented, we highlight the different challenges faced in implementation. To this end, we assess the potential for water quality trading in Canada to address agricultural sources of water pollution.

The feasibility of WQT in Canada was explored by investigating the different components of trading systems, specifically biogeochemical considerations, how the existing Canadian regulatory/policy frameworks can foster or hinder the development of WQT programs, and instrument design considerations, including the role of stakeholders.

The research elements of this project include literature reviews, commissioned research on the Canadian provincial and federal regulatory frameworks (we left out territorial systems mainly for time considerations) as well as on the experience in the Netherlands, and two expert workshops involving both brainstorming activities and discussions around a set of presentations. A number of experts were chosen for their practical experience with the design of trading programs.

The project benefited from the active support of Agriculture and Agri-Food Canada and Environment Canada. We want to thank them as well as Warren Wilson, who facilitated the first workshop, all the experts involved, and our colleagues at PRI for their contribution. It should be clear that the ideas expressed in this report are not necessarily those of individual participants in our workshops or those of our partners within the Government of Canada.

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Executive Summary

This report examines the extent to which water quality trading (WQT) and variants of this policy instrument can be applied in the Canadian context. Based on practices around the world, the report also provides some guidance on designing WQT systems. We do not purport to provide definitive answers to all questions, but provide policy makers with some basic tools with which to make their own evaluations.

The main conclusion is that existing Canadian regulatory and related policy frameworks would generally allow the implementation of WQT. The voluntary aspect of most trading programs, including agricultural non-point sources, would seem to fit appropriately within the current approaches to agri-environmental policies used in Canada. Furthermore, the administration of WQT programs can be made compatible with watershed-based management approaches being implemented by most Canadian provinces.

The main hurdles to WQT implementation may lie in the relative absence of the necessary scientific data in many watersheds, in modifying the institutional structures that have been established to address water pollution issues through command-and-control, technologically based regulation, and in bringing the main stakeholders to embrace such solutions.

Water Quality Trading and Pollution from Agriculture

Agricultural sources of water pollution are difficult to control, because the pollutants may follow a number of pathways and may be difficult if not impossible to trace back to a specific source. Fertilizer use, for example, has different impacts depending on the type of soil and climatic conditions. While quality information on agricultural pollution is not equally available across Canada, clear signs in a number of watersheds indicate that increases in pollution, threatening aquatic life and water quality more generally accompany any growth in agricultural intensity.

Water quality trading is a pollution trading approach to water quality issues implemented on a watershed or sub-watershed basis. It has been applied to address pollution from agriculture in the United States for the past 20 years, and in Australia and Canada more recently. Another applicable experience, that of manure management in the Netherlands, uses a different form of trading to address similar sources of pollution, which could be adapted to the Canadian context.

Water quality trading schemes are often offset systems developed within a cap-and-trade format. This means that total loads of a specific pollutant, for example phosphorous, are limited (the cap) in a given water body. The limit or cap is then allocated individually to point sources, for example to waste-water treatment plants (WWTPs) and to the total number of agricultural operations as a whole. Within that cap, existing point sources or new ones are authorized to meet allowed discharge limits of phosphorous by buying *at least equivalent* reductions (or pollution reduction credits) in phosphorous discharge from agricultural sources. This is how an offset system works: increases in pollution discharge to a water body from some sources are compensated by at least equivalent reductions from other sources.

An essential condition for trading to occur is the existence of large enough differences in pollution abatement costs for different operations. In WQT, for example, large differences often exist between WWTPs and agricultural operations in abating phosphorous or nitrogen discharges, making trading potentially attractive. These cost differences, when they exist, ensure that trading can reduce pollution at lower cost than other approaches, and can provide more flexibility for different operators to choose the abatement method most appropriate to their context.

However, while cost differences are a necessary condition for WQT, they are not a sufficient one. Lessons from trading experiences around the world provide an idea of what those conditions are, including challenges facing those wishing to design such systems.

Biogeochemical, Regulatory, and General Policy Considerations

At the most basic level, for a WQT system to work, there is a need for adequate biogeochemical information and a regulatory system that allows point sources to meet their environmental obligations through such trades.

In the Canadian context, it was found that phosphorous, nitrogen, and sediment offered the most potential for trading, which could also be considered in a few cases for bacteria and pesticides. In general, the following science-related factors may facilitate WQT as an option for pollution management:

- the existence of a clearly documented pollution problem;
- well-developed best management practices or abatement technologies for pollution reduction and the ability to quantify pollution reductions;
- historical monitoring data within the affected watershed including hydrological, water quality, and point source discharge data for pollutants; and
- a fundamental understanding of pollutant behaviour and watershed dynamics for determining critical load and trading ratios.

A watershed that is well understood and well monitored will be a good candidate for WQT, especially compared to a watershed where there is little information.

An analysis of the main regulations and policies in Canada reveals that several jurisdictions are in a strong position to implement a WQT program, including a watershed-based variant of the type adopted in the Netherlands. In fact, most provinces already have the basic tools, although at different stages of development. The legal barriers would be relatively simple to address.

However, there might be cultural and institutional barriers. Moving away from a technology-based, command-and-control regulation system toward ambient-based approaches may take some regulators out of their traditional comfort zone, and may require a culture shift among both regulators and the potential trading community. Such a change might be slow to occur.

Design Considerations

A large number of design challenges occur in implementing WQT. The number of past and existing experiences may highlight general rules, but probably not identify the right choices in particular circumstances.

- The administrative system has to ensure that trades are easily recognized as a means for regulated entities to meet their obligations.
- Buyers and sellers must be able to identify each other, what is available, and at what cost.
- Implementation and administrative costs more generally must be minimized for such a system to be attractive. This can be done by adapting existing and recognized program delivery mechanisms.
- Trading requires as much if not more monitoring and enforcement than any traditional regulatory approach. This is another reason why building a trading program where monitoring is already well organized makes sense. Sound choices have to be made with respect to enforcement to maximize compliance while minimizing costs.
- Policy guidance manuals can be useful for organizations wishing to examine and, maybe, implement WQT, clarifying the possibilities and eliminating some hurdles.
- As a watershed- or a sub-watershed-based approach, trading requires the collaboration of actors who may not have traditionally felt the need or obligation to do so. It is thus crucial for trading systems to include, from the planning stage, all relevant stakeholders, including environmental non-governmental organizations and possibly the public more generally. Such participation can also promote the development of systems that may be more equitable.

A Role for the Federal Government?

In practice, federal intervention may be warranted for legal reasons in specific locations where WQT would be planned. The Government of Canada could also support the development of WQT programs at the watershed level largely through indirect means, such as:

- providing the necessary scientific expertise;
- assessing how the existing relevant policy mixes actually reach their goals;

- fostering the coherence of policy instruments used to support agricultural activities and to promote better environmental outcomes to avoid counter-productive efforts;
- producing a guide to WQT adapted to the Canadian contexts;
- supporting pilot schemes and documenting their effectiveness in partnership with provincial authorities and local stakeholders;
- providing support for social/economic experiments in laboratory settings aimed at testing different trading systems in Canadian applications, similar to the Australian approach; and
- constructive and co-ordinated involvement of federal departments with responsibilities and legal obligations in specific watersheds where WQT programs are proposed. This might require the kind of co-ordination that may only be possible if an appropriate policy is in place to clarify the Government of Canada's role in watershed-based management.

A more direct option available to the Government of Canada could be to introduce more stringent regulations than those already in place in the *Canadian Environmental Protection Act* to address nutrient contamination or other sources of pollution from agricultural activities. We have not examined this more controversial option given the primary role of Canadian provinces in regulating agricultural activities.

1. Introduction

> [We] still know too little about which policies will work, under what circumstances, and why. Much of our knowledge about what policy instruments work and when is tentative, contingent and uncertain. We usually do not know how effective a particular instrument will be until it is tested in the field, and even then, the outcome is often context-specific (Gunningham and Sinclair, 2004b: 194).

This document explores the extent to which water quality trading (WQT) could become part of the policy toolbox of Canadian policy makers. To do so, we first explore lessons learned from trading in general, as well as from experiences with WQT more specifically, to ascertain the extent to which this policy instrument actually brings expected results, and if not, what would be required to do so. We also explore the compatibility of WQT with present Canadian regulatory systems and related policy frameworks.

Another important objective of this document is to offer some limited but valuable insights into the complex questions of instrument choice and instrument mixes. By closely examining how and in what context a specific instrument, such as WQT, has been implemented, it is possible to better understand how it fits with the diversity of instruments used to address similar pollution issues.

But as Claassen et al. (2001: v) suggested, successful implementation of an instrument is in great part a function of the capacity to design it appropriately, taking into account possible sources of failure, and the conditions for its implementation. Therefore, while implementing WQT could be feasible in a specific context, compatible with existing regulation, and would be acceptable to stakeholders, careful attention has to be given to design considerations.

Much of water pollution coming from agriculture, also known as non-point source pollution, is characterized by the inherent difficulty of establishing a clear link between agricultural activities and their environmental effects. This situation is worsened by the fact that the same production practices might have different effects in different watersheds, in different locations within the same watershed, or at different times of the year. We know, however, that in some Canadian watersheds the cumulative effect of increasingly intensive agricultural activities has led to major water quality problems, for example through excessive nutrient concentrations (Chambers et al., 2001; Coote and Gregorich, 2000; McRae et al., 2000). In this respect, Canada is certainly not unique (OECD, 2004).

Canadian governments have traditionally and are still mainly relying on education, training and, more generally, voluntary policy instruments to address the thorny issues of pollution generated by agricultural activities (Montpetit, 2003; Sauvé et al., 2005: 28). While some regulations have been introduced at the provincial level, there is relatively limited use of regulation in Canada when compared to most European countries. From this angle, the Canadian experience can be compared to the approach of Australia and, to a lesser extent, the United States, countries that are relatively reluctant to use regulation (Gunningham and Sinclair, 2004a; Claassen et al., 2001; BDA Group, 2005: 34). Apart from the Netherlands, where regulation plays a

Definition of Water Quality Trading

Water quality trading is a version of pollution trading designed to address issues of water quality. Like all pollution trading programs, in theory WQT allows firms to meet environmental objectives at lower cost and with more flexibility than other types of regulations. It builds on the fact that polluting sources, generally located in the same watershed or sub-watershed, often face different costs to control a given pollutant. Firms facing lower costs are in a position to reduce their pollution discharges more quickly and to trade to other firms what are often referred to as pollution allowances or pollution reduction credits. As this report shows, the effectiveness and efficiency of WQT programs largely depend on local biological and social conditions, as well as on careful attention to program design.

It is important to understand that WQT, like other market-based regulations, is not an alternative to, but a specific form of, regulation. It builds on market mechanisms and usually complements other government interventions, some of a regulatory nature and some that are more voluntary, such as training.

more important role, these are the only countries where trading has been introduced to tackle water pollution in some watersheds, including pollution generated by agricultural activities.

In theory, as a market-based instrument WQT promises to deliver environmental results at lower costs than more direct forms of regulation when some conditions apply. First, enterprises have to face some form of regulatory incentive to meet a given pollution target. (This target can be defined individually or for a number of enterprises collectively.) Second, if the costs of reducing pollution are different between firms, those facing lower costs will have an incentive to invest more quickly in new abatement technologies if they can trade their excess "rights" to pollute – defined either through permits or pollution reduction credits – to firms that are unable to meet their pollution target. Finally, firms are authorized by the regulator to acquire permits or pollution reduction credits to meet pollution level targets. Pollution trading can thus lower the overall cost of compliance for firms to achieve a given environmental objective. In addition, in such a market-based system, firms have more flexibility to achieve the environmental goal since they are not told what approach to use. While these three conditions may be necessary, they are certainly not sufficient to ensure the success of trading programs.

While some experiences with pollution trading have had enormous success (e.g., SO_2 in the United States), (see Tietenberg and Johnstone, 2004; Harrington et al., 2004) other experiences including the great majority of WQT programs have not been so successful, at least if measured by the number of trades that have happened (Hahn and Hester, 1989; Woodward et al., 2002; King and Kuch, 2003; King, 2005a).

Water quality trading purports to reduce water pollution from agriculture by making pollution reduction less expensive for farmers and municipalities. It has been applied for more than 20 years in the United States (Breetz et al., 2004; Morgan and Wolverton, 2005). This instrument has also been used more recently in Australia and Ontario (Birt and Wilman, 2004; Collins, 2005a; O'Grady and Wilson, 1999; O'Grady, 2005b; Conservation Authorities of Ontario, 2003). In the Netherlands, a trading system was implemented in 1994 to allow trading of manure quotas (Hubeek, 2005). These quotas were introduced in 1987 to ensure farmers had enough land to manage the animal wastes generated by livestock operations to control nutrient application to the soils, and thus nutrient losses to water bodies. Trading was introduced as part of a strategy to reduce manure production (Hubeek, 2005).

The relatively long but not always successful American experiences with WQT provide a number of insights into the development of such programs. The experience in the Netherlands also brings important insights into how different instruments can be linked together. These lessons, added to more recent experiences in Canada and Australia, provide a better understanding of the challenges and opportunities ahead for Canadian decision makers in the provinces and the federal government interested in developing WQT programs.

One important conclusion of this report is that the legal and related policy frameworks in Canada can easily allow for the development of WQT programs. But while this instrument could be implemented in any watershed where sufficient scientific information is available for a pollutant of concern, and where an adequate monitoring and enforcement system is in place, the appropriateness of the tool can only be evaluated at the watershed level.

Some suggest that such a system needs to be backed up by clear regulation that would lead all relevant sectors, including agricultural activities, to seek reductions in the level of a specific pollutant (King and Kuch, 2003; King, 2005a). But it is more likely that with or without strong regulation, WQT will be a useful instrument in Canada only when local stakeholders and other relevant parties have decided to invest time and energy in making it work, and after they have collectively agreed that the tool offers potential benefits.

An important consideration in assessing the relevance of WQT in Canadian contexts is to examine how it would fit with existing policy instruments and institutions put in place to deal with the environmental effects of agricultural activities, and also more generally those that have been put in place to support the farming sector. We have not reviewed this aspect in detail but provide some guidelines to do so.

The Government of Canada could support the development of WQT programs at the watershed level largely through indirect means, such as:

- providing the necessary scientific expertise;
- assessing how the existing relevant policy mixes actually reach their goals;

- fostering the coherence of policy instruments used to support agricultural activities and to promote better environmental outcomes to avoid counter-productive efforts;
- producing a guide to WQT adapted to the Canadian contexts;
- supporting pilot schemes and documenting their effectiveness in partnership with provincial authorities and local stakeholders;
- providing support for social/economic experiments in laboratory settings (PRI, 2005) aimed at testing different trading systems in Canadian applications, similar to the Australian approach; and
- constructive and co-ordinated involvement of federal departments with responsibilities and/or legal obligations in specific watersheds where WQT programs are proposed. This might require the kind of co-ordination that may only be possible if an appropriate policy is in place to clarify the Government of Canada's role in watershed-based management.

A more direct option available to the Government of Canada could be to introduce more stringent regulations than those already in place in the *Canadian Environmental Protection Act* to address nutrient contamination or other sources of pollution from agricultural activities. We have not examined this more controversial option, given the primary role Canadian provinces have in regulating agricultural activities.

Chapter 2 describes the context of agri-environmental policies to highlight the main environmental problems associated with agricultural activities, and our knowledge about them in the Canadian context. Chapter 3 examines options developed in OECD countries to deal with these issues. In doing so, we also compare Canada's approach in addressing agricultural sources of water pollution to that of other OECD countries.

Chapter 4 offers a short presentation of pollution trading to highlight the distinctiveness of WQT and some of the general lessons learned so far. We then examine in chapters 5 and 6 how these lessons have been translated in practice by describing respectively the bio-geochemical and regulatory conditions that can promote or hinder WQT in Canada. Chapter 7 examines the key design elements of some WQT programs, and Chapter 8 discusses the issue of stakeholder participation. Before offering concluding remarks on the feasibility of WQT in Canada, we isolate in Chapter 9 insights learned in terms of instrument choice and mixes of instruments.

2. Agriculture Impacts on Watersheds

There has been notable progress in Canada and a number of OECD countries in reducing water pollution from large industrial facilities (Faeth, 2000; Gunningham and Sinclair, 2004a; Swain, 2005). So much so that "it is a myriad of small enterprises, often on the urban periphery, and primarily agricultural, which cause the majority of pollution entering many waterways" (Gunningham and Sinclair, 2004a: 93). In some OECD countries, it is estimated that the:

> application of fertilisers in agriculture and animal effluent from livestock account for as much as 40% of N [nitrogen] and 30% of P [phosphorous] emissions in surface water...contributing significantly to the problems of eutrophication... . Pesticide run-off from agricultural land also impairs drinking-water quality and harms water-based wildlife (OECD, 2004).

In Canada, while there are a number of good and relatively recent assessments of the status of agricultural- and nutrient-related pollution, there is not enough data in general to assess and compare the relative importance of different sectors' pollution loads (see in particular Coote and Gregorich, 2000; Chambers et al., 2001, 2002; Environment Canada, 2001; McRae et al., 2000). These studies not only reveal limits to our understanding of water contamination in Canadian watersheds, but more importantly they highlight the fact that our knowledge base is unequal: some watersheds have been studied for decades while others are almost terra incognita.

Indeed, as Chambers et al. (2001, vii) suggested: "At present in Canada, there are not enough data to evaluate the risks to humans and aquatic biota from agricultural sources of [polluting] materials." At the same time, Harker et al. (2000: 27) highlighted the fact that:

> National monitoring of water quality has been largely discontinued, and many provincial monitoring programs have been cut back during the 1990s. Assessment of water quality must rely on the results of regional or watershed projects, often illustrated by specific case studies and field research.

Assessing the effects of agriculture on surface waters and ground water is further complicated by a number of factors, such as the difficulty

Definition of Nutrients

Nutrients are chemical substances that provide nourishment and promote growth of micro-organisms and vegetation. They include nitrogen, phosphorous, carbon, hydrogen, oxygen, potassium, sulphur, magnesium, and calcium as well as other elements required in smaller quantities: iron, zinc, copper, manganese, boron, molybdenum, and chloride.

In aquatic ecosystems, nitrogen, phosphorous, and sometimes iron are frequently the nutrients in short enough supply to limit biological activity. As a consequence, they are called limiting nutrients. Adding them to the water will also cause algal blooms.

A surplus of nutrients in an ecosystem can lead to increased plant growth and changes in biodiversity. Ammonia, nitrate, and nitrite are also toxic to aquatic and terrestrial animals, including humans, when present in quantities well in excess of requirements.

The 1999 *Canadian Environmental Protection Act* (CEPA) defines a nutrient as any "substance or combination of substances that, if released in any waters, provides nourishment that promotes the growth of vegetation." Under the Act, the Governor in Council may, on the recommendation of the minister, make regulations

> for the purpose of preventing or reducing the growth of aquatic vegetation that is caused by the release of nutrients in waters and that can interfere with the functioning of an ecosystem or degrade or alter, or form part of a process of degrading or altering, an ecosystem to an extent that is detrimental to its use by humans, animals or plants (CEPA 1999 Part 7, Division 1, 118(1)).

Source: Chambers et al. (2001: 1-2).

in tracing pollutants back to their non-point sources such as farmland; the high costs of monitoring; the large number and diversity of farms, soil types, and farming practices; and the time lag between when a substance is applied to the land and when its environmental effects may become evident.

This being said, we know that farming activities have intensified in many regions in the past 40 years and so has the pollution from agricultural sources. Among the agents responsible for declining water quality associated with these activities are soil particles (sediments), nutrients, pesticides, and bacteria (Coote and Gregorich, 2000). Note that the sources of some of these pollutants are not limited to agricultural activities. (For example, nutrients are also released from municipal wastewater treatment plants and some industries.)

With respect to nutrients, a Government of Canada report stated that "it is clear that nutrients are causing problems in certain Canadian ecosystems and affecting quality of life for many Canadians" (Chamber et al., 2001: v). In fact, nutrient loading, and in particular nitrogen and phosphorous, is considered the most serious effect of agriculture on water quality (McRae et al., 2000). The problems associated with excess nutrients include accelerated eutrophication of rivers, lakes, and wetlands resulting in loss of habitat, changes in biodiversity and loss of recreational potential; fish kills due to ammonia toxicity; elevated risks to human and livestock health through increased frequency and spatial extent of toxic algal blooms in Canadian lakes and coastal waters; and the increased economic burden to Canadians as a result of the need for treatment, monitoring and remediation of contaminated waters.

A number of policy tools have been developed in OECD countries, including Canada, to address pollution from agriculture. However, as Claassen et al. suggested (2001: v):

> Agri-environmental issues come in all shapes and sizes and a one-size fits all policy tool does not exist. Hence, harmonizing agricultural production with preferences for improved environmental quality may require a menu of policy options. But choosing one, or many, policy tools is just the beginning. How well a policy instrument performs and the distribution of benefits and costs – among and between farmers, consumers, and taxpayers – will depend as much on how a policy is designed as on which policy is selected.

In what follows, we briefly examine the types of policies that have been tried in OECD countries. This helps situate current Canadian approaches and, ultimately, where WQT fits within these options.

3. AGRI-ENVIRONMENTAL POLICIES

For many years, the agricultural sector in many OECD countries was not subjected to the regulations established under general environmental protection laws (Montpetit, 2003). This "agricultural exceptionalism" started to change in the 1980s, at least in some continental European countries, probably as a result of the perceived acuteness of the negative effects of intensive agricultural practices on the environment and human health. In these countries, regulations were introduced to control nitrate pollution, pesticides, intensive livestock operations, and the application of animal waste to land (Latacz-Lohman and Hodge, 2003).

However, attempts to address issues such as wildlife loss and habitat destruction through regulation failed, "paving the way for voluntary, incentive-based policies which would eventually become the dominant instrument of agri-environmental policy across Europe" (Latacz-Lohman and Hodge, 2003: 127). These policies take a number of forms, but they mostly rely on subsidies to encourage farmers to adopt more environmentally beneficial practices. Early programs were set up to preserve environmentally sensitive areas and were later extended to all agricultural land. A more recent adaptation of the same principle can be found in the development of cross-compliance mechanisms, which refers to linking agricultural support payments to environmental conditions. In this case, however, the incentive is negative: without the adoption of certain practices, payments are not available.

In contrast to the European experience, Australia, Canada and, to a lesser extent, the United States have made relatively little use of regulation, emphasizing instead education, training, and voluntary programs sometimes backed by positive financial incentives such as subsidies (BDA Group, 2005; Claassen et al., 2001; Gunningham and Sinclair, 2004a; Montpetit, 2003).

In summarizing the recent state of affairs with respect to agri-environmental policies, an OECD (2004: 22) report stated that "OECD countries currently address environmental issues in agriculture with a plethora of sometimes overlapping measures, combining elements of direct regulation, economic instruments, education, persuasion and community involvement." According to the same report, the key features of current agri-environmental measures include the following (Table 1 provides a range of possible policy instruments to address water pollution from agriculture):

- Set targets or thresholds especially for pesticide use, water quality, and ammonia and greenhouse gas emissions.
- Support regulations to enforce particular farming practices (e.g., manure storage), by fines and charges for non-compliance. These range from outright prohibition, to standards and resource-use requirements. In many cases, these requirements have been extended or developed over the past 15 years. An increasing number of regulations derive from state, provincial, regional, or local measures under the framework of umbrella legislation, to accommodate the local nature of many environmental concerns.
- Provide agri-environmental payments to contribute toward the cost of meeting regulations, compensate for income lost by adopting certain practices, and reward farmers for providing environmental services. This approach is more common in European countries and the United States, where such payments substantially increased between 1993 and 2003.
- Make very limited use of taxes and charges, and limited but growing use of other market-based approaches, such as tradable permits. With respect to tradable permits, their use has been limited to the Netherlands, the United States, and Australia. In Canada, a pilot project was adopted in Ontario's South Nation River Watershed at the end of the 1990s.
- New Zealand, Australia, and Canada have made widespread use of voluntary community-based approaches (e.g., through supporting local organizations). These approaches tend to take advantage of farmer's self-interest in environmental conservation, peer pressure, and make use of local expertise in solving environmental problems.

Table 1 – Possible Options for Addressing Diffuse Source Pollution from Agriculture

Education and Information Initiatives
• Information campaigns (government or industry associations) • Off-site training in environmental management • On-site training in environmental management (which may be subsidized) • Information from suppliers, namely chemical companies producing pesticides and fertilisers • Soil, manure and water monitoring
Voluntary Instruments
• Industry codes of practice • Environmental management standards • Voluntary agreements
Economic Instruments
• Input taxes or levies on nitrogen and phosphorous fertilisers, or pesticides (could be introduced on all inputs, or just those above a specific quota) • Tradable nutrient quotas (could be based on inputs or soil concentrations) or emissions trading (between non-point and point sources or non-point and non-point sources) • Subsidies for external audits and/or the adoption of best practices • Financial compensation for setting aside land, such as the creation of buffer strips or zones • Liability Rules which guide compensation decisions when polluters are sued for damages
Regulatory Instruments
• Compulsory adoption of environmental management plans • Placing a cap on polluting emissions • Controls on rates of fertilizer application • Banning environmentally risky farm practices (e.g., not leaving buffer zones to water ways and clearing vegetation near water ways) • Compulsory disposal methods of farm waste, particularly manure • Cross compliance provisions (depending on the extent of state government subsidies)
Planning Instruments
• Rezoning to exclude agriculture • Land retirement contracts or covenants • Land management contracts or covenants
Source: Taken from Gunningham and Sinclair (2005: 51). The authors adapted their table from P. Dampney, G. Goodlans and J. Hillman, *Methods and Measures to Minimise the Diffuse Pollution of Water from Agriculture: A Critical Appraisal* (DEFRA, 2000) p.40-5; and Shortle and Horan (2001).

While some studies suggest some improvement from the adoption of these policies, “agri-environmental measures are at a relatively early stage of development” making it difficult to assess their performance (OECD, 2004: 24). Experience appears to be showing that the effectiveness of agri-environmental policies is positively linked to the adoption of clearly specified environmental objectives “and the actions required by farmers closely targeted to the objectives, which may include tailoring measures to the localised nature of many environmental concerns” (OECD, 2004: 27). Close monitoring and assessment of farmers’ compliance, as well as provision of training and advice to ensure the best ways to implement measures are mastered by farmers, also tend to increase effectiveness (OECD, 2004). However, this tends to be very costly.

A notable finding of the OECD is that agri-environmental policy measures and agricultural support measures often lack coherence, as they can pull in opposite directions (OECD, 2004). Financial support to increasing production, for example, would likely negate some of the benefits of agri-environmental payments intended to modify practices.

With respect to voluntary measures which, as we suggested above, are dominant in Canada, Australia, and in the United States, according to Gunningham and Sinclair (2004a: 103), "there is little evidence to suggest that voluntary approaches deliver the expected environmental benefits and much that they do not."[1] More specifically, these authors argue that education, training, and voluntarism should not be used as stand-alone approaches. These instruments should however be used as an underpinning to other more interventionist approaches since they provide "the necessary understanding without which landholders and others are unlikely to accept the need to change their practices" (Gunningham and Sinclair, 2004a: 103; see also BDA Group, 2005: 49). Ribaudo and Horan (2004) reached a similar conclusion with respect to education programs, when implemented as a stand-alone instrument.

The main reason for this general lack of success, according to Gunningham and Sinclair (2004a), basically lies in the fact that voluntary programs will work to the extent farmers' and societal interests coincide. But since most changes required from farmers involve costs greater than the individual benefits, and since the benefits are mostly felt by a region or society as a whole, other approaches or incentives are needed.

Underlying these choices are fundamental issues concerning how equity is defined and the level of responsibility that should be assigned to the agricultural sector alone in solving such problems. In other words, the question is whether such issues should be approached through a strict application of the polluter pays principle, or, as Gunningham and Sinclair contended, by applying a wider community-based version of the principle, where the costs, as the benefits, are shared more broadly. The notion of community can refer to the geographical reach of the problems caused by agricultural activities; for water pollution issues it could be associated with a given water basin. But the notion of community can be extended to a whole region, province, or country. While the Canadian answer to this question is not explicit, current approaches suggest that a variation of a community-based approach is, so far, the default answer, since a large number of agri-environmental policies in Canada involve some type of subsidy funded through provincial and national programs.

The important mission then becomes, in the Canadian context, finding the other policy tools that should be used to complement educational and voluntary approaches given the current preference for some form of community-based approach to the issue of agricultural sources of pollution. We address this in Chapter 9.

4. Pollution Trading, Water Quality Trading, and Regulations

> Water quality trading was seen by the permitted sources as a way to encourage non-point sources to generate cheaper reductions than they could achieve themselves, and as a means to recruit agricultural sources to the table in a non-threatening manner, to discuss how these sources could help achieve the watershed's goals (Schary and Fisher-Vanden, 2004: 15).

Not all trading programs are equal. Just because trading has been effective in reaching an environmental goal at lesser cost in a specific instance, it will not necessarily work as well or even at all in another context. A number of factors affect the effectiveness of such programs. In what follows we first present the main features of pollution trading. This is followed by a presentation of the specificities of WQT. We conclude with some of the main lessons learned from trading experiences with a view to highlighting those more relevant to WQT programs.

A General Overview of Trading and its Relationship to Regulations

Pollution trading is a market-based instrument (MBI) in the sense that it builds on market mechanisms to address problems of environmental quality. Stavins (2001:1) defined MBIs as "regulations that encourage behaviour through market signals rather than through explicit directives regarding pollution controls or methods." These market mechanisms act as levers for regulators to modify the behaviour of polluters by offering financial rewards or penalties. In addition, MBIs are often superimposed on existing regulation to introduce additional incentives and more flexibility for regulated entities to achieve environmental objectives defined by the regulator.

Economic theory predicts that pollution, which is often external to the normal economic calculations of enterprises and individuals, will be reintegrated in the economic system through programs that allow pollution trading. If appropriate incentives are in place, there should be benefits for firms to change their practices and reduce their pollution load.

Trading is a *quantity-based* MBI that involves "setting standards for mitigation effort (e.g., emission standards) and allowing trade among those providing mitigation (allowing individual underperformance if it is compensated by overperformance elsewhere)" (Hatton MacDonald et al., 2004: 17). In essence, firms for which the costs to meet the standards of reducing pollution are lower might have an incentive in acting earlier, and even overcomply – to earn pollution credits (or sell excess pollution permits) while those facing higher costs might have an incentive to buy pollution reduction credits (or permits) to lower the costs of compliance.

Definition of Environmental Externalities

Any externality, including environmental ones, occurs when production or consumption by one firm or consumer directly affects the welfare of another firm or consumer, where "directly" means that the effect is not mediated through any market and is consequently unpriced.

As Daly and Cobb noted, the term externality suggests both that the phenomena are external to the market and also that they are external to the main body of theory built on the market as an economic concept.

The authors go on to add that all conclusions in economic theory about the social efficiency of pure competition and the free market are explicitly premised on the absence of externalities. The undeniable importance of externalities in today's world is therefore a serious challenge to the relevance of these conclusions.

Economic theory proposes to meet this challenge by "internalizing" all external costs and benefits in the money price paid by whoever buys the good or service and the production of which gave rise to the external cost. Market-based instruments, such as pollution trading or taxes are thus proposed, and sometimes used, at least in theory, with the purpose of "internalizing" costs.

Source: Daly and Cobb (1994: 53-54).

A Typology of Market-Based Instruments

Price-based instruments – are instruments that attempt to influence environmental performance by pricing negative externalities or subsidizing mitigation actions. There are several variants.

Environmental charges – charges with the rate related to the level of an environmental externality (e.g., discharge fees for effluent). Alternative implementation can involve charges on inputs related to an externality (a charge for vehicle registration with a rate based on engine displacement as a proxy of a discharge fee).

Incentive payments – involve subsidizing the cost of actions to mitigate an externality. Often, incentive payment levels are set at fixed rates.

Tendering – is an alternative approach to distributing incentive payments that involves distributing funds by tender or auction. This involves those seeking incentive payments making offers describing mitigation action and cost sharing payment terms. The government selects among offers based on value of mitigating per cost sharing for dollar.

Quantity-based instruments – involve setting standards for mitigation effort (e.g., emission standards) and allowing trade among those providing mitigation (allowing individual underperformance if it is compensated by over performance elsewhere). There are two major variants, as well as:

Tradable permits – involve setting individual rights to input levels, output levels or performance standards (e.g., individuals are granted an allowable level of emissions as a number of emissions permit). Individuals are then only allowed to exceed the standard if they purchase additional permits from someone who is under their allowable emissions and therefore has excess permits.

Environmental offsets – environmental offsets are actions taken to meet a standard (reducing pollution or environmental impacts) at a site away from where the action causing an environmental externality occurs. The party causing the externality can either take the action or pay for others to do it on the party's behalf.

Market barrier elimination instruments – focus on improving environmental outcomes by increasing consumer awareness of environmental attributes of products they may value, or removing barriers to market activity. Product labelling schemes are perhaps the most widely applied market creation MBI approach. They involve providing information about the environmental outcomes of production so those who value associated improved environmental outcomes can express their preferences through markets.

Source: Hatton MacDonald et al. (2004: 17).

In contrast, environmental charges (or levies or taxes), also MBIs, are said to be *price-based* in the sense that they directly modify or impose a price for an environmental externality.

There are basically two types of trading systems: tradable permits (also known as cap-and-trade or closed systems) and environmental offsets (also known as baseline-and-credit or open systems). The first establishes individual rights – through permits – to input levels, output levels or performance standards. In the case of water pollution, individuals are allowed to exceed their authorization to discharge if they purchase an appropriate number of permits from another individual (Hatton MacDonald et al., 2004: 17). Offsets are actions to meet a standard at a site away from where the pollution occurs. One is allowed to exceed the authorization to discharge if one buys pollution reduction credits generated elsewhere.

A crucial difference between tradable permit and offset approaches is that in the former, a cap or limit on total emissions, which is individually allocated to permit holders, needs to be defined. Such a cap is not a necessary feature of offset systems, but in many cases the regulatory system imposes some definition of an environmental threshold or baseline, which allows some measure of performance for participating firms. For example, a firm can be awarded a pollution credit by reducing pollution further than what is required to reach the baseline. Such a credit can then be bought and used by other firms to offset expected increases in their pollution discharges. The objective is generally to maintain or lower total pollution levels.

In practice, WQT systems involving agricultural sources of pollution are often a modified version of the offset system: they can include a total market cap, defined at the watershed or sub-watershed level.

This cap is partially allocated individually to permit holders (regulated entities) and the rest is allocated to the agricultural sector or another non-point source sector like municipality run-offs. Given the difficulties in assigning individual loads to non-point sources, limits can be imposed to those sectors as a whole. In such cases, every enterprise in a given non-point source sector shares responsibility for maintaining pollution levels under the defined limit.

Market-based instruments in general and trading in particular are often presented as cost-saving alternatives to command-and-control (CAC) approaches that can provide equivalent or better environmental results (Stavins, 2001; Tietenberg, 2001). Command-and-control refers to a regulatory approach whereby the state sets a standard, monitors compliance, and enforces through penalties. Regulation in this approach is often prescriptive and technology based. All enterprises in a given sector may be required to adopt a specific pollution reduction technology, which is expected to lead to the desired environmental improvement. Such an approach may be more costly, because there is little or no flexibility in the means available to achieve pollution abatement. However, from the point of view of the regulator, such regulation may be simpler to administer and may provide more certainty if enforced adequately.

Not all regulation is so prescriptive. *Performance-based regulation*, for example, establishes uniform emissions goals without prescribing the method to reach them (Stavins, 2001; Gunningham and Sinclair, 2004b). The costs of complying with this type of regulation will likely be higher than those of equivalent MBIs based on charging firms according to their specific pollution loads (e.g., load-based licensing) to the extent that firms face the same requirement independently of their abatement costs. However, by allowing flexibility in the technology used, it is likely to be less costly than technology-prescriptive approaches.

Another type of regulation, more appropriate to the type of pollution generated by agricultural activities is referred to as *process standards* by Gunningham and Sinclair (2004b). Such standards “dictate a series of management decision-making processes that are likely to improve environmental outcomes, without nominating particular technologies that must be employed or particular pollution reductions that must be achieved” (Gunningham and Sinclair, 2004b: 184). Nutrient management plans are a typical example of such regulation.

Definition of a Nutrient Management Plan

A nutrient management plan is a farm plan that evaluates all sources of crop nutrients (e.g., commercial fertilizer, manure, biosolids, etc.) and allocates them to crops for maximum economic benefit and minimum environmental risk (Coote and Gregorich, 2000: 149.)

For example, Ontario regulations now require farms that meet certain size criteria and store or use manure on their land, but do not generate manure for removal, must have a nutrient management plan. A plan consists of:

- a description of the type of operation and status of the plan (new or renewal);
- a farm unit declaration and sketch;
- analysis of nitrogen, phosphorous, potassium, and total solids;
- storage information, if applicable;
- a contingency plan (if weather prevents application or the storage gets too full);
- certification form;
- list of nutrients to be applied and total quantity;
- field information, cropping practices, and application rates; and
- landowner agreements that show adequate land base for application.

Source: Canadian Environmental Law Association (2004).

Description of the US SO_2 Allowance Trading System

Stavins (2001: 27) described this cap-and-trade program as the most important application of a market-based instrument for environmental protection, adopted to regulate SO_2 emissions, the primary precursor of acid rain. Cap and trade refers to pollution trading programs where a limit is set on the total amount of emissions firms are allowed to emit. This limit is then allocated between firms. The US SO_2 program was implemented in two phases. During the first phase, individual emission limits were first assigned to the 263 most SO_2 emissions-intensive generating units at 110 plants operated by 61 electric utilities, and located largely at coal-fired power plants east of the Mississippi River.

Almost all electric power generating facilities were brought within the system during the second phase, with certain exemptions granted to compensate for potential restrictions on growth and to reward units that were already unusually clean.

Trading resulted in estimated cost savings on the order of $1 billion annually, compared with command-and-control regulatory alternatives.

Schary and Fisher-Vanden (2004: 8-13) identified two fundamental principles, and their accompanying mechanisms, that made that program a success. The first principle is to create a standardized commodity, which was achieved by measurement accuracy, automated compliance checks and penalty provisions, no local hot spots or adverse environmental impacts, and accurate accounting of allowances. The second principle, to achieve the environmental goal at the least cost possible by making the trading system as efficient and attractive as possible, was achieved by flexible permit limits within trading parameters, simple trading processes that encourage a greater trading volume, and automate review and compliance to increase certainty.

What should now be clear is that MBIs are not an alternative to regulations (Johnstone, 2003). In fact, not only are MBIs a specific type of regulation, but most of the time they are intertwined with other forms of regulation, since they have been introduced to complement them. For example, US success with SO_2 emissions is directly linked to the existence of strong standards limiting the total amount of emissions allowed, coupled with extensive monitoring and enforcement mechanisms. The introduction of trading allowed enterprises to comply by either searching for cost-saving alternatives to reduce their emissions or by buying permits from another regulated enterprise (Schary and Fischer-Vanden, 2004; see also Heimlich and Claassen, 1998).

Furthermore, technology-based standards or other forms of regulation can provide the basis for setting environmental goals or to define a baseline. In fact, as Hahn and Hester contended (1989: 368), in their review of a number of trading experiments, trading programs rely heavily on the existing regulatory system. However, the nature of those systems can actually impede the development of efficient trading programs.

More generally, as Kraemer and Banholzer (2003: 33) explained, regulation makes MBIs possible and enforceable.

> Functioning schemes of water pollution trading tend to be intertwined with traditional environmental management systems and strong (pre-existing) regulatory regimes. The latter ensures both the effectiveness of and the integrity of trading schemes, by providing a (sometimes threatening) back-up of potential regulatory intervention.

In short, as Young and McColl (2005) reminded us, MBIs are as much economic as they are legal instruments. This being said, MBIs can offer more flexibility than traditional command-and-control regulations alone, as well as allowing users to reach environmental objectives at lower cost. Given this, the difficult issue is to find the right mix of policy instruments, which may include regulation and MBI's, as well as voluntary instruments and education. We explore this further in Chapter 9.

How Does Water Quality Trading Work?

Water quality trading to address agricultural pollution is a specific form of pollution trading adapted to address a specific set of problems. The classic example is a watershed where municipalities through their wastewater treatment plants (WWTPs) and farming operations discharge (among other things) significant amounts of nutrients, such as phosphorous. As we saw earlier, the discharge of nutrients in amounts exceeding the assimilative capacity of a water body can lead to eutrophication.

Under a traditional regulatory approach, municipalities would have to invest in technology (often of a specified type) to reduce the amount of nutrient discharged and to meet a regulated effluent concentration typically expressed in terms of milligrams of phosphorous per litre (mg/L). After a certain point, the level of investment required to control additional phosphorous discharges (due to city growth, for example) can be very high, so there might be clear economic advantage in looking for other options, keeping in mind the environmental objective being pursued. Such options can be found by looking at other sources discharging phosphorous within the same watershed. If others in the watershed could reduce an equivalent amount of phosphorous discharge at lower cost, and if the overall environmental effect of doing so is equivalent or better, it might be advantageous for the municipality to pay those dischargers to reduce pollution instead of doing so itself.

Farming operations can thus receive payment from municipalities to adopt practices that reduce, in this example, P discharges. Different options are available to the farmers with different costs and environmental benefits.

As Table 2 illustrates, cost differences in abatement measures between municipalities and farming activities, on average, can be important. But this is not necessarily the case for all operations as indicated in the Table by the minimum and maximum costs faced by farmers. In addition, Fang and Easter (2003) showed that environmentally beneficial practices appropriate for specific types of operations may not allow large enough cost differences for a WQT program to be cost effective.

Assuming there are large enough differences in abatement costs with a sufficient number of farm operations, trading gives the municipality the option of delaying or completely avoiding a costly investment by contributing to the reduction of *at least* an equivalent amount of phosphorous from other agents around the watershed. This could be done through a combination of permit trading and offsets. Permit trading would apply to regulated point sources, such as other WWTPs in the watershed, or to large regulated farming operations, which are sometimes considered as point sources. An offset could be added to the permit trading system and could apply to, for example, renovations of private septic systems, the control of urban run-off, and to changes in the practices of smaller farming enterprises.

Definition of Assimilative Capacity

The assimilative capacity of a water body is its ability to assimilate wastes that enter it with no detrimental effects on the water uses of that water body. The assimilative capacity is calculated on a variable-by-variable basis taking into account the relationships that may exist between each variable and other variables in the water column or sediment.

Furthermore, the calculation of assimilative capacity uses the highest safe concentration of a variable to protect all water uses (a guideline, objective, or standard) and is multiplied by an appropriate flow rate for the water body to determine the maximum allowable load of the variable. The allowable loading from dischargers is then determined by taking the assimilative capacity loading for a variable and subtracting the loading that may exist in the water body from other human or natural sources.

The term "loading" in reference to an effluent discharge is defined as the concentration of a pollutant in that discharge multiplied by the flow rate of the discharge. Concentrations in effluents are usually expressed in terms of mg/L or µg/L, flow rates in terms of m^3/d, and loadings in terms of kg/d. Authorizations to discharge are usually expressed in terms of pollutant concentrations and flow rates, or in reality, "loadings".

Source: Swain (2005).

Table 2 – Cost Effectiveness of Abatement Actions in Different Regions

Abatement Measure	South Creek, NSW (AU$/kg/yr)	Port Philipp Bay, VIC (AU$/kg/yr)	Great Miami River Watershed (US$/lb)	Great Miami River Watershed (US$/lb)	Bay of Quinte, Canada (C$/kg/yr)
Pollutant	**Nitrogen**	**Nitrogen**	**Phosphorous**	**Nitrogen**	**Phosphorous**
Urban Sources					
Constructed wetlands	10	80			
Better treatment at WWTPs	10,000	50			
Cost of point source upgrades			Avg: 62.62 Min: 5.83 Max: 551.51	Avg: 18.97 Min: 1.39 Max: 20.60	Avg: 160 Min: 14 Max: 4,521
Agricultural Sources					
Modifying fertilizer use by horticulture	<5	<5			
Riparian restoration	10				
Buffer strips on horticultural lands	<15				
No-till on all lands			Avg: 1.40 Min: 1.13 Max: 9.83	Avg: .50 Min: 26 Max: 2.58	
No-till and 50% fertilizer reductions			Avg: 7.69 Min: 1.13 Max: 59.66	Avg: 10.49 Min: .48 Max: 257.82	
Upgrade manure storage					Avg: 92 Min: 66 Max: 114
Milkhouse washwater controls					56

Note: The data presented here are only for indicative purposes. No comparison is possible between countries.

Sources: BDA Group (2005: 50); Draper et al. (1997b: 24-26); Kaiser & Associates (2004: 3-19).

There are relatively few examples of WQT around the world. Most experiences have taken place in the past 20 years in the United States, with most cases including non-point sources (Morgan and Wolverton, 2005). Australia started relatively recently and only a few fully fledged trading programs to address water pollution have been implemented, two of them in the state of New South Wales and the other in the state of Western Australia (BDA Group, 2005: 13). An underlying enabler for the adoption of trading in New South Wales is the prior adoption of load-based licensing, an approach whereby permitted facilities are required to pay a charge proportional to the amount of pollution they release (Collins, 2005a). Only one Australian trading experience in New South Wales has recently started to include non-point sources. Another pilot scheme, which might eventually include non-point sources, is now being explored in Queensland, Australia, in the Moreton Bay area near Brisbane. In Canada, a pilot project was initiated at the end of the 1990s in Ontario and includes non-point sources (South Nation watershed). Other WQT proposals in the same province did not pass the feasibility study stage.

In the Netherlands, a different type of trading system was introduced to foster the reduction of manure production in an already established manure quota system, itself part of a larger regulatory initiative intended to reduce nutrient loading in soils and water bodies (Hubeek, 2005). This approach was thought to be administratively more practical, as we will see below.

Time Lag is an Important Consideration for Policy Makers

In developing pollution management strategies, it is important for policy makers to be aware of the time lag associated with contaminants in the natural environment. Following the implementation of a pollution management policy or program, including those that involve considerable reductions or even the elimination of harmful pollutant emissions, it can often take a significant amount of time (potentially several years) before a measurable improvement in environmental quality is observed. This time lag depends on pollutant characteristics, specifically, retention times in different media, and ability to accumulate in plants and animals.

The pesticide DDT is an example of a pollutant that has characteristically long retention times in the natural environment. DDT was sprayed regularly in the Great Lakes region from the 1940s to the early 1970s, when Canada and the United States restricted the chemical, because of its devastating toxic effects, including the total reproductive failure in the region's bald eagles that became exposed to the compounds through bio-magnification in the aquatic food web. Bald eagles along the shorelines of the Great Lakes continued to experience total reproductive failure for nearly 10 years after the policy decision to greatly restrict DDT and other harmful pollutants (e.g., PCBs) was taken. It was not until the late 1980s that contaminant levels noticeably decreased.

Although there was a time lag of 10 to 15 years, the resulting reduction in contaminants in bald eagle eggs allowed reproductive rates to recover. The number of active nests increased and the number of eaglets produced per nest improved. Although the levels of DDT, PCBs, and other banned pollutants have been reduced, they are still regularly detected in the Great Lakes region and throughout the country (Environment Canada, 2001).

This classic example illustrates how the effectiveness of a policy may not be realized for a significant period, and stresses the importance of a fundamental scientific understanding in the crafting of pollution management policy.

Source: Morin (2005).

So far, the results of the WQT initiatives including non-point sources are mixed if not negative, if judged by the number of actual trades that have happened (Woodward et al., 2002; King and Kuch, 2003; Breetz et al., 2004; King, 2005a; Morgan and Wolverton, 2005). Few of the American initiatives have actually generated more than a few trades. The Ontario example in this respect is considered a success, and indications are that the South Nation River's current nutrient load is lower than what it would have been without the program (De Barros, 2005). But it is too early to assess the effect of the program on the environment, as well as the Australian one that includes non-point sources, since changes in farming practices may take some time to lead to clear environmental improvement.

In the Netherlands, trading has played a positive role in helping to reduce nutrient loads. But the number of instruments used in this country over the years is large, and it is thus difficult to attribute the cumulative result to trading alone. This caution also applies to most other programs, including the Ontario program, where WQT is but one part of a larger set of measures.

Analysts have suggested a number of reasons to account for the limited success of trading programs dealing water pollution from agriculture, including the low supply and demand for pollution credits, related to the fact that non-point sources are often not regulated (King and Kuch, 2003; King 2005a, b). Others highlighted the design flaws of such programs, particularly the existence of large transaction costs preventing trades from occurring (Woodward et al., 2002). Finally, others looked into the social conditions that may be relevant to trading, and examined how the absence of trust among stakeholders has been a factor inhibiting progress in trading programs (Breetz et al., 2005).

It is important to note that a small number of trades may not necessarily mean an unsuccessful program; it may well be that a few trades can bring important benefits that could not have been achieved, or that would have been more costly to achieve, with other tools.

Phosphorous Trading in the South Nation River Watershed

The South Nation River watershed, located southeast of Ottawa, is 3,900 km^2 in size, has a population of about 125,000, and is mixed farming with dairy, cash crop corn, and soybeans. The watershed has 15 municipalities. In the 1990s, it was found to exceed provincial water quality guidelines for phosphorous of 0.03 mg/L. Watershed studies showed that 90 percent of the phosphorous load came from non-point, mainly agricultural, sources.

In 1998, Ontario stopped issuing permits for new plants in this watershed except if they did not discharge phosphorous. Such a requirement, however, meant that growing municipalities had to improve wastewater treatment to a point that was not always technically feasible, physically possible, or socially desirable (because of costs).

To allow more flexibility in meeting the goal of controlling phosphorous discharges in the river, the Ministry of the Environment adopted a total phosphorous management (TPM) policy. The policy allows dischargers to contribute phosphorous from their treatment plants as long as they offset an increase in phosphorous load by controlling phosphorous from non-point sources in the same watershed.

The South Nation river watershed became the first pilot TPM program in 1999. It is still the only Canadian experience with WQT. The TPM program has been integrated into the South Nation Conservation Authority's (SNCA) Clean Water Program, which provides funding assistance to landowners on a cost-share basis for water quality improvement projects. From 2000 to 2003, six municipalities and two industries entered into agreements with the SNCA providing $800,000. In 2003, 712 kg/year of phosphorous removal was credited to TPM projects.

Sources: O'Grady and Wilson (1999); South Nation Conservation (2004).

It is also important to reiterate that trading in any pollutant can only work if there is a large enough difference between different sources in the cost of reducing discharges. If the trading program is adequately designed, and under the right conditions, a municipality and its citizens have a good chance of being better off if they can, for a lower price, reduce the amount of a certain pollutant in a water body by paying a number of farmers to do so. Cost differentials, however, while necessary, are not a sufficient condition for trading to work, as we see below. But before doing so, we briefly present the trading program developed to address agricultural pollution in the Netherlands.

The Manure Quota System in the Netherlands[2]

Manure is a major source of nutrients, such as phosphate and nitrogen, as well as other contaminants in surface and ground water in the Netherlands, the country with the highest livestock density in Europe.

In 1987, the system of manure production quotas was introduced as part of the three-phased *Fertilizers Act* to stabilize and reduce manure production in the intensive livestock industry, especially the pig and poultry sector in the southern and eastern part of the Netherlands. This policy measure is still in place but has undergone several changes in response to lessons learned and demands from regulated farms.

A system of manure production quotas was chosen, because then current regulatory practices, such as the registration of all livestock, allowed more precise and cheaper measurement and monitoring of manure production than the continuous monitoring of emissions, thus making it relatively easy to enforce. More generally, the administrative costs of such a measure were considered to be moderate. Another important motive behind the adoption of this system was to meet European policy requirements to cap phosphate production.

The system has four main characteristics.

1. Quotas were allocated on the basis of historical rights (i.e., past levels of production), because this was considered equitable and fair to all farmers. Anticipating behaviour from farmers resulted in allocating more quotas than the volume of production required and the possibility of an increased instead of a decreased level of manure production.

2. Quotas eventually became tradable. When introduced, quotas were non-tradable, but experience showed farmers needed more flexibility to respond to market changes. Introducing tradability improved competitiveness, but also resulted in fewer and larger farms.
3. The division between land-based and non-land-based quotas, the third characteristic, was intended to increase extensive livestock production, and decrease intensive livestock farming, especially in the pig and poultry sector. While this division resulted in a decrease in the maximum level of intensive livestock production, it also increased the average level of livestock intensity.
4. The fourth characteristic, geographical restriction on manure quota trading, was imposed to decrease the level of production in manure surplus regions located in the south and east of the Netherlands. During the years 2002 and 2004 livestock volumes have declined, after increases in the preceding years.

The system of manure production quotas has had both socio-economic and environmental impacts. From a socio-economic standpoint, the movement of pig farmers from a manure surplus to a manure deficit area, where land and quota prices are lower, was expected to equalize rents. However, non-acceptance by local communities and cultural roots in the surplus region limited the number of farmers who actually moved.

The introduction of additional incentives into the quota system stimulated innovation in farming operations and environmental improvement. Knowledge programs were developed to support farmers in complying with the Mineral Accounting System (MINAS) introduced in 1998 and to assist them in adopting new methods and processes considered friendlier to the environment.

Environment improvement in both soil and surface waters were initially mainly a result of the *Soil Protection Act*, which aims to improve the efficiency of manure application. Further improvements after 1998 were directly associated with the introduction of MINAS. Overall, the system of quotas decreased total manure production from livestock production by 15 percent and prevented an increase of 5 to 10 percent, for a cumulative 20 to 25 percent difference from a business as usual scenario.

Lessons Learned about Trading

> In some respects, it would be fair to say that tradable permit schemes primarily consist of infrastructure for monitoring and recording emissions, rights and transfers (OECD, 2001: 49).

While this statement is essentially correct, it leaves out some important considerations in describing trading programs and the reasons for which they may not always work. Some of these, such as SO_2 trading in the United States, have clearly shown that trading can lead to better environmental results at lower cost when compared to regulation alone (Stavins, 2001; Tietenberg and Johnstone, 2004; Harrington et al., 2004). Recent ex-post evaluations of different programs in the United States and Europe involving MBIs and command and control confirm that from the regulatee point of view, MBIs and tradable pollution systems in particular are the more cost effective (Harrington et al., 2004; Tietenberg and Johnstone, 2004; European Environment Agency, 2006). However, as noted by Tietenberg and Johnstone (2004: 33): "In their most successful applications tradable permits have been able to protect environmental resources at lower cost. However, *such programs remain relatively few in number.*"[3]

Overall, the cost effectiveness of a trading system will depend on the importance of transaction costs, implementation costs (i.e., establishing the program) and administrative costs (i.e., ongoing costs). These will generally tend to decrease (on a cost-per-trade basis) as the number of trades increases (Weersink, 2005). It is important to look at the cost sources separately as it sometimes seems that merely reducing the private costs of compliance would, for some, be a significant improvement that tradable permit systems can bring over direct regulation. From a policy standpoint, however, there is an obvious need to look at the potential sources of administrative costs, including implementation costs, to assess the feasibility and overall benefits of any system.

Underlying this is the question of administrative capacity. Moving from a certain way of doing things to another may be complex and require a long period of adaptation; it can also involve significant costs. In this respect, as we see later, the existence of strong watershed institutions or existing program delivery mechanisms may provide opportunities to reduce some of these costs, among other benefits.

Ex-post evaluations and other analyses of trading programs resembling the format taken by most WQT programs reveal a number of important lessons. Here we concentrate on those that appear the most relevant for water pollution trading.

Defining the Commodity to Be Exchanged and its Contribution to the Environmental Issue

According to Ellerman (2003: 5), “all environmental regulatory systems presume some definition of pollution, but none are required to define it as specifically as trading systems.” The reason for this is the need to establish equivalencies between the credits or pollution permits being traded. This means that the potentially polluting discharge has to be separately identified, the amount constituting pollution must be determined, as well as the spatial and temporal relation of discharges to the harmful effects.

All environmental regulations face similar requirements. But the connection between emissions and the problem justifying the emission constraint is usually less direct than in trading programs. For instance, “technology standards are prescribed not because they fit the problem but because they usually represent the ‘best’ that can be done at the present” (Ellerman, 2003: 5).

To Cap or Not to Cap

According to Tietenberg and Johnstone (2004), cap-and-trade systems can deliver better environmental results at least cost. Furthermore, they can deliver the results with more certainty than other instruments.

However, there has not been systematic ex-post evaluation of baseline-and-credit schemes, or offsets. Some difficult issues with these approaches are the definition of the baseline and the administrative procedure by which credits are created. Without a cap, reductions must be credited to what the source would have emitted in the absence of regulation (a business-as-usual scenario), which is unobservable (Schneider and Wagner, 2003: 17). Consequently, using a relative baseline can create significant transaction costs when prior approval of trades is required, as the authority must investigate each claimed counterfactual from which reductions are calculated and credits generated.

In theory, WQT programs do not necessarily need to be backed by a regulated environmental objective, but the practice is that in most cases they have been implemented with a target, often through regulations. In the United States, for example, “[m]ost of the [water quality] trading programs have a Total Maximum Daily Load (TMDL) in place or under development for the watershed”(Morgan and Wolverton, 2005: 11). This TMDL determines limits for pollutants that affect different water uses at the level of specific watersheds. Similarly, in the South Nation watershed in Ontario, it is the realization

Total Maximum Daily Load in the United States

A total maximum daily load (TMDL) is triggered under section 303(d) of the US *Clean Water Act* when a water body cannot support the “beneficial uses” designated for it (e.g., swimming, fishing, or supporting trout or salmon habitat) and violates water quality criteria established to maintain those uses. The TMDL is developed to establish the amount of pollution reduction needed to meet water quality standards, and is divided between the contributing sources as waste load allocations and load allocations.

Waste load allocations are separate portions of the reduced load assigned to each permit holder, which are then converted to permit limits. The size of the waste load allocation is based on a variety of factors pertaining to the regulated entities, such as their discharge amount, location in the watershed, and available compliance strategies.

A single load allocation is usually assigned to an entire category of non-point sources, such as agriculture. A separate implementation plan spells out the means by which the reductions will be achieved, usually through voluntary measures, since these sources are not regulated under the *Clean Water Act*.

Source: Adapted from Schary and Fisher-Vanden (2004).

that water quality objectives for phosphorous at the watershed level were already exceeded that triggered the search for a solution, such as a trading program.

It is important to mention that WQT programs typically have not solved the delicate problem of baseline accounting, a difficulty intrinsic in tracking non-point sources (Shabman et al., 2002). This makes the need to monitor changes at the watershed level a more crucial aspect of trading programs.

While a cap established by a regulation might not be a necessary element of a trading program, according to Gunningham and Sinclair (2004b: 184), approaches addressing water pollution in general should set a watershed-based objective. Indeed, they claimed that: "the benefit of adopting a catchment-wide pollution threshold is that it provides a discipline and focus to policy design, and importantly, a measure by which the success or otherwise of any policies implemented can be judged." However, objectives have to be set realistically, taking into account the difficulty in linking specific activities and the pollution problem. As a practitioner commented, "unrealistic goals can end in unsuccessful pollution programs".[4]

Establishing the Basis for Defining Baselines and Measuring Credits

Since offset-type approaches need not be based on a cap or an overall emission limit, they thus avoid the issue of allocating this cap between emitters, which can be a very sensitive issue. (See Tietenberg, 2001; Ellerman, 2003; or OECD, 2001 for good discussions of the options available and their consequences.) But as Ellerman (2003: 5) pointed out, rights to emit are implicit in credit trading, just as they are in conventional environmental permits.

According to the OECD (2001: 38-39): "Setting a benchmark for acceptable levels of emissions and the ability to measure or estimate emissions reliably are two prerequisites for the introduction of a credit-based approach." If the question of measuring credits is often difficult given the need to define a benchmark, in trading programs involving agriculture it involves an added level of complexity. As we have seen earlier, directly measuring effluents from agricultural activities can be next to impossible.

The consequences of this challenge should not be underestimated since, as practice has shown, establishing a wrong benchmark for a given firm could allow more pollution than that existing at the moment at which the program is introduced (OECD, 2001). The same could be said, however, of a cap defined by historical practices, which can be hard to evaluate as the manure example in the Netherlands has shown (Hubeek, 2005). As a result, there might be a need to revise the regulation to ensure there is a clear and environmentally appropriate understanding of how credits can be generated to ensure pollution is reduced. But this does not eliminate the difficult question of measuring the environmental effects of emissions.

Localized Detrimental Environmental Effects – Hot Spots

In theory, market-based approaches offer the clearest advantages for controlling pollutants for which location does not matter or where location of emissions cannot easily be affected by any policy (Harrington and Morgenstern, 2004). For example, the effect of a kilo of CO_2 emitted in the atmosphere is pretty much the same whether the source is in Québec City or Victoria, because of the high mixing of the global atmosphere and slow impact of CO_2 on the environment.

But this is not the case with water pollution. The timing and location of the release of effluents are often important considerations in trying to address such problems. For example, "hot spots" develop in the Great Lakes as pollution collects in embayments with high pollution loadings and poor circulation with the rest of the lake. This is a particularly serious problem in places such as Hamilton, as concentrations of industry, population and therefore pollution occur specifically in sheltered bays that make good harbours for shipping. In this context, Stavins (2001) argued that *an intervention that focuses on ambient, watershed-based concentrations is preferable.* (See also Weersink et al., 1998; Shortle and Horan, 2001.)

More generally, according to Tietenberg (2001) emission permits give rise to a concern about "hot spots," because they are caused by the amount of emissions (which are often controlled by emission permits) and by their location and timing (which are often not controlled by emission permits). Emission permits may increase the threat of hot spots for two main reasons: trades may create unacceptably high local concentrations near sources that have acquired permits as an alternative to further control, and permits may allow the long-range transport of emissions, thereby increasing deposition problems elsewhere.

Evidence shows that in trading programs the environmental damages associated with the commodity being traded are generally not homogenous (Tietenberg and Johnstone, 2004). Consequently, in practice most trading programs have had to find ways to address these geographical differences in environmental effects. One solution is the restriction of trades in sensitive zones. Another is to define trading ratios, a sort of exchange rate that can take into account the location of different sources of pollution. The use of trading ratios is common in the development of WQT, and we explain in more detail below how they are used.

It is important to note that there is not enough evidence to assess the efficacy of alternative means of addressing the problems associated with geographic differences in the impact of pollution loads (Tietenberg and Johnstone, 2004).

Banking and Borrowing

The CO_2 trading system in the European Union allows participants that have surplus allowances (permits or credits) to keep them for later use (European Environmental Agency, 2006). This is called banking. With borrowing, those having a shortage of such allowances are similarly authorized to borrow from a future year. The basic rationale is to provide added flexibility to the system, such as when there are sudden shifts in the prices of those allowances.

Tietenberg (2001) explained that one danger of providing such flexibility is that it could change the resulting pattern of emissions, clustering them in time, thus potentially causing more localized damage than the system could tolerate. This is similar to the issue of hot spots; thus, allowing temporal flexibility depends on a good understanding of the effect of pollutant discharges at different times and locations in a watershed.

Some WQT programs, such as in the Kalamazoo system in Michigan, have allowed banking, but not borrowing. This decision was made mainly to encourage early reductions of water pollution in the context of a pilot project that was being put into place (Kerr et al., 2000). Michigan has now adopted a state-wide policy allowing banking in WQT programs for as long as five years, whereas Virginia also allows banking, but only for a year (Morgan and Wolverton, 2005). Some other states, however, do not allow banking.

Voluntary Versus Mandatory Participation

Somewhat related to the absence of a cap is the issue of voluntary participation in a trading program. We have highlighted above the point that agri-environmental educational and training, and voluntary programs more generally may not by themselves lead to clear environmental improvements.

A number of baseline-and-credit programs are voluntary. While their effectiveness has not been evaluated, there are signs that some of them may not be producing the expected environmental benefits (Schary, September 28, 2005). There are also cases, however, where they led to some results, such as in the PERT[5] program.

This is relevant for WQT programs to the extent that in general the agricultural sector's participation will be voluntary since it is not regulated in the same way as other sources, such as municipal wastewater treatment plants. This can limit the supply of water pollution reduction credits and thus limit the number of trades (King and Kuch, 2003; King, 2005a). Another potential effect is the possible resentment felt by the regulated sectors at the "agricultural exceptionalism," which can result in a rejection of trading altogether by these sectors as an option, if they consider this approach to be unfair.

Mandatory schemes will tend to be more cost effective, because participation will tend to be higher than in voluntary programs. The potential gains from trade are linked to the existence of differences in abatement cost, and with lower participation those differences will tend to be lower in voluntary programs. In addition, transaction costs (which we review below) in voluntary programs are typically high (Schneider and Wagner, 2003: 15).

Monitoring and Information Needs for Compliance and Enforcement

Implementing a tradable program requires three kinds of monitoring data (Rousseau, 2001: 14): data on the condition of the environment, data on transfers of polluting rights (permits or credits) as well as on the nature of those rights, to monitor compliance, and, related to the preceding point, data on the identity of permit or credit holders. A key element in the success of tradable permits, Rousseau (2001) added, is the accessibility of data to eligible users, which makes trading easier, as well as data availability to the public, which facilitates compliance. This information can also assist the work of enforcement agencies.

Penalties for non-compliance should be backed by credible sanctions that provide sufficient incentives to make trading more attractive than non-compliance. That is, a firm should not be in a position to choose non-compliance because it is cheaper.

The BDA Group (2005: 85) stated that insufficient monitoring and enforcement can lead to the failure of offset systems. (See also Rousseau, 2001: 14; Fang and Easter, 2003: 12.) According to Kerr et al. (2000: 30), in their review of the San Joaquin (California) trading project to address selenium, a detailed monitoring system also provides stakeholders with regular updates on progress in meeting required loads and consequently allows quick turnaround time to modify management practices.

Tietenberg and Johnstone (2004) remarked that tradable permits seem to have resulted in greater demand for accurate monitoring than other approaches, involving increased costs. More generally, Kraemer and Banholzer (2003: 32) suggested that a tradable permit system is "a more demanding instrument in terms of enforcement, effective monitoring and a system of settling disputes than other economic instruments for water pollution control." As a result, explained Kerr et al. (2000), describing a WQT pilot program on the Kalamazoo River (Michigan), agricultural sources operating under a baseline-and-credit scheme had to document existing operations and management practices, calculate pollutant baseline loadings, and quantify operational changes, and management practices that can reduce loads.

Trading systems can be more data intensive, explained Ellerman (2003: 4-5), because compliance in traditional regulatory approaches usually consists of enforcing best practices, such as installing and operating certain equipment, engaging in certain practices, or limiting certain inputs. All these reduce pollution without the need to monitor the actual emissions. In contrast, tradable permit systems require measurement and continuous monitoring of the regulated emissions themselves; there is no other way to determine compliance in the absence of a best practices-oriented approach.

Harrington et al. (2004) arrived at a more nuanced conclusion, at least with respect to the need for monitoring, in the sense that their review of the implementation of a range of MBIs and command-and-control regulations shows that both approaches may in fact require substantial investments in monitoring to be effective.

Even with imperfect monitoring, tradable permit systems may provide benefits. Montero (2003) used the example of Santiago-Chile's tradable system to control suspended particulate from stationary sources. Because sources were too small for sophisticated monitoring procedures, the authority did not design the program based on the source's actual emissions, but on a proxy variable equal to the maximum emissions a source could emit in a given period if operated without interruption. This is a similar approach to that used in the Netherlands, where manure production control has been used as a proxy for nutrient release (Hubeek, 2005).

Administrative Costs

While it is claimed that overall the use of MBIs is more cost effective than command-and-control approaches, evidence shows that trading or other market-based regulations are not necessarily less costly to set up and administer, and to enforce (see Oates et al., 1989; OECD, 2004; Harrington et al., 2004; Ellerman, 2004). The BDA Group (2005: 48) reminded us that "trading schemes require significant developmental and administrative work and are generally pursued where the expected gains from trade are large."

And as we have seen in the above section, the information needs of trading programs are important. While technological change may decrease the costs of monitoring and enforcement (Ellerman, 2003), these costs can still be important, in particular when the infrastructure does not already exist.

An important consideration that arises from the implementation of all trading programs is the issue of sharing the costs of the program between the state and participants. Some might argue that the private benefits gained by an increase in economic viability resulting from the implementation of these programs (e.g., fisheries management, see Tietenberg and Johnstone, 2004) constitute a good argument for increasing the share of private participation in monitoring and enforcement. However, such a view is difficult to generalize, in particular in a sector, such as agriculture, where economic viability is often threatened.

The OECD (2004) also observed that the administration of tradable permit systems can result in changes in bureaucratic functions. "Administrators who can monitor and enforce compliance replace engineers who seek to identify the correct control strategies and negotiate permit exemptions."

These changes vary according to the type of trading system. Credit-based programs must often keep a large element of the previous administrative infrastructure in place. In addition, a baseline must be determined, often at the level of each individual plant. Programs with regulatory approval of trades may even have greater administrative costs, since each individual transaction implies an administrative burden for the regulatory authorities.

In water quality programs in the United States, high administrative costs are linked to high monitoring costs, extensive review of applications for trading, oversight of non-point source implementation of approved best-management practices, and inspection costs (Morgan and Wolverton, 2005).

Transaction Costs

In his seminal article, Stavins (1995) explained that transaction costs are ubiquitous in a market. They can arise from the transfer of any property right, because parties to exchanges must at a minimum find one another and exchange information. Tietenberg (2001) and Woodward et al. (2002) enumerated three potential sources of transaction costs in pollution trading: search and information, bargaining and decision, and monitoring and enforcement (including estimation of load reductions and the development of trading ratios) (BDA Group, 2005: 71). Note that the third element involves transaction costs, to the extent they might introduce some uncertainty in the completion of trades, as well as administrative costs (Hahn and Hester, 1989: 379).

Depending on how they are addressed, transaction costs can take one of two forms: inputs of resources (including but not necessarily limited to time) by a buyer and/or seller, or a margin between the buying and selling price of a commodity in a given market. As a result, transaction costs indirectly increase the aggregate costs of pollution control, by reducing the total trading volume (as some trades become unprofitable when transaction costs are factored in) and directly by adding to total costs of control (Stavins, 2001). However, these effects can be reduced in markets with a large number of participants.

To reduce transaction costs, programs should be designed to ensure the needed information is available, including reducing regulatory uncertainty and avoiding regulatory barriers, which can be achieved with a system based on pre-approval of trades; allowing brokerage services; and even allowing future markets where possible. A possible option for government to reduce transaction costs is to take on a brokerage role, which can include supplying information about potential buyers and sellers, and helping sources identify one another, but this involves administrative costs. In addition, an emission-trading registry would facilitate a market by allowing better access to emission reduction opportunities (reducing the transaction cost associated with the "search and information" component).

One main lesson from experience is to make administrative procedures as simple as possible and equip potential trading partners with means to communicate market-relevant information efficiently with each other (Tietenberg, 2001).

Market Structure

The notion of market structure refers to the procedures adopted for obtaining and exchanging rights. Such structures differ by the extent to which information regarding the good is publicly visible, whether the transaction relationships in the market are discrete (terminating when the contract performance is complete), or relational (persisting over time) (Woodward et al., 2002). Market structures, in general, evolve over time in response to changes in information about the market, transaction costs, legal restrictions, evolving norms, and market size. Woodward et al. (2002) identified possible market structures, and described how they relate to the context of WQT.

- **Exchange** markets can develop only when a unit of the good from one seller is viewed as equivalent to one from any other source. In this type of market, the initial costs of establishing the infrastructure for communication and enforcing trades are greater, but decrease with advances in information technology.
- **Bilateral negotiations,** such as for used cars. The strength of that structure is in its ability to accommodate non-uniform goods that could not be traded through an exchange. It is the most common structure for WQT in the United States, particularly those systems including non-point sources (Morgan and Wolverton, 2005). Credits based on predicted emissions are specific to a given non-point source and the management practices used to abate pollution.

- **Water quality clearinghouses.** In a WQT system, a clearinghouse is an entity authorized by the responsible governmental agency to pay for pollution reductions and then sell credits to sources needing to exceed their allowable loads. This approach differs from a broker in a bilateral market in that it eliminates all contractual or regulatory links between sellers and buyers. A clearinghouse has to be allowed by legislation; it must have authority to pay for pollution reductions, denominate credits based on the reductions obtained, and resell those credits to interested buyers. This is the approach used in the Ontario pilot project, where a quasi-public watershed-based agency, the South Nation Conservation Authority (SNCA),[6] plays this role. According to Morgan and Wolverton (2005: 14), a "clearinghouse works best when the impacts of pollution discharges are similar enough to allow for the transfer of rights between a large number of buyers and sellers in the watershed."

Wetland mitigation banking has benefited from the services provided by such clearinghouses, which could include, in the case of WQT: aggregating credits from large buyers, verifying credit performance, and discounting credits for location, performance and/or uncertainty (Hall, 2005). Another useful role is to act as an intermediary between farmers and municipalities, which may not be naturally inclined to operate together (see below and Chapter 8 on these difficult relations).

Liability

Important for trading programs is the question of liability. Who is responsible when a purchaser of credits uses them for compliance and a regulatory agency questions them? Linked to this is the question of how the buyer determines the quality (acceptable to a regulator) of the credits being purchased. In a system of seller liability, the contract is discrete and does not create a future obligation to monitor compliance over time. This reduces transaction costs (Woodward et al., 2002). Buyer liability creates incentives for monitoring by the buyer, potentially reducing government administrative costs and increasing the probability that the necessary pollution reductions are achieved. This tends to increase environmental efficacy.

In the United States, the most common approach in WQT is to have the buyer liable for trades (Morgan and Wolverton, 2005).

Role of Stakeholders

A closer look at WQT programs all over the world indicates they usually involve some form of stakeholder and public participation. But this aspect of trading has not been analyzed in depth. The acceptance of a trading program by the main potential traders and by public interest groups can make or break the implementation of a program. As Rivers and Nielsen (1999) remarked in their review of the PERT pilot program in Ontario, finding a balance between the interests of different stakeholders in providing a workable and effective emission reduction trading program has been the ultimate objective of PERT.

Bringing stakeholders together in co-operating on the development of a program, such as trading, can be a main objective, and the main result, of the trading program. This means that such co-operation cannot be assumed.

Summary

To summarize these lessons learned, we can infer that trading requires the following.

- Define the **environmental objective** for a given water body (this can be part of a watershed) examined as a whole. Therefore, prior to considering trading, one must make sure there is a good understanding of the water body and of the effect of the parameter being controlled in different sections of the water body.
- Clearly **define the commodity.** In the example above where a municipality could trade with farmers, the commodity can be reductions in total phosphorous discharges. Means have to be found to ensure the environmental equivalency of the commodity in different sections of the watershed. For example, reducing discharges in the amount of 5 kg of total phosphorous upstream may have a similar environmental effect as removing 20 kg downstream.
- **Avoid hot spots.** As seen below, trading ratios are a useful tool to achieve that goal.
- Examine and, if necessary, adjust the **regulatory structure** in which the trading system would operate.

- Ensure the existing **administrative structure** is adapted to the implementation of a trading program.
- Determine an **appropriate trading mechanism and rules** to ensure trades can actually reduce private as well as administrative costs, and transaction costs. The determination of liability also needs to be resolved.
- **Provide the appropriate incentives** for agents to trade. Apart from differences in abatement costs, regulation often provides the basic incentive (binding environmental objectives are defined). It may not be necessary for all potential buyers and sellers to be regulated. This aspect may be one of the crucial issues to be debated in developing trading systems involving non-point sources, such as farming operations.
- **Involve all relevant stakeholders and foster co-operation** between them. There may be different approaches used to do so, but this will likely need time.
- **Measure the results** of the actions taken. Effects of WQT programs can be difficult to measure in the short term. This is intrinsic to the nature of many non-point polluting sources. Still, some form of monitoring is required to ensure the programs achieve their objectives. In addition, good knowledge of the effects of best management practices and an evaluation of their appropriateness for a given watershed is needed.

The reader will have noticed that offset systems assemble many of the problems and uncertainties associated with trading, including administrative implications, and related costs. The BDA Group (2005) classified WQT including agricultural sources as one of the most difficult trading systems to implement. They also suggested that gaining experience with nutrient trading involving only point sources before including non-point sources might be more opportunistic.

To begin assessing the feasibility of WQT in the Canadian context, we follow in what follows the structure we chose for this research program, highlighting solutions that have been used in certain cases to deal with some of the issues raised so far: a first workshop was held in May 2005 to examine biogeophysical aspects of WQT; commissioned research examined the regulatory and broad policy context; and, a second workshop held in September 2005 looked at program design considerations.

Chapter 5 concentrates on the biogeochemical considerations in trading and Chapter 6 examines regulatory issues. We further distinguished the design elements of a trading program and stakeholder involvement. These are examined in Chapters 7 and 8, with a view to not so much assess the feasibility of trading programs, but to highlight possible options available to deal with design questions.

5. Biogeochemical Considerations for Water Quality Trading in the Canadian Context

This Chapter reviews WQT programs similar to those implemented in the United States, Australia, and Ontario. We have not examined biogeochemical considerations for input-based trading systems, such as the one developed in the Netherlands. As indicated earlier, one impetus for choosing manure trading to control nutrient pollution in the Netherlands was the relative simplicity of monitoring and enforcement. Knowledge needs of this kind of program compared to other WQT programs likely differ with respect to creating a commodity, but are probably as important when the time comes to evaluate environmental effectiveness.[7]

This being said, the design of a WQT program requires a very good understanding of the pollutant considered for trading and of the watershed it affects. Of particular interest are the pollutant sources, pollutant behaviour (fate and transport), and how these pollutants can be abated and by how much.

Although such scientific knowledge is important, there will always be some uncertainty when implementing pollution management schemes in the natural environment. Trading ratios can be used to address different elements of scientific uncertainty and regional aspects of trading associated with pollution markets. Appropriate trading ratios can ensure that environmental objectives are achieved with an acceptable level of confidence.

Pollutant Sources and Potential Trading Partners

Water quality trading would only be suitable for pollutants for which there is a potential to create a market (supply and demand) for pollution reduction credits within the affected watershed. With respect to the main agricultural pollutants, there are several potential trading partners for agricultural phosphorous, nitrogen, and sediment, and fewer for bacteria and pesticides.

Phosphorous, nitrogen, and sediment can enter a waterway from several sources and, thus, there could be a number of potential trading partners with which agricultural producers could trade credits. Of particular interest are the sources that are likely to be regulated and monitored, including municipal wastewater and industrial facilities. Furthermore, the possibility of nutrient loading exists with almost any type of agricultural activity, since most involve fertilizer, manure, or both, and thus there is widespread potential for nutrient-related surface and ground water pollution in Canada's agricultural regions. The release of sediment into waterways is also a common problem in agricultural areas due to soil erosion. The ubiquity of nutrient and sediment sources, both agricultural and non-agricultural, contributes to their suitability as candidates for WQT.

Bacteria can be associated with septic systems and urban storm water sources that are not often measured and may be unpredictable in terms of effluent composition and volume of discharges. Pesticides are widely used, but the type of pesticide varies depending on the system (e.g., residential, forest, crop) and the pest being managed (e.g., fungus, weeds, insect). Within a given watershed, pesticide use could be quite diverse and opportunities for trading may be minimal unless there is a sufficient scientific understanding of the pollutants and their behaviour to establish inter-pollutant trading for different types of pesticides. For these reasons, it may be more difficult to implement WQT for these pollutants than for nutrients and sediment.[8]

Salinity trading occurs in other countries, such as Australia, but concerns regarding salts and trace elements are not widespread in Canada. Endocrine disrupting chemicals (EDCs) are most likely emitted from several non-agricultural as well as agricultural sources, but information is limited as such chemicals are not typically measured, and we are only beginning to explore their ecological and human health impacts.

Table 3 – Main Agricultural Pollutants, Potential Trading Partners, and Major Science Considerations

Agricultural Pollutants	Potential Trading Partners						Science Considerations	
	Municipal wastewater	Industry	Septic systems	Forestry	Mining	Urban storm run-off	Behaviour known	Quantifiable reductions from NPSs
Phosphorous	X	X	X			X	X	X
Nitrogen	X	X	X			X	X	X
Sediment	X	X		X	X	X	X	X
Bacteria			X			X	*	
Pesticides				X		X	*	
Trace Elements					X			
Salts**		X			X	X	X	X

Notes:

* Depends on the type of bacteria or pesticide.

** Not typically a problem in Canada.

Source: Morin (2005).

Pollutant Fate and Transport – Determination of the Critical Load

The fate and transport of a contaminant in the natural environment is important for determining the critical load, which is necessary for the design of a WQT program. Pollutant behaviour can be simulated using scientific models and requires knowledge of both pollutant and watershed characteristics. Important pollutant characteristics include how a chemical partitions between different media (water, air, soil) and under what conditions (e.g., temperature, pH, oxygen). The required watershed inputs will reflect ground and surface water interaction, hydrology (recharge, flow), topography, and soil types. Information on the biota will also be important for gauging biological uptake of the pollutants and the biological risk.

The nutrient cycles of phosphorous and nitrogen are well understood, including their chemical forms and transformations in the environment, which allows us to predict nutrient behaviour if the watershed itself is well understood. Complications can arise, however, when pollutants become airborne (which may be an issue for nitrogen) and when deciding which forms of the nutrient to manage or trade.

Unlike many other pollutants, the behaviour of sediment depends almost entirely on water flow and physical properties (particle size) that will determine if the particles settle or become suspended and at what point. The scientific understanding of a number of pathogens and emerging pollutants is limited. If such pollutants become increasingly problematic (e.g., antibiotic-resistant bacteria or EDCs), a greater sense of urgency may force an increase in our level of understanding to a point where WQT may be viable for those pollutants.

Best Management Practices

For nitrogen, phosphorous, and sediment, the ability to reduce pollutant loadings through best management practices or other pollution abatement technologies is an important function of a WQT scheme as it creates a supply of pollution-reduction credits if the reductions can be quantified with an acceptable level of confidence. Quantification is significant, as the likely range of pollution reduction achieved through the implementation of a best practice on a particular farm will be converted to credits for trading purposes.

It is not practical to measure changes directly in the amount of pollutant emitted from most farms. Rather, the level of pollution reduction achieved by a given best management practice can be calculated using methods derived from scientific research. Such methods are based on pollutant characteristics and will often require biogeochemical information of the site within the watershed, as the success of a specific best practice might vary depending on the type of farming system (e.g., tillage, crop) and characteristics of the specific location (e.g., soil, slope, rain intensity) at which the best practice is being used.

A wide range of agricultural best management practices for managing sediment and nutrient loss have accepted methods for estimating pollution reduction. Other agricultural pollutants can be reduced using best practices designed to manage nutrients and/or sediment. As an example, methods for reducing surface run-off and soil erosion may reduce the amount of any pollutant that is water soluble or sediment bound, including certain pesticides and pathogens. Such positive side effects could only generate additional pollution reduction credits if those reductions were quantifiable.

Trading Ratios and Scientific Uncertainties

Most WQT programs targeting phosphorous in the United States have established trading ratios at a value of 1 for 2 (1:2 in what follows). This means that, for example, to compensate for the discharge of one unit of phosphorous from a municipal wastewater treatment plant, a municipality needs to acquire two units from agricultural sources. In the system developed in the South Nation River system, in Ontario, this ratio has been set at 1:4.

Scientific uncertainty will always exist when trying to predict the behaviour of a pollutant in the natural environment. With respect to using WQT for managing agricultural sources of pollution, this uncertainty can be an issue when calculating the effectiveness of a given best management practice in reducing the amount of pollutant entering the waterway. Although based on scientific studies, the formulas typically used to calculate pollution reductions will always be subject to natural variability when applied to unique physical circumstances. Typically, our scientific understanding allows defining a probable range of pollution reduction as opposed to a specific value. An appropriate trading ratio accounts for the range in values. Similarly, model simulations for pollutant behaviour in a given watershed can never provide an exact reflection of reality; but a sensitivity analysis, for example, can be used to predict a range of outcomes that are likely to occur.

It should be noted that the higher the trading ratio, the greater the expense for the purchaser of the pollution reduction credits. This underscores the importance of science, as reducing scientific uncertainty allows for lower trading ratios.

Trading Ratios, Watershed Heterogeneity, and Location of Trading Partners

All watersheds will have some degree of heterogeneity with respect to the biogeochemical characteristics (e.g., vegetation, soil type, flow rate), which will influence how a pollutant behaves at any given location. For example, a pollutant release at the mouth of a river will be more rapidly diluted than a release at the head of the river, which may affect water quality downstream. Consequently, the location of trading partners may affect the environmental impact of otherwise similar BMPs.

With a basic understanding of watershed and pollutant dynamics, trading ratios can be used to ensure the environmental equivalence of trades by accounting for the influence of the given landowner's locations (e.g., upstream, downstream, topography, proximity to waterway). For example, the Lower Boise River trading system in the United States is proposing location-based trading ratios, which are established against a standard geographical reference point to prevent localized impacts or hot spots, and to reflect the water quality equivalence of the reductions made at different locations in the watershed.

Trading ratios are also adjusted to account for a source being located along a tributary as opposed to along the Boise River itself, as well as the distance from the source to water, as these characteristics influence the impact of the reductions (Schary and Fisher-Vanden, 2004). Another possibility is to define trading zones, restricting the direction of trades into predefined zones of a river system or its tributaries (Tietenberg, 2001). Adding restrictions, however, runs the risk of making trading less cost efficient.

Trading Ratios and Inter-Pollutant Trading

In relation to inter-pollutant trading (WQT that would involve more than one type of pollutant), trading ratios can be used to account for impacts of the different pollutants on water quality or ecological integrity. For example, phosphorous and nitrogen have different impacts on biochemical oxygen demand, an indicator of ecological integrity. This difference between pollutants has been accounted for in a particular trading arrangement in the Minnesota River Basin, for which a measure of biological oxygen demand (BOD) is the tradable commodity as opposed to the pollutants that affect BOD. The conversion rates were set at 1:8 for phosphorous (for every unit of phosphorous load reduction, eight units of BOD would be credited) and 1:4 for nitrogen (Fang and Easter, 2003). Based on these conversions for environmental equivalence, as measured by the effect on BOD, the appropriate trading ratio could be established to allow for inter-pollutant transactions.

Summary

A number of biophysical and geochemical factors need to be considered when designing a WQT program. The following is a list of science-related factors that may facilitate the WQT as an option for pollution management:

- the existence of a clearly documented pollution problem (e.g., manifestation of ecological effects, violation of water quality standards);
- well-developed BMPs or abatement technologies for pollution reduction and the ability to quantify pollution reductions (which implies and understanding of the pollutant and the biogeochemical conditions of the watershed where the BMP is to be implemented);
- historical monitoring data within the affected watershed including hydrological, water quality and point source discharge date for pollutants;
- fundamental understanding of pollutant behaviour and watershed dynamics for determining critical load and trading ratios; and
- a watershed that is well understood and well monitored will prove to be a good candidate for WQT, especially compared to a watershed where there is little information.

6. Water Quality Trading and Canadian Regulatory Systems

We saw in Chapter 4 that pollution trading is closely linked to the legislative and regulatory systems in place. The main objective of this chapter is to provide an assessment of the capacity of the current Canadian systems to integrate such a tool. The analysis focuses on regulations, but also considers the relevant current policy frameworks in each jurisdiction. More specifically, we are interested in understanding how these systems hinder or support the development of WQT programs. The analysis was limited to surface waters, since ground waters are often treated separately in legislation, and since there is still limited information available on ground water in general, and ground water contamination in particular.

The analysis is based on the results of two studies, one by ÉcoRessources Consultants and the other by Tri-Star Environmental Consulting, carried out for this project, and which are available as PRI working papers and cited in this text respectively as Sauvé et al. (2006) and Swain (2006). Taken together these two studies provide:

- an examination of WQT systems in the United States and Australia, and of the Netherlands' approach with an emphasis on their regulatory context and the related policy frameworks to establish possible trading models applicable at the watershed level. These models are designed to infer the conditions that make WQT possible in practice; and
- a review of existing water pollution regulations in Canadian jurisdictions at the provincial and federal levels, excluding the territories, to assess their compatibility with respect to some of these conditions.

From a legal perspective, Woodward et al. (2002) suggested that the main issues are authorization, monitoring/reporting, and enforcement. With respect to authorization, the authors contended that a trading program must be consistent with the substantive and procedural mandate of all applicable legislation. In the United States, for example, while WQT is not explicitly prohibited, it is not explicitly authorized, even though recent policy statements at the federal and state levels have clarified the links with the regulatory regimes. So the challenge in that country for WQT programs is to authorize trading without violating existing regulations.

With respect to monitoring and reporting, the issue is that a transaction can only be completed when the legal requirements for transfer of rights or obligations are satisfied. Satisfying those requirements when non-point sources are involved, as we saw in Chapter 4, is challenging. Enforcement is also an issue as ensuring compliance is necessary to ensure environmental objectives are achieved, and to the efficiency of the market. This hinges on the issue of liability, also discussed in Chapter 4.

Hatton Macdonald et al. (2004: 33) contended that for both permits trading and offset regimes, a regulatory driver is necessary to compel participants (or some of them when non-point sources are not regulated) to be involved in trading.

> Quantity-based MBIs are only feasible if some type of overall cap or standard that limits emissions is in place. Tradable permits require a very specific type of property right that is usually associated with water use or discharges to air or water – a performance standard that assigns a specific amount that is allowable for use or discharge for each individual and allows trading in the right to use or discharge. Offsets, in contrast, can be implemented with a range of standards, development restrictions or other rules limiting activities with adverse environmental consequences. In essence, once a standard has been established, offsets can be used to allowed the standard to be relaxed at one site, if this is compensated for by providing environmental improvement elsewhere.

But there are many types of regulations, as indicated in Chapter 4. Which ones have been used in trading involving agricultural sources, and why? How have the other legal issues reviewed above (monitoring, reporting, etc.) been settled? Are these or other solutions available to Canadian jurisdictions? We examine some possible answers to these questions below, based on Sauvé et al. (2006) and Swain (2006). More details on the specific contexts within which trading experiences are introduced are available in Sauvé et al. (2006).

Regulatory Requirements to Allow WQT

Examining the regulatory and policy contexts in which trading systems to deal with water pollution from agriculture developed around the world led to the following questions, and related answers, regarding the adequacy of the Canadian regulatory systems, either in the provinces or at the federal level. (In what follows, tradable permits encompass offset systems (Sauvé et al., 2006: 25; Swain, 2006, for question 8)).

1. Are there enabling provisions within the legislation that allow for the use of tradable permit systems?

It was found that four, maybe five provinces (Alberta, Nova Scotia, Ontario, Quebec, and maybe Manitoba) had authorizing provisions supporting the development of tradable permit system.[9] The other provinces, however, have the means through existing advisory boards to consider the development of tradable systems and make recommendations to the responsible minister to that effect (Swain, 2006).

The Government of Canada would be in a position to implement WQT programs for coastal and estuarine waters and, in collaboration with provinces, for those waters deemed to be of national significance.

2. Are there policies, programs, regulations, or any other documents that facilitate the development and use of tradable permit systems?

Two provinces (Alberta and Ontario) have adopted regulations concerning the development of tradable systems for air pollution, which could be adapted to address WQT. In Manitoba, the minister has the ability to develop a regulation to market units of allowable emission of specific pollutants. Ontario regulation establishes a registry, the Ontario Emissions Trading Registry, for the operation of the trading system and a trading code to supplement the regulation.

3. Are there legal provisions requiring that emitters monitor their discharges to the environment and report to public authorities?

All provinces have provisions concerning the measure and declaration of discharges in water bodies, and to regulate the issue. Some provinces require the monitoring and reporting of that information for regulated industrial sectors (the pulp and paper sector for instance). However, only two provinces (Alberta and Ontario) have adopted specific regulations on monitoring and reporting.

4. Are there any legal, regulatory, policy, or any type of documents that relate to the capacity to determine water quality criteria/objectives of water bodies or the soil's assimilative capacity of certain types of nutrients?

All provinces and the federal government have the legislative means to establish ambient water quality guidelines, objectives and standards, a crucial element in using the assimilative capacity of water bodies, and one of the cornerstones for implementing WQT programs.

Even though all provincial legislation includes powers to set water quality criteria/objectives and to use them for regulatory purposes, the use of these powers is not used often in regulations addressing discharges/effluents from specified industry categories. Technology-based regulations as opposed to ambient-based ones are still more prevalent.

5. How are these criteria/objectives being met?

Those criteria/objectives are used in the issuance of certificates of authorization or permits for activities not directly regulated or they are used for planning purposes. Regulated activities, such as the pulp and paper industry, are subject to specified technology-based standards.

Provincial authorities usually develop a policy incorporating the use of water quality criteria/ objectives to guide the content of the certificate of approval or the permit.

6. Is a watershed-based approach being used to adopt and implement policies and regulations, or issue permits? Are institutions dedicated to implementing integrated watershed management?

The majority of provinces are developing watershed-based management systems, but not all of them are at the same level of development. The federal government and all provinces but Prince Edward Island have the means to initiate a trading program through a watershed management process, a nutrient management plan, or some other planning process. Ontario has by far the most structured approach. The conservation authorities are well-established institutions working on a watershed basis.

7. How do the legal/regulatory agri-environmental provisions of the various jurisdictions interact with WQT?

Although there is no consensus in the literature on the necessity of regulation to trigger agricultural participation in WQT programs, some might argue that the limited regulation affecting the agricultural sector could limit the development of trading programs. The most relevant measures with respect to WQT include the following.

- Manure/nutrient management plans, which could be used to develop a Netherlands-like model, are prescribed within the regulatory systems of five provinces (Alberta, Saskatchewan, Manitoba, Ontario, and Quebec) and used in the issuance of certificates of authorization in the others.
- Two provinces (Ontario and Quebec) have prescribed limits for phosphorous on the land application of manure. Quebec has the most stringent prescriptions of the two. Quebec regulation would be appropriate for the development of a modified version of the Dutch model applied at the watershed scale: the regulation makes it possible to determine a cap on a soil capacity basis and manage it on a watershed scale.
- Two provinces (Prince Edward Island and Ontario) regulate riparian buffer zones. Quebec's policy is enforced at the municipal level.
- Agri-environmental policies rely, in most provinces, on incentives and subsidy programs. This raises the issue of double payment if WQT programs are developed. This issue is explored further in Chapter 9 on the mix of policy instruments.

8. More generally, how do the legal/regulatory water quality provisions of the various jurisdictions affect the possibility of adopting a WQT trading system?

- Flexibility is lacking to relax some standards in British Columbia, and Newfoundland and Labrador. (Trading systems require the flexibility to modify permit requirements and associated standards, which can be compensated through offsets or buying permits.)
- There is no clarity with respect to the calculation of assimilative capacity in terms of flow rate. As mentioned above, it was also found that most jurisdictions still mostly rely on technology-based command-and-control regulation.
- The federal *Fisheries Act*, which prohibits the discharge of deleterious substances that could affect fish populations, must be considered in determining the assimilative capacity of a water body. This requirement would probably be met as long as effluents are not found to be acutely toxic.
- There might be some institutional changes needed to implement a system based on ambient goals, even the basic instruments to do so are there. The passage to another type of approach by some administrations may thus face cultural barriers.

9. Has there been a major initiative, at the government level, to promote the use of economic or market-based instruments in environmental management?

Most jurisdictions have experienced initiatives in one form or another to promote the use of an economic instrument. In Ontario, Quebec, Alberta, Nova Scotia, and Manitoba, these have led to legislative changes.

The analysis reveals that several jurisdictions are in a strong position to implement a WQT program, or a trading program of the type adopted in the Netherlands. In fact, most provinces already have the basic tools, although at different stages of development. The legal barriers that were found would be relatively simple to address.

However, some main barriers might be of a cultural and institutional nature. Moving away from technology-based command-and-control regulation toward ambient-based approaches may take some regulators out of their traditional comfort zone, and may require a culture shift among both regulators and the trading community. Such a change might be costly to achieve.

We have now looked into the biogeochemical, legal, and some broad policy considerations that may affect the feasibility of adopting WQT to address agricultural sources of water pollution in Canadian jurisdictions. In general, the existing frameworks can allow the development of such programs. The major limitations found are the availability of good biological/geochemical information, and the lack of scientific understanding of some pollutants, restricting the application of WQT to some watersheds and some pollutants.

Table 4 – Canadian Regulatory Systems and Water Quality Trading

Jurisdiction	Direct Legislative Authority for Trading	Possible Means to Establish Trading	Requirements to Report Discharges to Environment	Regulations Define Effluent Limits	Agri-environmental Provisions	Ambient Conditions (Objectives) Can Be Established	Watershed or Other (Nutrient) Planning Possible
Alberta	✓		✓		Nutrient plans	✓	✓
British Columbia		✓	✓	✓		✓	✓
Canada		✓	✓			✓	✓
Manitoba	✓	✓	✓		Nutrient plans	✓	✓
New Brunswick		✓	✓			✓	✓
Newfoundland and Labrador		✓	✓	✓		✓	✓
Nova Scotia	✓		✓			✓	✓
Ontario	✓	✓	✓		Nutrient plans; P limits; Buffer zones	✓	✓
Prince Edward Island		✓	✓		Buffer zones	✓	✓
Quebec	✓	✓	✓		Nutrient plans; P limits; Buffer zones	✓	✓
Saskatchewan		✓	✓		Nutrient plans	✓	✓

Sources: Sauvé et al. (2006); Swain (2006).

But to restate Claassens et al.'s (2001) assertion, successful implementation of an instrument is in great part a function of the capacity to design it appropriately, taking into account possible sources of failure. We reviewed the main design issues affecting trading programs in general as well as WQT programs in Chapter 4; in what follows we concentrate and expand on some proposed solutions. A number of options are available, but none might be appropriate in all circumstances. A key social issue, which remains relatively unexplored, is the recurrent difficulty in fostering the participation of crucial stakeholders, in particular the farming community, but also municipalities.

7. Key Design Elements of Water Quality Trading Systems to Achieve Environmental Objectives at Lower Cost

Once the environmental objective and a commodity are defined, the possibilities of trading assessed from an economic and a biogeochemical standpoint, and the compatibility of the regulatory framework verified, a trading system can reduce transaction and administration costs if:

- Trades are easily recognized by regulators as a means for regulated buyers to meet their environmental responsibilities;
- Potential buyers easily connect with sellers and contracting can proceed;
- These requirements are achieved at lower cost than regulation or other options, including administrative costs, ensuring the economic gains trading can provide while achieving the desired environmental goals; and,
- There is limited uncertainty overall with respect to the different elements of the trading program.

A number of approaches have been tried, with variable success, to deal with these challenges. While it appears difficult to generalize, we can take a look at how some basic principles are applied to make trading more attractive.[10]

Schary and Fisher-Vanden (2004) provide a very useful point of departure. The Lower Boise trading pilot in the United States was designed with the objective of adapting the key elements that made SO_2 trading successful to WQT. In presenting the main elements of their proposed approach, we identify some important differences adopted in the successful South Nation pilot in Ontario, Canada. We also highlight general lessons learned through some documented experiences.

Recognizing Trades as Valid Means to Meet Environmental Obligations

One main goal of WQT programs is to provide flexibility to those being regulated in the choice of method to meet some regulated objective or, in the case of non-regulated non-point sources in the United States, to achieve an aggregate pollution reduction target, which may or may not be enforceable. At a minimum, for this to happen participants need some certainty with respect to the acceptability of trades to meet their goals or obligations.

In many early trading experiments, and still in some present ones, trade approvals are relatively cumbersome, as decisions are made on a case-by-case basis (Hahn and Hester, 1989; Fang and Easter, 2003; Kerr et al., 2000). In addition, uncertainty with respect to the acceptability of trading to meet the United States' *Clean Water Act* requirements may have limited the attractiveness of the instrument. Therefore in 2003, the US Environmental Protection Agency clarified this in a policy document. For similar reasons, the Ontario government established a process to ensure that trading is a valid option to meet water quality objectives in certain circumstances. One main element of the Ontario approach is that proposals to use trading have to go through an environmental assessment (Conservation Authorities of Ontario, 2003).

Given the inherent difficulties associated with measuring baselines in baseline-and-credit systems, a common set of rules for offsets in water quality trading systems is that pollution reductions should be (Rivers and Nielsen, 1999; Kieser, 2005; Faeth, 2000):

- **real** (i.e., reduction resulting form specific actions);
- **surplus** (i.e., beyond any other requirements to reduce emissions in that pollutant);
- **quantifiable and verifiable** (i.e., capable of being determined reliably and repeatedly and able to be audited by other parties).

Such rules provide more certainty to the public that environmental objectives can and will be met.

In practice, with agricultural enterprises, baselines can be defined as the "level of pollutants associated with existing land uses and management practices that comply with applicable regulations" (BDA, 2000: 84). In other words, the baseline is defined on the basis of what is actually going on at the time of implementing the program, assuming all participants comply with existing rules. In addition, some programs may not allow "double-dipping." That is, a farmer who has received a subsidy to implement a given practice is not allowed to trade the pollution reduction credit created by its implementation. But such restrictions may actually limit the attractiveness and cost effectiveness of WQT programs since they eliminate from trading some low-cost credits (King, 2005b).

To solve the difficult question of measuring changes in emissions, one main strategy that has been adopted is to measure credits based on **expectations** of pollution reduction following the adoption of some beneficial management practice.

The trade approval process in the case of the Lower Boise pilot is made relatively simple by establishing in advance a list of acceptable best management practices (including a process to revise or add to the list). This list is prepared in collaboration with the United States Department of Agriculture and takes into account the specifics of the Lower Boise watershed. Such a list provides farmers (i.e., potential sellers of credits), buyers, and regulators with an up-front common understanding of the expected environmental results of their investment. They can thus consider different options depending on their perceived needs. The key here is "up front": once a best management practice makes it through the list, there is no need to establish a trade-by-trade approval process, thus reducing uncertainty and delays for all actors, thereby reducing transaction costs.

In the case of the South Nation program in Ontario, the South Nation Conservation Authority (SNCA) is the institution managing the program and acting as a clearinghouse (see Chapter 4). Funding is provided by a number of sources, including those regulated entities wishing to find offsets. Farmers can propose projects for funding (which is only partial), thereby creating available credits. A multi-stakeholder program committee that includes farmers and municipalities reviews and approves these projects. The credits are made available once the project is implemented.

One crucial point is to establish where liability lies in a case where the expected environmental benefits are not realized or, where non-point sources are involved, when best management practices are not implemented the way they were supposed to be. In the case of the Lower Boise pilot, as well as in a number of other United States programs, it lies with the buyer, which is the regulated entity (Schary and Fisher-Vanden, 2004; Morgan and Wolverton, 1995). It is the buyer's responsibility to make sure the credit is valid. From the buyers perspective, the enforcement mechanism is the market place: risks are taken into account through the private contract binding the traders. The regulator only deals with the regulated entity.

The same applies in the South Nation project. While the SNCA acts as the clearinghouse, liability lies with the regulated dischargers, who have the choice of choosing to fund their own non-point sources reduction program. But they have preferred to deal with the SNCA and fund its programs given the Authority's familiarity with such programming (O'Grady and Wilson, 1999). Risks have been managed to the satisfaction of the Ontario Ministry of the Environment in that the SNCA has used a pre-existing and documented cost-shared program and technical assistance program available to farmers to fund the implementation of new practices (Conservation Authorities of Ontario, 2003).

From the regulator's perspective, in both the Lower Boise system and in the South Nation system, the only thing to worry about is whether those regulated are in compliance. This means making sure dischargers are at or below their limit or, if not, that they have enough credits.

This is done in the Lower Boise system through a monthly submission of a discharge monitoring report and the monthly trades recorded in a trade tracking system. "Permit holders must also self-report any violations in their Discharge Monitoring Report if calculations show that they did not hold sufficient credits to offset the adjusted discharge amount" (Schary and Fisher-Vanden, 2004: 21). Penalties for not complying are subject to settlement terms agreed to by the Environmental Protection Agency and the state's Department of the Environment.

In the case of the South Nation system, municipalities and industries that operate under the total phosphorous management approach have to provide periodic reports that may include monitoring results, and offset credits achieved, including the type and number of projects implemented (Conservation Authorities of Ontario, 2003).

Connecting Potential Buyers and Sellers, and Reducing Transaction Costs

Information is key to any market. A WQT market is no exception and needs information to ensure potential buyers and sellers can make transactions by knowing what is being offered and at what cost. Important information for participants also includes the watershed and trading boundaries. It is common for programs to be established in parts of a watershed.

To facilitate information flows, the World Resources Institute created a program called NutrientNet that can function as a registry and perform other services for traders. It allows market participants to evaluate different trading options and assess the combination of controls and credits that would work best for them (Kramer, 2003: 5).

In the South Nation system, as we have seen before, the SNCA acts as a clearinghouse in a trading program that has been built around an existing cost-share program. In fact, the trading element of the program is not apparent to farmers who can get funding to implement a selection of best management practices according to their needs. For the SNCA, municipalities that buy pollution reduction credits instead of investing in new treatment technologies provide a supplementary source of funding for the cost-share program. In practice, this means that all information about the program is the responsibility of the SNCA, and buyers and sellers need not come into contact. In most WQT systems, however, trades are actual bilateral contracts between a seller and a buyer, but they can be facilitated by third parties, such as brokers.

In recent pilots, such as with the Lower Boise, tools are used to make trading easier. Here, transfers of credits will be conducted by completing a trade notification form and submitting it to the trade tracking system. Credits are automatically removed from the seller's account and added to the buyer's one.

Reducing Administrative Costs

Monitoring and enforcement costs are among the most important administrative costs of a trading program (Chapter 4). Different programs limit those costs by allowing a degree of uncertainty in the actual achievement of environmental objectives. While some verify all best management practices used to generate credits, others inspect only between five and ten percent (Morgan and Wolverton, 2005). Some programs monitor water quality of the target watershed to complement inspections. Only Idaho, Michigan, West Virginia, and Colorado have outlined detailed monitoring and reporting requirements, including an initial as well as an annual inspection of the installation of best management practices for non-point sources (Morgan and Wolverton, 2005).

The Lower Boise pilot has chosen to verify and monitor most best management practices, at least at the inception of the program, to establish confidence in the effectiveness of the program. But administrative costs are limited by avoiding a trade-by-trade approval process. Best management practices are inspected by the Environmental Protection Agency and the Idaho Department of Environmental Quality, accompanied by Idaho Soil Conservation Commission representatives (who work with the farmers), as part of the routine inspection program for the permitted sources. This is done after the best practices are in place and private contracts between sellers and buyers have been established – not as part of the credit certification system. Any discrepancies between the intended design, implementation, and maintenance of a given best practice and what is actually observed in this inspection is documented. An enforcement action, if needed, is only taken up with the permitted source that purchased the credit.

The South Nation project in Ontario concentrates on inspecting 10 percent of the completed projects. In addition, costs are lowered by the leading role played by farmers in delivering the program, more specifically in doing in-field inspections (O'Grady, 2005a). As O'Grady (2005a: 28) puts it, the SNCA manages for the 95 percent of participants who participate in an honest manner.

In the South Nation system, using an existing cost-shared program as a delivery mechanism managed through a familiar existing institutional setting (the South Nation Conservation Authority) also simplifies the administrative burden of the program. It must be noted, however, that in spite of this familiarity it took a number of years to convince many farmers of the value of the program.

Table 5 – Approaches to Reduce Administrative and Transaction Costs in the Lower Boise and South Nation Water Quality Trading Pilots

	South Nation	Lower Boise
Recognizing Trades as Valid Means to Meet Obligations	Environmental assessment under provincial rules required to show trading provides valid option for permit holder; agreement between permit holder an SNCA, which provides credits; proposed best management practices reviewed by multi-stakeholder program committee for funding; SNCA calculates phosphorous loadings associated with each project.	EPA's 2003 policy offers general guidance on when and how trading should occur, consistent with existing legislation; best management practice list evaluates in advance environmental value of credits.
Connecting Buyers and Sellers	SNCA acts as clearinghouse, no direct link between buyers and sellers.	Automated transfer of credits conducted through trade notification form and submitted in trade tracking system.
Reporting	Permit holders provide periodic reports, including offset credits used, to provincial environmental authority.	Permit holders submit monthly discharge monitoring report including trades recorded in the trade tracking system.
Enforcement	10% of projects inspected; leading role played by farmers.	Most best management practices used by farmers for credit generation will be inspected at program inception; the degree of inspection will lower with time; enforcement action taken with permitted source if needed; private contract sets the obligations between seller and buyer.
Monitoring	No monitoring in addition to provincial programs.	Existing watershed monitoring can be complemented by on-site monitoring, thus providing added credits to sellers.
Policy Guidance	Ontario's Total Phosphorous Management Program.	EPA's 2003 policy offers general guidance on when and how trading should occur, consistent with existing legislation; EPA's 2004 *Water Quality Trading Assessment Handbook* guides stakeholders in feasibility analysis.

Sources: Schary and Fisher-Vanden (2004); Conservation Authorities of Ontario (2003).

In the Lower Boise system, part of the monitoring cost is covered by the traders themselves, through their obligation to report. More importantly, the goal of reducing the costs of administering the program was an integral part of the design process. It is unclear whether this is a result of putting in place a trading system per se or just the effect of setting this as a goal to be achieved up front.

Providing Increased Certainty through Policy Guidance

In general, while not an absolute necessity, some form of policy guidance is useful to provide greater certainty to the regulated entities that trading is a valid means to meet environmental obligations. Several states as well as the Environmental Protection Agency have adopted such a policy (Morgan and Wolverton, 2005). In Ontario, the province adopted a total phosphorous management policy to allow trading and to define steps to implement it (Conservation Authorities of Ontario, 2003).

One main benefit of such policy documents is to clarify for everybody the goals pursued through trading programs, and particularly the role of each actor in these programs. These documents only provide general guidance, and the specifics of each trading program will be determined on a local basis, with the participation of relevant stakeholders. These policies also specify what is required for regulated entities to meet regulatory obligations through trading.

In the United States, a guide was prepared to provide stakeholders with basic tools to help assess the appropriateness of a WQT system for their watershed (United States EPA, 2004).

We have reviewed here some practical choices made in WQT programs with respect to the principles of reducing transaction and administrative costs to achieve environmental effectiveness at a lower cost. There are certainly other options available to potential partners in designing WQT programs. While design is important, the importance of looking at the interactions between those actually involved in designing trading programs and/or impacted by them also needs to be looked at carefully. At the end, a decentralized program, such as WQT, can only work if those entities that are supposed to trade actually do so. Understanding why they might be hesitant to be part of such a system, as well as the role of public interest groups, experience shows, is crucial in developing a trading program.

8. Stakeholder Involvement: The Role of Farmers and Municipalities

Different explanations have been suggested to account for the fact that in most trading programs, at least in the United States, the number of trades is limited. As we saw before, reasons can include high transaction costs or limited regulatory incentives to trade. Another possible explanation lies in the understanding of the social context in which trading occurs.

Trading compared to other regulation or even subsidy programs involves changes in the pattern of interactions between agents. From a bilateral relation between a state agency (or a number thereof) and farmers or municipalities, a shift occurs in a trading program where a number of potential trading partners have to be involved.[11] Not only does this change the nature of the enforcement and compliance process, which partly occurs through private contracts (Woodward et al., 2002), but it may also involve sustained relations between a number of stakeholders, who may not have needed to work together before.

Related to this is the fact that most WQT programs, although supported by national or sub-national agencies, have been implemented at the local level. In an examination of how local factors affect the uptake of MBIs, Feitelson and Lindsey (2001: 203-204) found that a "fairly well defined set of factors, including local culture and politics, drives the use of economic instruments at the local level." These factors include:

- the simplicity of the instrument;
- the capacity of the local jurisdiction and its experience in dealing with similar instruments;
- the adoption of economic instruments facilitating higher growth, where the development industry might be able to take advantage of them;
- instruments that reward rather than punish are more attractive; and
- local political culture.

"The conceptions of how things should be done, and the resulting attitudes toward specific instruments, are an outcome of the local power structures, history and the attitudes of specific interests groups" (Feitelson and Lindsey, 2001: 204).

Research in Alberta seems to support such results; it was found that the main barriers to the application of such an instrument are the lack of awareness of this kind of system, the lack of science, and no trust. To address the trust issue, it was found that a useful approach would be to bring in not-for-profit brokers/clearinghouses. There is also a need to quantify the economic benefits for farmers (Haugen-Kozyra, 2005). Indeed, the Dutch experience in the development of policy tools led, after 1994, to the realization that farmers would simply not comply with a policy they did not support (OECD, 2005a).

In WQT programs of the type adopted in the United States, Kramer (2003: 6-7) summarized the challenge of including the farming community in trading:

> Agricultural non-point sources were very reluctant to get involved with trading discussions and agreements because they perceived that they had little to gain and much to lose. This group of sources has enjoyed near immunity from regulations regarding runoff to surface waters (with the exception of some concentrated animal feeding operations). Also, having a long history of being subject to market and production factors that are beyond their control, such as price fluctuations and weather, farmers have been understandably reluctant to voluntarily expose themselves to yet another – involvement with a discharge permit. Most agricultural non-point sources wanted to see good evidence that trading would benefit their bottom line before they would risk a trading agreement. Also, these sources were very reluctant to draw any public attention to themselves because of a perceived potential for negative publicity.

From our review of trading experiences involving agricultural non-point sources, it appears that this statement is a nearly universal truth. But this should not be construed as a rejection of the need to better care for the environment. As O'Grady (2005a: 28) contended, many farmers view themselves as stewards of the land and have a strong conservation ethic. Much of the time, however, they cannot afford to do the conservation work, even if they would "rather voluntarily put in a few dollars of their own than have the government force them to implement BMPs [best management practices]" (O'Grady, 2005a: 28).

The rural-urban divide is another important limit to the development of WQT programs. In some programs involving municipalities, farmers were reluctant to participate as they saw their participation as an indirect way to fund urban growth. Municipalities also had their issues (Kramer, 2003: 14). To begin with, although an important consideration, compliance costs may not be the primary concern of local WWTP managers. They might want to make sure they make the right choice to enhance water quality for their community. They might fear criticism if they are seen to be paying for pollution reductions outside of their communities. Finally, they might also resent the fact that the agricultural sector does not face as stringent regulatory requirements as they do.

When the agriculture sector is subjected to strong regulations, the main problem has been to obtain some clarity with respect to the directions taken. In the Netherlands, this was complicated by making a very large number of changes through a relatively small number of years. One lesson learned with the application of diverse approaches, including MINAS and eventually trading, is that "farmers need time to adopt new techniques and management styles to adjust to improved farming conditions.... They have to learn and they have to be convinced of the need for change, otherwise they remain reluctant to change and ignorant of improved practices. Direct guidance, demonstration farms and pilot farms are essential in this respect" (OECD, 2005a: 31).

In the Netherlands, the great number of changes in the manure management policies have, with time, led to confusion among farmers – and to a "wait and see" attitude resulting from a distrust in the long-term value of any investment made in what recent history suggests may be a short-lived policy context. Addressing the question of farmers' participation and buy-in thus appears to be one of the most difficult issues in implementing WQT. A common theme in the review of experiences is the length of time required to ensure everyone is on board. There is, first, a question of language. Clarifying the concepts and making them clear to all is an issue to be addressed. Some communities may react negatively to terms such as "pollution permits" or buying credits. Related to this is the question of trust. Putting in place a transparent process as well as ensuring the right people or the legitimate representatives of farmers' organizations are at the table can be an important challenge (O'Grady, 2005b).

Breetz et al. (2005), in a study examining mechanisms to increase farmers' participation in WQT programs in the United States, reviewed options based on existing experiences. The authors examined three main options for breaking the initial barriers that affect participation, including the mistrust farmers have of regulators or other actors. These options are communication mechanisms, such as education and outreach; third-party facilitation; and the use of existing networks. Each instrument has its strengths and weaknesses, and their use is conditioned by a specific program's objective and local conditions. The point here is that strategies to address the initial reluctance of farmers to participate in WQT systems have to be developed, taking into account local circumstances, if such programs are to be effective. The authors also noted that none of the strategies can necessarily guarantee the expected results.

Social factors are an essential element in the development of any policy tool, even those said to be market based. More research is needed to better understand these factors.

In the cases of the Lower Boise and in the South Nation watersheds, co-ordinating committees for the programs have been developed, which include a number of government departments and stakeholders. In Ontario, the Total Phosphorous Management Policy actually encourages such an approach, as does the US Environmental Protection Agency guide on trading (United States EPA, 2004). This can ensure agreement on the purposes of the program and help clarify everybody's roles and responsibilities. It also increases buy-in by allowing participation in defining the elements of program design so the rules of the game are clear for all participants. Such buy-in has also been considered the most important factor in the success of a wetland mitigation project called Great River and Land Trust developed along the watershed of the Mississippi in the United States (Ringhausen, 2005).

This being said, as with choices made in designing a program, there is probably no magic recipe and the choices made in the Lower Boise or in the South Nation systems may not be appropriate for others. However, the principles that have guided the choices in these programs provide some direction with respect to the respective roles of traders and other stakeholders, as well as of governments in a trading system.

We have seen that trading programs, in particular those addressing water pollution, are a complex policy tool. Under the right circumstances, and with attention given to designing them carefully and in partnership with stakeholders, WQT can bring significant results for the environment at lower cost than traditional approaches. An important element to determine the "right" circumstances is a careful assessment of the policy context within which WQT would be implemented. This involves not only an assessment of the effects of the existing agri-environmental instruments or other environmental instruments implemented to address similar environmental issues; it also involves an analysis of those instruments that may appear to have only a limited relationship to environmental issues but that may be providing opposite incentives and thus limit the effectiveness of efforts to improve water quality. In what follows, we provide some parameters to guide such analyses, recognizing that this is an emerging yet crucial field of policy research.

9. Instrument Choice, Policy Coherence, and Instrument Mixes

For a long time, market-based instruments have been promoted as cost-saving, flexible alternatives to command-and-control regulation. By opposing these two seemingly opposite approaches, a large part of the literature has limited the analysis to different instrument mechanics and relative cost effectiveness, mostly on theoretical grounds. However, as we saw in Chapter 4, MBIs are closely linked to existing regulations. In addition, recent empirical analyses of market-based instruments tend to indicate that the question is not so much what instrument provides environmental results at lower cost, but what mix of regulations, MBIs, and voluntary instrument are necessary parts of an effective package (European Environmental Agency, 2006; Marbek Resources and Renzetti, 2005; Policy Research Initiative, 2005).

In what follows, using some of the insights gained through the analysis of water quality trading, and based on some other experiences, we examine how regulations, MBIs, and voluntary/education instruments could used complementarily, in combinations. We also approach the issue of developing policy mixes while pursuing the goals of environmental effectiveness, economic efficiency, and equity.

From Instrument Choice to Instrument Mixes

Experiences tend to show that no instrument can realistically work alone, and efforts should be made to better understand how instruments fit together in specific cases. As we saw in Chapter 3, for example, education and training to address water pollution from agriculture, by themselves, are not likely to lead to desired environment results. However, they are a crucial element of any package in that they provide the necessary tools and understanding for farming enterprises to make different choices. Unfortunately, there is still little empirical analysis available to assess the appropriateness of such mixes, and existing studies are too recent to provide strong conclusions. The OECD (2005b,c) recently initiated such a project; its results are not yet publicly available.

Obviously, the nature of the environmental problem determines some of these options. We have seen that water quality problems are better addressed by setting ambient goals, often in regulation, mainly because different sources have different effects at different locations in a watershed. Without that kind of direction, solutions will be partial at best. But the infrastructure or the regulatory framework needed to monitor and enforce such goals may be lacking, thus limiting the range of instruments that can be used efficiently and effectively.

In addition, instruments have to be adapted to the pollution sources being addressed. Process-based regulations, for example, are more suited to agricultural activities than performance-based ones. Similarly, not all MBIs are suited to agricultural sources of pollution or to water pollution issues, although some may be adaptable. Weersink et al. (1998) suggested that ambient charges are a possible MBI to consider when farmers would be rewarded for environmental quality results that are higher than a certain standard (or penalized if under-performance is observed). In such a scenario, as for WQT, the standard may have to be enforceable, thus set in regulation; and, as we have seen for WQT programs, since individual contributions to the pollution load are generally unobservable, the system should be based on a target applied to a group of farmers.

We also saw that WQT in practice requires capacity and resources to address pollution issues at the watershed level (See Chapter 6). In a number of the reviewed cases, either institutions at that level existed, regulatory requirements imposed such an approach, or both. For example, determining factors in the development of WQT in New South Wales in Australia, which did not initially address agricultural non-point sources of pollution, included the need to try new approaches since previous ones did not work (Collins, 2005b). But a WQT system did not impose itself directly. What made it possible was the prior adoption of a load-based licensing regime, allowing better measurement and allocation of individual contributions to a watershed quality issue, in this case salinity (Collins, 2005b). Water quality trading became a natural extension of the load-based licensing regime. But it took a number of years experimenting with point source trading before adapting the concept to non-point sources in other contexts.

While a number of instruments may appear appropriate to address a specific problem, social factors may limit the choices available. For example, choosing between charges or WQT may depend on social considerations other than their relative theoretical effectiveness (Majone, 1989). Harrington et al. (2004) observed that European countries make much more use of tax-like systems than Americans (or Canadians), who seem to be more interested in trading schemes. Montpetit (2003), in comparing agro-environmental policies in France, the United States, and Canada, described how networks of stakeholders and institutions affect policy choices and effectiveness. And choices made at the local level may also depend on a number of social conditions, as mentioned before (Feitelson and Lindsey, 2001).

Other options to deal with agricultural sources of pollution involve addressing inputs instead of emissions. Pesticides, which are difficult to define as a tradable commodity when released, could be tackled through a trading system similar to the one the Netherlands has developed, or through a charge system, as already implemented in a number of European nations. In both cases, an appropriate regulatory system needs to be in place. The Dutch tradable manure quota system made sense since a registration system was already in place to account for animals on farms, backed by physical inspections (Hubeek, 2005). Hubeek also noted that experience showed that this input measure had to be supplemented by instruments controlling the efficiency (timing and method) of manure application.

Training and education also played an important role in the Netherlands to ensure that the methods to gain efficiency in manure application reached their goal. Another Dutch example shows how combining approaches made MBIs more effective. Bressers and O'Toole (2005: 143), in an examination of effluent charges, noted that their positive effect was in great part (about 50 percent of the impact) due to factors other than the economic instrument per se. These included communication about the policy problem and possible solutions, a disruption of habitual behaviour (thus forcing the issue onto the agenda of firms), and activation of other actors. From an instrument mix perspective, one could say that information and education were conditions for the success of this MBI.

Returning to WQT systems, most of the contexts in which they evolved have some mix of education/voluntary and economic instruments, as well as more direct regulation. It thus may seem that the question is not so much to discover the best instrument but the best mix of instruments to address a specific problem. Given what we just said, however, such a best mix may simply not exist. That is, it might be more judicious to talk about a more appropriate mix, one that is appropriate for a specific problem in a specific location. In turn, this may well depend on historical factors, or experience, which is also related to the capacity of different actors to work together in the application of specific sets of instruments, or what political scientists sometimes refer to as governance (Montpetit, 2003; Gunningham and Sinclair, 2004b; Eliadis et al., 2005).

Thus while a number of instruments seem to be available, including a number of combinations, policy makers have to account for technical as well as non-technical limits that affect the feasibility of instrument choices and combinations. Not all theoretically possible combinations are available for most cases. They depend on the environmental problem, local social conditions, past experience and administrative capacity, among other considerations. Such constraints should not be construed as eliminating the need to introduce new, more effective instruments, which may appear to be difficult to implement, but rather to acknowledge the fact that some possibilities may be more reasonable to contemplate than others.

Constraints should not stop the analyst from discovering new options, and indicating how to proceed to make them possible, given the context. The question then becomes how does one go about developing such appropriate mixes, given constraints, but acknowledging possibilities?

Developing a Policy Mix

The reason why policy mixes might ultimately be necessary may lie in the fact that the main classes of instruments, (i.e., directive regulation, market-based instruments, voluntary instruments and education) rely on different institutions for their implementation and operation. Note that institutions are not completely independent of each other. Regulations are the most directly linked to state institutions in that the state sets both the objectives and, to a certain extent depending on the type of regulation, the methods to achieve them. The State also enforces them; MBIs, in contrast, while also relying on state objectives and enforcement, leave more room to private actors, in the setting of market institutions, to determine methods to achieve the objectives; voluntary instruments and education, which can also depend in part on state objectives or state-defined methods, leave the decision to adopt them to private actors. Voluntary approaches mainly rely on moral suasion or exhortation in a given social context. From an institutional standpoint, actors are understood as part of some social network, for example a physical community or a group of enterprises in a given sector, which provides the basic impetus for the adoption of the instrument. Note that all these instruments need adequate monitoring to ensure their effectiveness.

Gunningham and Sinclair (2004b), building on previous work from Gunningham et al. (1998), came up with an approach to instrument development and use based on the idea of combinations, and tried to identify the circumstances that condition the adoption of specific policy mixes. Their analysis, which they recently applied to water pollution from agricultural sources in Western Australia is also relevant to the Canadian experience where, as we saw in Chapter 3, there is also relatively limited use of regulation.

To begin with, an important factor in considering instrument mixes is to acknowledge that all instruments have strengths and weaknesses. The use of different instruments should be conceived in a way that harnesses the strengths of some while compensating for their weaknesses by the use of other, complementary instruments (Gunningham et al., 1998: 15). In addition, a mix of instruments will tend to work better if a broader range of participants is capable of implementing them. This brings us to restate that previous experience and social conditions more generally are crucial considerations in policy implementation.

In selecting policy instruments, decision makers should focus on how these instruments can impact upon and influence each other (Gunningham et al., 1998: 125). The authors proposed a three-fold typology where the interactions between instruments can either be complementary, neutral, or counter-productive. Complementariness is determined in part by the fact that the use of one instrument created a demand for another. In the WQT example, trading should be backed, for example, by the complementary actions of a regulated ambient-based goal, training to ensure adequate implementation of BMPs adopted to reach that goal, as well as a market structure appropriate to the context. All tools need the collection of quality data. Alternatively, as in the Dutch case, regulation and training on efficient manure application, and other tools to foster farm-level nutrient balances complement input-based trading.

Neutral interactions exist when there is independence between instruments. While there might not be an obvious need to have such instruments co-exist, the same authors suggest that given the inherent limits of most instruments, it might not be a bad thing to back an instrument with another. The issue here, however, is one of cost effectiveness.

Counterproductive instruments are found when the effects of one measure neutralize the effects of another one. There is the general case of commodity subsidies promoting increases in production while agri-environmental measures would call for a control of such production in some cases. Concerning WQT programs, there is some debate on the appropriateness of having subsidies to implement best management practices at the same time as having a WQT program. For some, this could reduce the supply of pollution credits, thereby limiting the effectiveness of a WQT program (King and Kuch, 2003). However, this may not be the case when the use of these instruments is co-ordinated, and made complementary.[12] This points to the difficulty in establishing clearly when instruments will be complementary. There is still much to be learned about policy instruments and the way they may interact with each other.

Another issue is to ensure that an instrument (or mix thereof) chosen to address a specific environmental issue will not create other environmental problems. Conversely, there might be benefits in looking at how existing instruments can be used constructively for other purposes. For example, if farmers adopt practices to reduce their greenhouse gas emissions for trading purposes, there might be a case to also evaluate the effect of these practices on water pollution. Credits earned for one market could also become commodities in another one. It might also be possible to use the same market institutions for both purposes.

Caution should be used in developing policy mixes, to avoid what Gunningham and Sinclair (2004b: 194) referred to as a “smorgasbord” approach, where regulators would be tempted to implement simultaneously a number of instruments. Cost effectiveness is also an important parameter in addressing environmental problems.

A general guide to developing policy mixes, which would help to avoid a “smorgasbord” approach, is to ensure that each specific instrument is used to achieve only one specific objective (Young and McColl, 2005). However, the difficulty lies in identifying with an adequate degree of precision the different objectives that need to be met to make a program, such as WQT, work. In the absence of such precision, this approach can still serve as a useful guide in avoiding duplication of efforts and in crafting policy and programs, understanding that this is a learning process.

In the context of water pollution from agriculture, Gunningham and Sinclair (2004b) argued that when there is limited experience with regulation, it might be preferable to adopt a phased approach, where education/training would come first, followed by more forceful tool, such as MBIs and then, if necessary, more directive regulation. Decisions to add supplementary tools should be based on an adequate assessment of the causes of failure of tools previously implemented, and thus depend on the establishment of targets, and on verification/monitoring. This is clearly a call for adaptive management, or the conscious effort to view policy development as a form of experiment where efforts are made to document implementation activities, and lessons learned are used to adjust as required.

Such efforts need to be made in collaboration with all the regulated community, at a minimum. One lesson is that regulated groups will try to anticipate changes in government policy and will support more certainty in policy directions (OECD, 2005a; Fisheries and Oceans Canada, 2004). Without an appropriate understanding of where the regulators are going, how, and for what reason, stakeholders might prefer a wait-and-see approach rather than embracing change. In addition, inclusive approaches may lead to more equitable choices.

A recent experience in designing policy mixes showed the benefit of stakeholder involvement in designing an approach to control pollution from the pig farming sector in Portugal (Santos et al., 2006). Following the one objective/one instrument precept, stakeholders and regulators developed, in collaboration, an approach based on the use of the main classes of instruments: command-and-control regulation, MBIs and a voluntary instrument. This approach combines the recognition that behaviour change occurs in different ways through different set of institutions, as well as the recognition that significant stakeholder and public involvement in the policy-making process can help ensure choices and design are appropriate given the context in which instruments are implemented.

There is still much to learn about different policy mixes and the interactions between different instruments. Choices made in the past, and the administrative capacity that results, condition, to a certain extent, the possibilities for the future. But when these choices are shown to be insufficient to solve problems, and there is a need to innovate, a careful examination of all the options is needed. Experience is now indicating that efforts are probably needed on many fronts, and mixes of policy instruments may often be required. The challenge is to find appropriate options in specific circumstances, to determine an equally appropriate course of action, and doing this in an environmentally effective, economically efficient, and equitable manner.

Policy makers who want to consider the adoption of WQT need to examine carefully the existing policy context. We reviewed in this document some basic elements that are required to implement this instrument; while WQT is generally compatible with existing regulatory contexts, we have not looked at how this tool would actually complement existing policy choices made in Canadian jurisdictions, which would require an analysis of the effectiveness of these choices. We have reviewed here some of the principles and the parameters that should guide this analysis. A remaining question is whether stronger regulations would be required to make WQT work better. A possible answer might be, as Gunningham and Sinclair (2004a,b) suggested, to evaluate first the extent to which voluntary participation and existing programs, on a project by project basis, bring results, and if not, to make sure the reasons for failure are known.

10. Conclusion

Water quality trading could be a useful instrument in the toolbox of Canadian policy makers to address agricultural sources of water pollution. It could either take the form of the model developed in the United States, Australia, and Ontario, or a modified version of the Dutch experience applied at the watershed level. The existing Canadian regulatory and related policy frameworks established to address water quality issues and agricultural sources of pollution more generally, for the most part, would allow the implementation of the instrument. In addition, the voluntary aspect of most trading programs including agricultural non-point sources would seem to fit appropriately within the current approach used in Canada.

The administration of WQT programs can be made compatible with watershed-based management approaches being implemented by most Canadian provinces. However, a number of conditions need to be respected for such an instrument to be effective, in terms of cost and in reaching the environmental objectives it is designed to address. Indeed, experience shows that there has been limited success with implementation of the instrument, at least measured by the number of trades, which is arguably not the sole measure of success. This underlies the fact that, to be effective, any instrument needs to be carefully designed, and the interactions between instruments should be thoroughly investigated.

To begin with, a clear understanding of the specific form of pollution being addressed within the context of a given watershed is needed. Water quality trading, as trading in general, often requires more information than other instruments, in particular where the pollution pathways are complex and can greatly differ spatially and in time. Such information is needed to understand how different sources of a targeted pollutant affect the watershed, to determine an adequate pollution target as well as to monitor and evaluate results to ensure compliance. Basically, an adequate monitoring system is needed.

Consequently, Canadian watersheds where pollution from agricultural sources is already a documented problem, and where other approaches have had limited success, to the extent they meet the information requirements, would be more likely candidates for trading.

Phosphorous, nitrogen, and sediments would be the most appropriate pollutants to be targeted by WQT systems, while consideration could be given to address pesticides though input-based trading systems, although there is limited knowledge of pesticide effects on watersheds. It should be clear that there will never be perfect information on pollution and that uncertainty should not be seen as an insurmountable barrier. Tools such as trading ratios can alleviate some of the risks associated with uncertain information and ensure positive environmental change can occur at relatively low cost.

Creating any market involves a number of challenges. This is particularly true of the variant of baseline-and-credit markets that WQT usually takes. Assuming there are important differences in the abatement costs facing different participants, the designs of the market and the program developed to administer this market have to minimize costs. In general, the larger the number of participants, the lower the unit costs of trades will be. However, environmental improvement at relatively low cost can also occur with a small number of participants involved in one-off trades, and such options should not be rejected a priori.

There are basically three sources of costs in establishing and running any pollution market: transaction, implementation, and administrative costs. Transaction costs, that is the costs involved in initiating and completing trades will be reduced if information systems are in place and if the need for government approval is reduced. The other sources of cost can be reduced, for example, by building a WQT program through existing local institutions and by integrating it within an already existing program apparatus. But there is no general rule, since what works in one location might not in another. The use of experimental economics as is being done in Australia and in some US pilot schemes can be valuable both to improve the design of a pollution market, but also to train potential participants in pollution trading.

Trading for water pollution is highly dependent on local circumstances, including social ones. A source of failure in a number of trading programs has been the reluctance of farmers, and of other actors, such as municipalities, to participate. While limited participation by farmers could partly be linked to relatively weak environmental requirements, the Dutch experience indicates that without farmers' buy-in, even strong regulations are likely to have limited impacts. Careful attention has to be given to explain the purpose of any program, in particular, new types of approaches such as WQT. Involvement of key stakeholders, and extensive participation of local public interest groups may increase trust and limit resistance, but more research is needed to better assess the effectiveness of different approaches.

Finally, WQT programs never appear in a vacuum. Other programs affecting agricultural activities will have an impact on the potential effectiveness of trading. Assessment of the probable positive and negative interactions of trading with other programs is needed. This is particularly important at another level. Experience shows that environmental change is not likely to occur from the application of any one instrument. More specifically, education and training or other voluntary approaches, MBIs, and regulation are usually all part of the equation. But the effective use of each element requires a careful approach to ensure the weaknesses of specific instruments are balanced by other ones. In turn, this requires a commitment to continuous evaluation and adaptive management.

A Federal Role for Water Quality Trading?

Freshwater management is, for the most part, under provincial jurisdiction. There are, however, a number of important roles played by different departments of the federal government in particular, but not limited to water quality in waters shared between provinces or with the United States.

Given its responsibilities in water, the Government of Canada's involvement would likely be more indirect, and vary according to the situation or location. Knowledge building is one such possibility, including understanding the effects of agricultural and other sources of pollution in watersheds and the effect of selected practices in the environment, or improving the models. Such work is already being undertaken by Agriculture and Agri-Food Canada and Environment Canada, but could be expanded in specific watersheds if needed. Capacity

Co-operation on the Fraser River

The Fraser Basin Council (FBC), created in 1997, is the result of co-operation between federal, provincial, and local governments that began in the early 1990s to address severe problems of pollution and over-fishing in this large watershed of British Columbia. The FBC is a non-profit, non-governmental organization with a mandate to promote the economic, environmental, and social sustainability of the Fraser Basin. The Council, which maintains a presence in five sub-regions of that large watershed, plays a key leadership role in facilitating dialogue, helping to resolve conflicts, educating the public about sustainability, and motivating people to take action.

The FBC is governed by a 36-member board of directors, representing governments, First Nations, and private and non-profit sectors.

The Fraser Basin is historical home to many indigenous peoples, has a population of nearly three million people and accounts for about 80 percent of British Columbia's economy. It supports highly productive salmon and waterfowl breeding grounds; contains 21 million hectares of forest, half of British Columbia's agricultural lands, and several major producing mines, and offers significant tourism and recreational opportunities.

For more information, go to: <http://www.fraserbasin.bc.ca>.

building at the watershed level may be another indirect means to approach the issue, similar to what some Fisheries and Oceans Canada programs are doing by supporting the work of watershed stewardship groups involved in fisheries habitat protection.

Knowledge building is also required in fields other than the natural sciences. There is a need to better understand the conditions that make farmers, among other participants, adopt more and newer environmentally beneficial practices. More generally, there is a need to better understand the type of partnerships that can be established between governments and other actors in administering programs, such as WQT. By partnerships we refer here to formally sharing responsibilities and accountabilities.

Since water management is increasingly being implemented at the watershed level, the main challenge for the Government of Canada may be to ensure it plays its role when needed to help the process of watershed-based management, which also has repercussions for the implementation of policy instruments, such as WQT. There are now very good examples of interdepartmental federal involvement in watersheds, such as in the Fraser Basin or in the Great Lakes, where co-operation with provinces and other stakeholders is exemplary. Can the lessons from these examples lead to a general approach for the Government of Canada in supporting provincially based watershed management initiatives?

Our research on WQT highlights general lessons that are not limited to this specific policy instrument. The need for jurisdictional co-operation and for the constructive involvement of a number of stakeholders at the watershed level in addressing water quality issues, as well as the need to ensure adequate integration of policy instruments are prerequisites for the successful application of any instrument.

Co-operation in the Great Lakes

The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA) provides a framework for co-ordination and co-operation with the goal of restoring, protecting, and conserving the Great Lakes Basin ecosystem. The Agreement also contributes to meeting Canada's obligations under the Canada-United States Great Lakes Water Quality Agreement.

Signatories to the Canada-Ontario Agreement are Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans, Health Canada, Heritage Canada, Natural Resources, Public Works and Government Services, and Transport Canada; and the Ontario ministries of Agriculture, Food and Rural Affairs, the Environment, and Natural Resources.

The Great Lakes Quality Agreement was first signed in 1972 to restore and maintain the chemical, physical, and biological integrity of the Great Lakes Basin ecosystem.

The magnitude of the Great Lakes water system is difficult to appreciate, even for those who live within the basin. The lakes contain about 23,000 km^3 of water, covering a total area of 244,000 km^2. The Great Lakes constitute the largest system of fresh, surface water on Earth, containing roughly 18 percent of the world supply. Only the polar ice caps contain more fresh water.

In spite of their large size, the Great Lakes are sensitive to the effects of a wide range of pollutants. Sources of pollution include the run-off of soils and farm chemicals from agricultural lands, the waste from cities, discharges from industrial areas, and leachate from disposal sites. The large surface area of the lakes also makes them vulnerable to direct atmospheric pollutants that fall with rain or snow and as dust on the lake surface.

For more information, go to:
<www.on.ec.gc.ca/greatlakes/default.asp?lang=En&n=D11109CB-1>
<www.on.ec.gc.ca/greatlakes/default.asp?lang=En&n=FD65DFE5-1>
<www.epa.gov/glnpo/atlas/index.html>.

NOTES

1 Note that while Faeth (2000), is in general agreement with this statement, he emphasized that these approaches have had a positive impact on reducing soil erosion in the United States.

2 This section is taken from Hubeek (2005).

3 Our emphasis.

4 Daniel O'Sullivan, Queensland Environmental Protection Agency, Personal communication, 23 February 2006.

5 PERT stands for Pilot Emission Reduction Trading, which was the first major emissions trading project in Canada. PERT was started in 1996 as an industry led, Ontario based emission reduction trading project. The initial focus of PERT was NOx and Volatile Organic Compounds emissions in southern Ontario but expanded to include CO, SO_2, and CO_2 in 1997.

6 Ontario conservation authorities are watershed-based organizations created in Ontario, in the 1940s through an act of the legislature. They are autonomous organizations developed to promote the protection and wise use of water resources, or in more modern terms, integrated water resources management. While a number of provinces have recently begun the development of watershed-based organizations, the Ontario experience is unique by its longevity.

7 This chapter is largely a summary of Morin (2005), which reports on the May 2005 workshop.

8 Note that a trading system in pesticide use rights could be envisaged on a national or provincial basis. Such a system would be similar to the manure quota trading system implemented in the Netherlands (Hubeek, 2005).

9 Our consultants did not agree on the interpretation of legislation in one province.

10 See Hahn and Hester (1989), Draper et al. (1997a, b), Kerr et al. (2000), Conservation Authorities of Ontario (2003), Fang and Easter (2003), Kramer (2003), Fortin (2005) and BDA Group (2005) for discussions on the design of specific trading programs in Ontario, Australia, and the United States.

11 This applies also to programs like the South Nation in Ontario where although trading is implemented through a cost-shared program, multi-stakeholder committees are put in place to manage the program, including its trading element.

12 Horan et al. (2004). See also Johnstone (2003: 11) on the use of tradable permit systems with subsidies.

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APPENDIX A

Agenda for the Workshop on Biophysical and Geochemical Considerations in the Development of Water Quality Trading to Address Agricultural Sources of Pollution in Canada

AN EXPERT "THINK TANK" HOSTED BY AGRICULTURE AND AGRI-FOOD CANADA (AAFC) AND THE POLICY RESEARCH INITIATIVE (PRI)

LES SUITES HOTEL
130 BESSERER, OTTAWA, ON
MAY 27, 2005

AGENDA

Purpose

To assess (from a scientific perspective) the feasibility of WQT as a tool to address agri-related water pollution by identifying:

- Bio-physical considerations that will impact the feasibility of WQT.
- Scientific barriers to trading between emitters.
- Data issues/gaps that will need to be addressed to facilitate WQT in agriculture.
- A preliminary list of biophysical and geochemical conditions for developing a WQT protocol including agricultural sources of pollution in Canada
- Other related issues.

Roadmap

8:30 Continental breakfast

Context for the Workshop

9:00 Getting started/Welcome —— Ian Campbell (PRI)/Isabelle Proulx (AAFC)

- Purpose of the meeting

9:10 Process Review —— Facilitator

- How we will work together
- Introductions

9:20 WQT as a Concept —— Bernard Cantin (PRI)

- Highlights of the discussion paper

9:40 Discussion

- Any questions of clarification?
- High level feedback on WQT as a concept

Biophysical Considerations

10:00 **Discussion – Focus on Pollutant Characteristics**

- From the list of pollutants provided...and from a scientific perspective...
- Which pollutants lend themselves to trading? Why? Why not?
- Are there issues with trading specific pollutants?

10:45 Discussion on pollutants continued...

13:00 **Discussion – Focus on Basin Characteristics**

- What characteristics would make a particular basin a candidate for WQT?

14:00 **Focus on Possible Trading Between Emitters**

- What are the potential scientific barriers to trading between emitters?
- What are the biophysical/geochemical considerations that would facilitate WQT?

15:15 **Focus on Other Issues**

- What are the additional data gaps and/or issues that will need to be addressed in order to facilitate WQT in agriculture?
- Are there any candidate watersheds that come to mind? Why?
- Any other issues that have not been raised so far?

The Path Forward

15:45 Next Steps — Ian Campbell (PRI)

- What/Who/When?
- September workshop
- Other project milestones

15:55 Closing Comments — Isabelle Proulx (AAFC)

- Evaluate the meeting

Appendix B

Participants for the Workshop on Biophysical and Geochemical Considerations in the Development of Water Quality Trading to Address Agricultural Sources of Pollution in Canada

Participants	Job Title	Branch	Department/Organization
Yves Bourassa	Policy Manager	Environmental Economics	Environment Canada
Philippe J. Crabbé	Professor	Department of Economics	University of Ottawa
Dr. Richard Butts	Science Director	Soil, Water and Air Quality	Agriculture and Agri-Food Canada
Peter Dillon	Professor	Department of Environ-mental & Resource Studies	Trent University
Bernard Cantin	Senior Policy Research Officer		Policy Research Initiative, Government of Canada
Dr. Craig Drury	Soil Biochemist	Integrated Crop Production Systems	Agriculture and Agri-Food Canada
Ian Campbell	Senior Project Director		Policy Research Initiative, Government of Canada
Gordon Fairchild, Ph.D.. P.Ag.			Eastern Canada Soil and Water Conservation Centre, Moncton University
Rick Findlay	Director		Pollution Probe
Sarah Kalff	Environmental Policy Analyst	Agri-Environmental Policy Bureau	Agriculture and Agri-Food Canada
Connie Gaudet	A/ Manager	National Environmental Effects Monitoring Office National Water Research Institute	Environment Canada
Mark S. Kieser	Senior Scientist		Kieser & Associates
Brook Harker	Senior Soil/Water Resource Specialist		Agriculture and Agri-Food Canada
Brigitte Laberge		Institut national de la recherche scientifique	Université du Québec
Paul Jiapizian	Specialist	National Guidelines and Standards Office	Environment Canada
Anne Morin	Analyst		Policy Research Initiative, Government of Canada
Dennis O'Grady	General Manager		South Nation Conservation
Alfons Weersink	Professor	Agricultural Economics and Business	Guelph University
Isabelle Proulx	Senior Environmental Analyst	Agri-Environmental Policy Bureau	Agriculture and Agri-Food Canada

APPENDIX C

Agenda for the Workshop on Water Quality Trading in Canada

La Grange de la Gatineau
Cantley, Québec

September 19-20, 2005

This workshop, an event organized and sponsored by the Policy Research Initiative (PRI), Agriculture and Agri-Food Canada (AAFC), Environment Canada and the Canadian Water Network, is the second stage of a study on the feasibility of Water Quality Trading (WQT) or similar trading systems to address water pollution from agricultural sources in Canada. The project involves an examination of the main biophysical, regulatory and policy aspects of WQT programs, focusing in particular on the potential role of the federal government in supporting such approaches to pollution control. The project also examines issues of instrument choice and design, illustrated by the issues associated with introducing a specific type of market-based instrument.

The purpose of this workshop is to explore a number of key policy areas influencing the feasibility of WQT-related systems, specifically: how do the existing Canadian regulatory and policy contexts for water pollution, particularly in the agricultural sector, support or hinder the development of water quality trading or similar initiatives? What are the main design issues in setting up a trading program to ensure environmental effectiveness is achieved at least cost? The workshop will also examine how stakeholders, and which ones, can be involved in the development of trading programs to achieve its goals.

The format of the workshop is one of facilitated discussion, led by a few brief expert presentations inspired by current Canadian and international examples of trading in water pollution. All participants are expected to contribute their specific expertise.

Day 1 | September 19, 2005

8:00	**Departure from the Four Points By Sheraton Hotel in Gatineau**	
8:30	**Continental Breakfast**	
9:00	**Introduction**	
	Chair	Ian L. Campbell, Agriculture and Agri-Food Canada
	Speakers	Paul Martin, Agriculture and Agri-Food Canada, *Opening Address*
		Ian D. Campbell, Policy Research Initiative, *Overall Presentation of the Project*
		Bernard Cantin, Policy Research Initiative, *Reviewing the Agenda*
		Anne Morin, Policy Research Initiative, *Biological Considerations in Developing a Water Quality Trading Program (Results from a Spring Workshop).*

10:15	**Session 1**	
	Water Pollution Trading Around the World During this session participants will be provided information about the key elements of trading programs, through presentation of current international examples. Among the questions examined will be the determinants of instrument choice.	
	Chair	Ian L. Campbell, Agriculture and Agri-Food Canada
	Speakers	Mark Kieser, Kieser and Associates, USA Drew Collins, BDA Group, Australia Francisca Hubeek, Agricultural Economics Research Institute, the Netherlands
11:00	**Questions and Open Discussion**	
12:00	**Lunch**	
12:30	**Lunch Speaker** Bill Jarvis, Director General, Environment Canada, Strategic Analysis and Research Advancing Understanding of Market-based Instruments in Water Management in the Context of the Competitiveness and Environmental Sustainanability Framework (CESF)	
13:30	**Session 2**	
	How Can the Canadian Regulatory and Policy contexts for Water Quality Support or Hinder Water Pollution Trading? There are a number of different policy and regulatory approaches in Canada to deal with water pollution, including for the agriculture sector. This session aims at better understanding how those different approaches affect the feasibility of water pollution trading, with a view in particular to better understand what could or should be the federal role.	
	Chair	Ian D. Campbell, Policy Research Initiative
	Speakers	Ian L. Campbell, Agriculture and Agri-Food Canada Conrad De Barros, Ontario Ministry of the Environment Jean Nolet, ÉcoRessources Bernard Cantin, Policy Research Initiative
15:30	**Open Discussion**	

Day 2 | September 20, 2005

8:00	**Departure from the Four Points By Sheraton Hotel in Gatineau**
8:30	**Continental Breakfast**
9:00	**Session 3**

How Can Trading be Designed to Ensure Environmental Effectiveness at Least Cost?

There are many trading programs and pilots around the world dealing with water quality. Some of them have worked well, some have seen no trading at all. The objective of this session is to better understand what factors can limit the success of trading programs and to examine possible solutions to issues such as transaction costs, monitoring costs, compliance and others.

Chair Ian D. Campbell, Policy Research Initiative

Speakers Alfons Weersink, Guelph University
Mike Fortin, M. Fortin Consulting Economist
Claire Schary, United States Environmental Protection Agency

10:00	**Questions**
11:00	**Open Discussion**
12:00	**Lunch**
12:30	**Lunch Speaker**

Engaging Stakeholders in Implementing Individual Tradable Quota Systems

Rhéal Vienneau, Regional Director, Resources Management Division, Fisheries and Oceans Canada

13:30	**Session 4**

How Should Stakeholders be Engaged to Better Attain the Objectives of Water Pollution Trading Programs?

Perhaps a key aspect in developing pollution trading programs is the role of stakeholders. This session will examine the main barriers and possible approaches in working with stakeholders, in particular farmers. It will highlight their potential roles in the design and implementation of WQT or other trading systems. This discussion should keep in mind current developments regarding Watershed-based management in a number of Canadian provinces.

Chair Ian L. Campbell, Agriculture and Agri-Food Canada

Speakers Hanna Lori Breetz, MIT
Dennis O'Grady, South Nation Conservation Authority

14:15	**Questions and Open Discussion**
15:30	**Closing Remarks – Next Steps**

Appendix D

Participants for the Workshop on Water Quality Trading in Canada

Participants	Job Title	Branch	Department/Organization
Murray Birt	Consultant		Climate Change Central
Denis Boutin	Agronome et économiste rural, M.Sc	Direction des politiques en milieu terrestre, Service agricole	Ministère du Développement durable, de l'Environnement et des Parcs
Hanna Lori Breetz		Department of Political Science	Massachusetts Institute of Technology
Ian Campbell	Senior Project Director		Policy Research Initiative, Government of Canada
Ian L. Campbell	Senior Manager	Agri-Environmental Policy Bureau	Agriculture and Agri-Food Canada
Bernard Cantin	Senior Policy Research Officer		Policy Research Initiative, Government of Canada
Patricia Chambers	Project Chief	Human Impacts on Aquatic Ecosystem Processes	Environment Canada
Dr. Murray Clamen	Secretary	Canadian Section	International Joint Commission
Drew Collins	Partner		BDA Group, Australia
Dr. Shawn Dalton	Research Associate	Environment and Sustainable Development Research Centre	University of New Brunswick
Conrad De Barros	Project Leader, Cornwall Sediment	Assistant Director's Office	Ontario Ministry of the Environment
Denis Draper	Senior Policy Advisor		Environmental Commissioner of Ontario
Scott Duff	Resource Management Policy Analyst	Environmental Policy and Programs Branch	Ontario Ministry of Agriculture, Food and Rural Affairs
Mike Fortin			M. Fortin Consulting Economist
Jessica Ginsburg			Canadian Environmental Law Association
Karen Haugen-Kozyra	Environmental/Land Use Member	Policy Secretariat	Alberta Agriculture, Food and Rural Development
Dr. Lixia He	Post Doctoral Research Associate	Department of Economics	University of Calgary
Dr. Théodore Horbulyk	Associate Professor		University of Calgary
Francisca Hubeek	Lei Wur		LEI Wageningen UR
Sarah Kalff	Environmental Policy Analyst	Agri-Environmental Policy Bureau	Agriculture and Agri-Food Canada
Mark S. Kieser	Senior Scientist		Kieser & Associates
Luis Leigh	Director		Environment Canada
Bob MacGregor	Chief	Agricultural and Environmental Policy Analysis	Agriculture and Agri-Food Canada

Participants	Job Title	Branch	Department/Organization
Dr. Chandra Madramootoo	Dean	Faculty of Agricultural and Environmental Science	McGill University
Anjela Markova	Policy Research Officer		Policy Research Initiative, Government of Canada
Paul Martin	Director General	Marketing Policy	Agriculture and Agri-Food Canada
Don McCabe	Vice President		Soil Conservation Council of Canada
Greg McComb	Economist	Environmental Economics Branch	Environment Canada
Dr. Sarah Michaels	Associate Professor	School of Planning	University of Waterloo
Anne Morin	Analyst	Sustainable Development Project	Policy Research Initiative, Government of Canada
Jean Nolet	Président		ÉcoRessources Consultants
Dennis O'Grady	General Manager		South Nation Conservation
Joanne Papineau	Environmental Quality Guidelines Specialist	Sustainable Water Use Strategies	Environment Canada
Alain N. Rousseau	Centre Eau, Terre et Environnement	Institut national de la recherche scientifique	Université du Québec
Tracy Ryan	Supervision of Conservation Services		Grand River Conservation Authority
Claude Sauvé	Associé Senior		ÉcoRessources Consultants
Karl Schaefer	Senior Science Policy Advisor	Science Liaison Branch	Environment Canada
Claire Schary	EMS Coordination	Office for Environmental Management and Information	United States Environmental Protection Agency
Nicolas Stämpfli	Professional Associate	Centre Brace pour la gestion des ressources des hydriques	Université McGill
Adrian Steenkamer	Senior Policy Analyst	Municipal Wastewater Effluent	Environment Canada
France St-Onge	Analyste des politiques	Direction des politiques agroenvironnementales	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation
Barry Turner	Director	Government Relations	Ducks Unlimited Canada
Ted Van der Gulik	Senior Engineer	Resource Management-Abbotsford	British Columbia Ministry of Agriculture and Lands
Erik Veldman	Senior Project Manager Water Program		Pollution Probe
Rhéal Vienneau	Regional Director		Fisheries and Oceans Canada
Michel Villeneuve	Senior Policy Advisor	Sustainable Water Use Strategies	Environment Canada
Dr. Marian Weber	Economist		Alberta Research Council
Alfons Weersink	Professor	Agricultural Economics and Business	University of Guelph
Mary-Ann Wilson		Water Innovation and Information Development	Agriculture and Agri-Food Canada
Jamie Wuite	Head	Water Management	Alberta Agriculture, Food and Rural Development

NOTES