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Non-regulatory Means To Protect Water Quality: A Review

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1. Introduction

When most Canadians turn on the tap, they expect that the water that they drink will not make them sick. Abundant, clean freshwater has become synonymous with the Canadian landscape, further entrenching the idea that our water is safe to drink. However, ensuring the safety of water destined for household consumption is an extensive process, and one which requires a multi-barrier approach.

A multi-barrier approach indicates that there are multiple steps to providing safe drinking water, including water treatment plants, regularly maintained distribution systems, and systematic testing (de Loë and Simms 2009). However, protecting the quality of source water – "raw water from streams, lakes or aquifers that supplies drinking water systems" (de Loë & Simms 2009: 1) – is a crucial component of a multi-barrier approach. Combining source water protection with the traditional safeguards is an approach often referred to as "source to tap", and is an effective strategy for ensuring safe and reliable drinking water (Environment Canada 2008; de Loë & Simms 2009).

The traditional approach to source water protection would involve the creation and enforcement of regulations (May 2005). However, voluntary approaches have become increasingly common as a tool for water quality protection, and are the focus of this report. An identification and description of the non-regulatory tools that have been or are in use in Canada and internationally to protect lakes, rivers or aquifers from water quality degradation will be made, contributing to a greater awareness of the tools available for a multi-barrier approach to providing safe drinking water.

2. Understanding source water protection

In order to design effective source water protection strategies, it is important to understand water quality: what do we consider to be clean, safe, water? Furthermore, what are we protecting source water from? Naturally occurring substances are almost always present in rivers and lakes, including calcium and magnesium, which originate from surrounding soil and vegetation, wildlife, precipitation and other sources which may not be directly attributable to anthropogenic practices (Environment Canada 2008). The levels of total dissolved solids can be determined using analytical techniques, and are regulated according to the *Guidelines for Canadian Drinking Water Quality*, published by Health Canada (2008). While the levels of dissolved solids are an important determinant of water quality, the chemicals from industrial, agricultural and household practices are a greater threat to the health of Canadians, and are the focus of many source water protection efforts (Environment Canada 2008b). Environment Canada (2008) presents a number of facts concerning water quality contaminants: a drop of oil can render 25 litres of water unfit for drinking, one gram of a common household herbicide can contaminate a billion litres of potable water, and excess nitrates derived from agricultural fertilizers can render an aquatic environment unsuitable for fish.

There are a multiple pathways through which these contaminants can enter the drinking water system: point source and non-point source. Point source pollution refers to contaminants entering via a specific location (e.g. industrial discharge), whereas non-point source pollution enters the drinking system through a non-discrete path, such agricultural or urban surface runoff (Huang and Xia 2001). For instance, urbanization and the creation of impervious land surfaces have resulted in an increase in storm water runoff, which carries non-point source pollutants into the drinking water system and reduces water quality (Parikh et al. 2005). Agricultural practices,

in particular, have been identified as a threat to drinking water quality and to human health: in the United States, agriculture is "the leading contributor to the pollution of lakes and rivers" (Castelnuovo 1999: 315). Drinking water can become contaminated by a number of agricultural pollutants, including sediments, nutrients (such as nitrogen and phosphorus), pesticides, salts and microorganisms, including *E. coli* (Castelnuovo 1999; Kay et al. 2009). Many of these contaminants can affect human health: suspended sediments can reduce the effectiveness of water quality treatment (Summit Environmental Consultants Ltd. 2008), high nitrate levels are dangerous for infants under six months (Conservation Ontario 2009), and microorganisms can directly cause morbidity and mortality. In May 2000, drinking water in Walkerton, Ontario became contaminated with the *E. coli* bacterium from a nearby livestock farm, resulting in the death of seven people and severe illness in thousands of others. This event prompted a public outcry and awoke citizens and policy-makers to the importance of drinking water security (de Loë and Kreutzwiser 2005).

While many of the pollutants that enter the drinking water system are removed through municipal water treatment plants, addressing the source of pollution through source water protection is both safer and less expensive than treating raw water (Conservation Ontario 2009). There are a variety of source water protection activities that can be undertaken by municipalities, including the identification of potential threats to source water and the creation of zoning by-laws and local plans (de Loë and Simms 2009). However, there are also a number of strategies that can be undertaken by the landowner. In the case of farmers, these are called best management practices. For instance, Conservation Ontario (2009) recommends that farmers use highly efficient fertilizers, rotate crops, minimize tillage systems, plant cover crops, test soils for nutrient needs and prevent manure runoff from entering streams, as well a number of

other best management practices for nitrogen management. Caldwell (2001) identifies a range of approaches for source water protection that can be used to prevent water contamination from intensive livestock operations, such as limiting livestock densities and using covered concrete storage facilities for liquid manure. Furthermore, landowners can take steps to preserve or restore wetlands on their land.

While many of these practices are encouraged and are shown to improve water quality (Conservation Ontario 2009, Manitoba Water Stewardship 2009), ensuring that source water protection efforts are implemented can be a significant challenge. Traditionally, governments would address these challenges by creating and enforcing regulations (May 2005). However, voluntary approaches have become increasingly common in environmental protection (Alberini and Segerson 2002; Harrison 1999; May 2005; Potoski and Prakash 2002), and are preferred by some as an alternative approach to source water protection. Harrison (1999) explains that voluntary approaches to environmental protection are favoured for their promotion of public participation and democratic principles. Famers participating in voluntary environmental protection programs in Ontario have indicated that they are attracted to the program due to its voluntary nature, thereby allowing them to maintain control (Robinson 2006). May (2005) explains that the environmental sector, in particular, came under fierce criticism for excessive regulation, prompting an interest in alternative strategies. In some cases, it is believed that government may not have the expertise to develop and regulate environmental protection programs, and hence voluntary approaches are preferable as industry expertise can be incorporated (Harrison 1999). For these reasons and others, there has been a rise in popularity of non-regulatory approaches to environmental protection, including an interest in a variety of voluntary programs for source water protection.

The following section will identify the voluntary and non-regulatory tools that have been or are in use in Canada and internationally to protect lakes, rivers or aquifers from water quality degradation, providing a comprehensive overview of the range of voluntary strategies available. While many of the strategies that will be addressed here are broader in scope than the protection of drinking water, in all cases improved raw water quality and the subsequent increased safety of drinking water are gains that can be made. Hence, although broad objectives such as "environmental protection" or, more specifically, "water quality protection" may be identified, all of the strategies can be considered tools for source water protection.

3. Voluntary tools for source water protection

Governments can enforce compliance when regulations are created. The lack of a government's ability to mandate participation is the distinction between voluntary and non-voluntary approaches (May 2005), and will serve as the definition of voluntary approaches used in this report. Voluntary approaches typically consist of strategies to encourage adoption of practices to improve raw water quality, without the use of regulation. Non-regulatory tools for source water protection can take on a range of forms, including drinking water strategies, integrated watershed management planning, education programs, including raising awareness and providing technical assistance, incentive and disincentive programs, funding and support programs and market-based mechanisms. Each of these tools will be described in detail, and examples where they have been implemented will be provided to enhance understanding of the available strategies.

3.1 Drinking Water Strategies

In Canada, drinking water strategies are a common tool for guiding the provision of safe drinking water to citizens. These strategies highlight the importance of a multi-barrier approach to protecting drinking water quality, and outline plans or programs that address source water protection challenges. In many cases, these are non-regulatory in nature and serve to inform citizens of the government's actions to protect water quality, or to encourage participation.

This was an approach taken by Prince Edward Island in 2001, when it introduced *Clean from the ground to the glass: 10 Points to Purity*, published by the province's Department of Fisheries, Aquaculture and Environment. This drinking water strategy identifies ten steps that the provincial government planned to take, five of which address the protection of private supplies and five of which address the protection of municipal supplies. While many of the steps identified are regulatory in nature (e.g. "We will develop water monitoring and public reporting regulations for central water supply and wastewater treatment systems, updating guidelines established in 1999" (Prince Edward Island Department of Fisheries, Aquaculture and Environment 2001: 6)), typically the publication of a drinking water strategy is non-regulatory, and could be used by any government or organization aiming to outline commitments or provide information on actions to address source water protection.

3.2 Integrated Watershed Management Planning

Integrated watershed management planning is a tool that is broader in scope than source water protection, but is a strategy that can be used to make significant gains in the provision of safe drinking water. A watershed is defined as "the area of land that catches precipitation and drains it into a larger body of water such as a marsh, stream, river or lake" (Alberta

Environment 2005). Blomquist and Schlager (2005) explain that watershed boundaries are "natural", as opposed to "human-created boundaries", and consequently, watersheds usually span political and geographic boundaries. Traditionally, institutions, such as those managing land and water, have been separated into a variety of different organizations, often formed according to geographic location or program function, limiting each institution's ability to achieve its objectives (Imperial 2005). Alternatively, watershed-scale organizations would "bring together all the stakeholders and produce integrated watershed management" (Blomquist & Schalger 2005: 101), ensuring that interactive watershed components are governed collectively and necessitating cooperation between traditionally distinct organizations. This trend towards a more integrated approach to water management is closely related to two non-regulatory tools for source water protection, namely integrated drinking water strategies and watershed management plans.

3.2.1 Integrated Water Strategies

An integrated water strategy is similar to the drinking water strategy addressed above, but addresses a variety of different processes, such as land use planning, water allocation, and ecosystem protection, for instance. Source water protection is typically addressed within the broader goals related to water quantity and quality. Integrated water strategies usually encourage an integrated approach to water management, including watershed-based planning, and create partnerships at the provincial, regional or local level that will contribute to the achievement of the strategy's objectives.

An integrated water strategy was introduced in Alberta in 2003, entitled *Water for Life*. The plan was developed in response to concerns for the future of water in Alberta, as increasing

demand has been met with fluctuating and uncertain supply (Alberta Environment 2003). *Water for Life*'s three main objectives are ensuring safe drinking water, healthy aquatic ecosystems, and sufficient water supplies for the economy (Alberta Government 2008). Furthermore, the province emphasizes that water is best managed at the level of watersheds and the need to integrate the management of water supply, use, and quality (Alberta Environment 2005). To enable wide participation, partnerships have been developed at the provincial, regional, and local levels (Alberta Environment 2003, Alberta Government 2008, Alberta Water Council 2007), including Watershed Planning and Advisory Councils, which provide recommendations for appropriate actions to water and land use decision-making bodies, create forums for stakeholder discussion and information presentation, and investigate issues at the watershed level (Alberta Environment 2005). This strategy is non-regulatory in nature, and was renewed in 2008, placing emphasis on the importance of protecting water sources (Alberta Environment 2008).

3.2.2 Watershed Management Plans

The creation of a watershed management body, such as the Watershed Planning and Advisory Councils initiated by Alberta's *Water for Life* strategy, typically involves the development of a watershed management plan by local actors. This task is composed of an information gathering and assessment stage, in which the water quality, quantity and ecosystem health are assessed, followed by an identification of the land and water use practices undertaken in the watershed, as well as any other water-related concerns. With this information, objectives and recommendations, ideally with implementation and monitoring plans, are developed (Lightman and Simms 2009 *not yet published?). These non-regulatory management plans can

be used to guide water protection activities, and actors are encouraged to abide by the plan's recommendations. In the case of Alberta, each of the Watershed Planning and Advisory Councils are tasked with developing a Watershed Management Plan, such as the Bow Basin Watershed Management Plan on Water Quality, which was published in 2008. This document was developed by the Bow River Basin Council, a provincially-designated Watershed Planning and Advisory Council based in Calgary, consisting of board members from the provincial government, irrigation districts, local industries, municipal governments and environmental organizations, among others. The watershed management plan presents 61 recommendations for improving water quality in the Bow River Basin, some of which address pesticide use and wetland preservation (Bow River Basin Council 2008), both practices that can contribute to source water protection. All recommendations are voluntary, and although there is no mechanism to enforce compliance with the recommendations, the plan received tremendous support from the organizations represented on the council (Bow River Basin Council 2008).

Similar strategies have been adopted elsewhere, and can be both regulatory and non-regulatory. In comparison to Alberta's non-regulatory strategy, Washington State passed the Comprehensive Watershed Planning Act in 1998, proving a regulatory framework for developing plans on a watershed scale (Washington State Legislature 2009). Furthermore, watershed management plans can have more directed objectives; plans addressing specifically source water protection, typically called source water protection plans, can be created, using the same principle of integrated watershed management, but focusing solely on goals related to source water protection.

3.3 Education

Providing education is a commonly recognized voluntary tool for encouraging source water protection (e.g. Bosch et al. 1995, Castelnuovo 1999, May 2005). Employing educational strategies to address source water protection assumes that individuals or organizations that contribute to the degradation of water quality do so because they do not realize the existence or importance of the issue, or do not understand what can be done to manage it (Bosch 1995; May 2005). Educational approaches can address this challenge by raising awareness or providing technical assistance.

3.3.1 Raising awareness

Raising awareness about water quality issues is an important component of source water protection (Castelnuovo 1999). Publicizing threats to water quality and outlining steps that can be used to minimize harm from industrial, agricultural and household practices can be a useful tool in a multi-barrier approach to drinking water protection. In some instances, raising awareness is done through the educational system. In Saskatchewan, Project WET is an activity-based education program on water which supplements the traditional elementary and high school curricula, with lessons based on human health, water use, ground and surface water, among other topics (Saskatchewan Watershed Authority 2009). Similarly, the Regional Municipality of Waterloo and local school boards have developed a water based educational curriculum for students in Grades 2 and 8 (Regional Municipality of Waterloo 2009). The curriculum includes units on the water cycle and the local water supply, and is accompanied by a supplementary educational kit, containing products like shower bag test kits (Regional Municipality of Waterloo 2009).

However, raising awareness of water quality issues need not be limited to the educational system. Environmental farm plans are a voluntary tool that encourages farm families to understand their impact on the environment and develop a plan to mitigate their effects. Originally developed by Farm*A*Syst/Home*A*Syst, this applied approach is an action-oriented strategy in which traditional roles are redefined: the farmer is no longer the "passive recipient of information" (Castelnuovo 1999: 317), but becomes an active participant in creating and implementing an environmental protection plan for his or her farm. With this approach, farmers are provided with a detailed assessment worksheet, which they use to assess their operation for environmental threats. This is followed by an assessment the farm's strengths and weaknesses with regards to managing environmental threats and the development of an action plan, outlining steps to address the identified weaknesses (Castelnuovo 1999; Pollution Probe 2004). It has been shown that farmers participating in the Farm*A*Syst/Home*A*Syst are motivated to voluntarily make changes to their farm to prevent pollution: in a Nebraska-based Farm*A*Syst pilot program, participating livestock producers voluntarily contributed between US$2100 and US$8400 to addressing environmental concerns in their operations (Castelnuovo 1999). The system has been widely replicated: 39 states have implemented some variation on the program, as have some Canadian provinces (Robinson 2006). One such example is the Canada-Ontario Environmental Farm Plan Program, which encourages farmers to attend a workshop where they are provided with information and a workbook, after which participating farmers are encouraged to complete a risk assessment and submit an action plan (Ontario Ministry of Agriculture, Food, and Rural Affairs 2009). A number of other provinces have also implemented similar programs, which may include a cost-share component to help farmers finance their action plans. However, the environmental farm plan is considered to be

primarily an educational tool, as it raises awareness of the environmental impacts of agricultural practices and promotes voluntary adaptation of source water – and broader environmental – protection efforts on the part of farmers and farm families.

3.3.2. Technical Assistance

The provision of technical assistance to farmers to help address source water protection can be seen as both an educational and a capacity-building tool, as technical assistance allows farmers to develop the skills needed to change their practices and limit environmental harms (Castelnuovo 1999, May 2005). Technical assistance can be provided to farmers by governments: in Ontario, technical assistance is available to farmers implementing Environmental Farm Plans by the Ontario Ministry of Agriculture, Food and Rural Affairs, for instance (Ontario Ministry of Agriculture, Food and Rural Affairs 2009). However, technical assistance can also be provided by non-governmental organizations. The Alberta Riparian Habitat Management Society (more commonly referred to as "Cows and Fish") is an organization that aims to educate and provide assistance to landowners, particularly ranch owners, on strategies to manage riparian areas (Alberta Habitat Management Society 2009; Fitch and Adams 1998). The Lethbridge-based organization educates land owners on the importance of riparian areas and their ecosystem services and helps farmers, ranchers and other community members to evaluate, monitor, and improve the health of their riparian areas. A detailed booklet entitled *Caring for the Green Zone: Riparian Areas and Grazing Management* is available online, which outlines a variety of strategies for improving the health of riparian areas (Alberta Habitat Management Society 2009), including sections called "Tools and

Techniques for Outsmarting a Cow", "Holding Pastures", and "Corridor Fencing" (Fitch et al. 2003: 3).

3.4. Incentives

While designing voluntary watershed management plans or providing education can be useful strategies for source water protection, non-regulatory incentive based programs can provide additional motivation to adopt source water protection activities. Incentives can be non-financial, such as programs that provide recognition for efforts or achievements, or financial, such as support and cost-sharing programs.

3.4.1 Non-financial incentive programs

The provision of non-financial incentives, such as awards, titles, or recognition may encourage voluntary adoption of source water protection practices. The Blue Flag program is a highly respected voluntary "eco-label" (Blue Flag 2009; Environmental Defence 2009), which has been awarded in 41 countries to beaches and marinas that meet strict water quality and other criteria (Blue Flag 2009). Both a national jury and an international jury must review an application before awarding the Blue Flag designation, and awards last one year. Upon expiration, the application process must be repeated (Blue Flag 2009). The Blue Flag program counts the United Nations Environment Program, the World Tourism Organization and the World Conservation Union among its partners, and the program is credited with encouraging tourism to areas which have been awarded a Blue Flag (Blue Flag 2009; Font 2001). Currently, there are 4 beaches and 3 marinas in Canada that hold a Blue Flag, all of which are located in Ontario. While the Blue Flag program is limited in Canada (by comparison, 493 beaches and 78 marinas in Spain hold a Blue Flag (Blue Flag 2009)), a widely-known incentive program

recognizing areas that adhere to strict water quality guidelines may provide incentive for municipalities and community members to voluntarily adopt policies to improve water quality.

Non-financial incentive programs to increase water quality can also be developed to encourage voluntary adoption of source water protection practices by industry. The Business Environmental Pledge Program, based in Abbotsford, British Columbia, was created by the Abbotsford Chamber of Commerce to encourage businesses to be more environmentally responsible (Environment Canada Green Lane: Pacific and Yukon Region 2009). While the program has now closed, 45 businesses pledged to change their management practices in order to address environmental concerns, including concerns to water quality, and the implemented changes were documented by program volunteers (Environment Canada Green Lane: Pacific and Yukon Region 2009). Participating businesses were rewarded with local media exposure (Community Futures South Fraser 2009).

A third non-financial incentive approach has been implemented in Whitehorse. Geared at local groups, the City of Whitehorse's "Adopt-A-Stream" program can be considered as both an incentive and an educational tool. The program was developed for school groups, clubs, community associations, or any other organization or group that has an interest in protecting a stream environment. Once a group decides to be part of the program, a project agreement form is completed with a City of Whitehorse Habitat Coordinator, which will identify the expectations involved with the stream adoption (such as quarterly reports) and the commitment required, and an orientation will be held for the group at the stream location (City of Whitehorse 2009). The program benefits local community members, as improving the water quality of the stream improves the drinking water quality downstream, and is educational in that it encourages groups to gain knowledge about stream protection (City of Whitehorse 2009). Furthermore, the

concept of adopting a stream is an incentive for groups as it can be associated with a sense of ownership and pride.

3.4.2. Financial incentive programs

Financial incentive programs for water quality protection are widely adopted strategies to encourage recipients to take steps to protect source water. These incentives work by removing existing barriers to source water protection, specifically the required investment and risks associated with the cost (Castelnuovo 1999), or at least reduce the cost to a level that the relative benefits gained from implementing protection measures exceed the cost (Alberini and Segerson 2002). This support can be granted through a cost-sharing program, in which governments or organizations agree to finance a percentage of the cost of a particular project, or through a support program in which a sum determined by the size of the land that is being protected or restored. Both of these strategies are being employed in Canada and internationally.

3.4.2.1 Cost-sharing

As described above, cost-sharing programs allow farmers and other actors to take action to protect water quality by reducing or eliminating the financial barriers associated with the investment cost on a per-project basis. The Canada-Ontario Farm Stewardship Program is the voluntary cost-sharing component of the Canada-Ontario Environmental Farm Plan program, and encourages producers to improve their management of agricultural land by adopting best management practices to protect air and water quality, increase soil productivity, improve natural habitats, or conserve energy (Ontario Soil and Crop Improvement Association 2009). Producers can be compensated at a rate of 30 or 50% of the project's costs, up to the category's

cap (ibid). Similarly, the Grand River Conservation Authority offers a regional cost-share program for farmers, entitled the Rural Water Quality Program. The program provides successful applicants with funding covering between 30 and 100% of the costs of implementing approved best management practices for improving water quality, up to a maximum of CAN$25,000 (Grand River Conservation Authority 2009). The financial incentives of this program can be combined with the Canada-Ontario Farm Stewardship Program, thereby covering the incurred costs of voluntary steps to improve water quality at a rate of 80 to 100% (ibid).

A similar cost-sharing program exists in the United States, headed by the United States Department of Agriculture, called the Environmental Quality Incentives Program (EQIP). The EQIP provides financial or technical support to eligible agricultural or livestock producers to assist in the installation of equipment or implementation of management practices that aim to increase environmental quality (United States Department of Agriculture 2009). The EQIP will cover up to 75% of the costs or lost income incurred through the implementation of conservation practices, although this amount may be increased to 90% if the applicant belongs to a traditionally underserved producer (ibid). However, this funding cannot exceed a maximum of US$300,000 per individual or legal entity over a six year period, although this amount may be raised to US$450,000 in the case of a project with noteworthy environmental importance (ibid).

3.4.2.2 Support Programs

Similar to cost-share programs, some governments have implemented financial support programs that are incentive-based, although funding is not provided on a percentage-basis per

project. Alternatively, these programs provide financial incentives based on the relative size of the land on which changes are being implemented. Manitoba's Wetland Restoration Incentive Program, a partnership between Manitoba Water Stewardship, Ducks Unlimited Canada and the Manitoba Habitat Heritage Corporation, provides land owners with funding to restore drained wetlands (Manitoba Water Stewardship 2009). Landowners voluntarily enter into a legally binding Conservation Agreement, requiring the long-term protection of the wetland habitat, although provisions are made to ensure that agricultural activities can continue on productive agricultural land (ibid). In return for the wetland restoration, land owners receive a one-time Conservation Agreement payment, based on the assessed value of the land, as well as an additional Wetland Restoration Incentive Program payment of CAN$ 200/acre (Manitoba Water Stewardship 2009b). At least 40 acres of habitat must be restored or protected under the Conservation Agreement, and project partners complete the wetland restoration, at no expense to the landowner (ibid).

Similarly, England's voluntary Stewardship Program is an agri-environmental program launched in 2005 by England's Department for Food, Environment and Rural Affairs. The program provides funding to farmers for using best management practices, and consists of three levels at which farmers can participate (Natural England 2009). Entry Level Stewardship (ELS) consists of compensation for basic environmental stewardship actions. Farmers can choose from more than 50 stewardship options, such as ditch management and the installation of buffer strips. A number of options are designed to minimize surface runoff and reduce pollutants entering the water system (Natural England 2009b). Each stewardship option on a hectare is worth a certain number of points, and typically participants receive £30 per hectare in order to meet a minimum average point threshold per hectare (ibid). The second and third levels are

similarly structured, although the second level is designed for organic farming at the entry level (OELS), requiring a higher minimum point threshold, but providing £60 per hectare. The third level, Higher Level Stewardship (HLS) is geared at priority areas and additionally complex stewardship activities, and requires ten year agreements (ibid).

While support and cost-share programs are widely implemented programs for encouraging water quality protection, the opposite approach – encouraging voluntary efforts through the implementation of programs which increase costs for industries or agricultural producers that do not take steps to address environmental harms – are called disincentive programs.

3.5 Disincentives

As explained above, the disincentive method of encouraging voluntary action involves the implementation of programs which increase costs to industries or agricultural producers that do not take steps to address environmental harms. For instance, farmers' access to government subsidies may be made conditional upon famers' meeting specified environmental criteria (Gunningham and Sinclair 2005). This approach is used in the European Union, where commodity support payments are subject to compliance with environmental protection obligations (Gunningham and Sinclair 2005; Europa 2009). Centner et al. (2007) also suggest the disincentive method to encourage small-scale livestock producers to adopt pollution prevent measures. As small scale livestock producers are exempt from federal water quality regulations, the authors suggest that states disqualify small-scale farmers who do not use acceptable manure application processes from the protection against nuisance laws provided by "right-to-farm" laws (Centner et al. 2007).

Segerson and Miceli (1998) examine an alternative disincentive model for increasing water quality, based on the threat of imposing regulation. The authors note that while "carrot" strategies have historically been used to encourage farmers to adopt voluntary environmental protection strategies, a "stick" approach involving the threat of mandatory requirements can be an effective tool for encouraging adoption of voluntary agreement to protect water quality (Alberini and Segerson 2002; Segerson and Miceli 1998). Although this strategy is non-regulatory in nature (if it is successful in enticing the adoption of voluntary agreements), this approach cannot be considered strictly voluntary, as parties are forced to choose between the creation of a tax or the adoption of a voluntary plan (Goodin 1986).

3.6 Market-based mechanisms

The use of the market as a mechanism for addressing environmental issues is receiving increased attention by policy-makers (Woodward and Kaiser 2002). In the United States, the *Clean Air Act* of 1990 established a market for sulfur dioxide (SO_2), and increasing attention is being paid to the possibility of water quality trading (Schary and Fisher-Vanden 2004, Woodward and Kaiser 2002). While the structure of water quality trading can vary, the mechanism is based on the assumption that in a given watershed, the cost of achieving comparable gains in water quality will vary among the pollution sources (United States Environmental Protection Agency 2009). There are three program types, as outlined by the United States Environmental Protection Agency (2008): cap-and-trade, in which a total cap is placed on the combined pollution released by participating facilities; case-by-case, in which trades are examined on an individual basis, often used for one-time trades; and an open market, in which a framework exists to facilitate trades with no total cap or initial pollution allocations.

The Long Island Sound Trading Program in New York and Connecticut has been the most active of the programs established in the United States (Environmental Protection Agency 2008). The cap-and-trade program was designed to reduce nitrogen levels in Long Island Sound, as called for by the Comprehensive Conservation and Management Plan (CCMP). A Total Maximum Daily Load (TMDL) was approved in 2001, which includes allocations from point and non-point sources. The State of Connecticut also established its own trading program for point sources in order to lower the cost of meeting the limits set by the CCMP and the TMDL. The trading program is written into Connecticut State Law, and the 79 wastewater treatment plants on the Long Island Sound operate under a single permit for a total nitrogen load (Environmental Protection Agency 2008). If sources discharge at a level lower than their annual limit, the State is forced to buy back the nitrogen credits, and if the limits are exceeded, additional nitrogen credits must be purchased from the State (ibid).

The Long Island Sound Trading Program has produced results: between 2001 and 2006, the total nitrogen load from the 79 facilities was reduced by 15,500 pounds per day, which accounts for approximately half of what is needed to reach the goals set by the TMDL (Johnson et al. 2007). Furthermore, surveys completed in 2002 and 2006 demonstrate that the area of the Long Island Sound suffering from severe hypoxia – a lack of dissolved oxygen that is a consequence of nitrogen loads – has been reduced (ibid).

Trading programs are not limited to use in the United States. The MINAS program – a tradable permit program for the application of nitrogen and phosphorus fertilizers and manure – is a market-based tool being used to address non-point source pollution in the Netherlands (MacDonald et al. 2004). Approximately 50% of Dutch livestock producers are subject to the program (due to the density of stock), as well as arable farmers. Farmers must submit a report

indicating nitrogen and phosphorus levels that remain in the soil (deemed "surplus"), and the allowable surplus is lowered over time. Surplus manure can be traded with farms that have not reached their allowable limit, which often occurs from livestock farms to arable farms (MacDonald 2004).

Market-based mechanisms can also be applied to address water quality issues beyond nutrient loading. Parikh et al. (2005) suggest a cap-and-trade program for storm water runoff, whereby a cap is set – based on ecological criteria for allowable runoff – and divided amongst individual sources. The allowable runoff per source would be based on a differential between the runoff that would have occurred pre-development, based on the land's state and properties (soil type, for instance), and the runoff caused by development. The allowances could then be traded, encouraging sources which can reduce runoff at a lower cost to do so, while selling their allowances to those for which reducing runoff is more costly (Parikh et al. 2005).

It is important to note that while market-based mechanisms involve voluntary trading on the part of farmers, industries, or other participants, a trading framework can be stipulated in law, such as the water quality trading program on the Long Island Sound in Connecticut. In fact, in a study conducting by the United States Environmental Protection Agency in which interviews were conducted with individuals involved with American water quality trading initiatives, the vast majority of interviewees indicated that they perceived water quality trading to be a "Tool in the Regulatory Toolbox" (Environmental Protection Agency 2008: 3-2). A much smaller number of respondents indicated that they believed that water quality trading was a form of voluntary stewardship (ibid), indicating the importance of having a regulatory framework for water quality trading initiatives. However, the choice to participate in trading is voluntary, and water quality trading appeals to policy-makers and stakeholders as a "voluntary,

businesslike approach" (Schary and Fisher-Vanden 2001: 281) and as an innovative mechanism for achieving water quality objectives (Environmental Protection Agency 2009).

4. Conclusion

This report has presented a wide range of voluntary and non-regulatory tools for water quality protection. In some cases, data demonstrating the effectiveness of the program in addressing water quality goals is presented. While there have been studies indicating that voluntary approaches alone may not be sufficient to adequately address pollution problems (May 2005; Segerson and Wu 2006), regulation and mandatory controls have drawbacks (Segerson and Wu 2006), and may not produce the second-order educational effects of some voluntary strategies (Bosch et al. 1995). Furthermore, while many of the programs provide information or incentives to entice participants, barriers to participation still exist. In a recent study examining variables that explain farmers' adoption or lack of adoption of soil conservation practices, researchers found that few universal variables exist, highlighting the importance of designing strategies tailored to the intended audience and setting in order to encourage the adoption of best management practices (Knowler and Bradshaw 2007).

Regardless of the challenges, voluntary approaches are becoming increasingly popular as a tool for environmental protection (Alberini and Segerson 2002; Harrison 1999; May 2005; Potoski and Prakash 2002), and are often preferred to regulatory approaches. It is likely that the solution to addressing water quality challenges and ensuring source water protection lies in a combination of strategies: May (2005) argues that when protecting water quality, voluntary approaches and regulatory tools should be considered "as ends of a continuum rather than sole choices" (31), arguing that both traditional approaches and voluntary strategies can be effective.

Furthermore, approaches need not be based solely on the voluntary tools addressed here; successful approaches to achieving water quality goals may be based on innovative tools beyond drinking water strategies, integrated watershed management planning, education, incentive programs or market-based mechanisms. Protecting drinking water will continue be a priority for governments and private users, and the first step of the multi-barrier approach – ensuring healthy streams, rivers, lakes and aquifers – is a crucial component of ensuring safe and reliable drinking water.

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