Policy Research Initiative | Projet de recherche sur les politiques

SUSTAINABLE DEVELOPMENT
BRIEFING NOTE

# Water Quality Trading II: Using Trading Ratios to Deal With Uncertainties

## Highlights

- Trading ratios are effectively exchange rates that establish equivalency between different pollution reduction measures.
- Trading ratios can be used in market-based pollution management tools, such as water quality trading (WQT), to ensure that the actions taken by the respective trading partners are environmentally equivalent.
- Scientific uncertainties regarding pollutant behaviour and the heterogeneity of a watershed can be factored into a WQT program through the use of trading ratios.

www.policyresearch.gc.ca

## Background

The design of a Water Quality Trading (WQT) program requires a sufficient understanding of the pollutant in question and the watershed it affects – in particular pollutant sources, pollutant behaviour (fate and transport), and how these pollutants can be abated and by how much.[1] Although such scientific knowledge is important, there will always be some uncertainty when implementing pollution management schemes in the natural environment.

With respect to market-based instruments, trading ratios can be used to address different elements of scientific uncertainty and regional aspects of trading associated with pollution markets. The appropriate trading ratio can ensure that environmental objectives are achieved with an acceptable level of confidence.

This briefing note defines trading ratios and discusses a variety of potential applications in which their judicious use can help make market-based approaches to pollution reduction workable.


***Balancing different types of pollution reduction, such as wastewater treatment and farming best management practices, may require the use of trading ratios, particularly when there is scientific uncertainty about their environmental equivalence.***

1 A more complete review of the scientific considerations for WQT is provided in the PRI Working Paper, “Biogeochemical Considerations of Water Quality Trading in Canada,” and the Briefing Note “Water Quality Trading I: Scientific Considerations for Agricultural Pollutants,” available by following the publication link at <www.policyresearch.gc.ca>.

Canada

## Water Quality Trading

WQT is a market-based instrument that involves the trading of pollution allowances or reduction credits between different polluters within a geographically defined region (typically a watershed) and can be used to manage pollution from different sources, including point sources (PS) and non-point sources (NPS) like agriculture.[2] The water quality credit is the tradable commodity that represents the amount of pollution removed from the system (e.g., 1 kg of phosphorous). In a typical scenario, a polluter (e.g., agricultural producer) can supply water quality credits by reducing the amount of pollution that enters the waterway through the implementation of a best management practice (BMP). The water quality credits can be sold to another polluter (e.g., municipal wastewater treatment facility) for which the purchase of credits may be a cost-effective means of complying with the pollution standards defined in its permit agreement, when compared to alternative options (e.g., costly system upgrades). The overall effect of such trading compared to technology-based regulation is to allow the polluter whose costs for pollution reduction are lowest to make the greatest contribution, thus achieving environmental objectives at a lower economic cost. It should also allow more flexibility for polluters to determine the pollution abatement option that better suits their circumstances.

For a WQT program, the trading ratio refers to the number of water quality credits that need to be purchased (i.e., the anticipated pollution reduction) for each water quality credit that is used (i.e., the amount of pollutant discharged). Thus it is effectively an exchange rate between credit producers and credit users.

## Environmental Equivalence of Trades

Using the scenario described above, a PS discharger is, in theory, allowed to contribute an amount of pollutant to the watercourse that is equivalent to the number of pollution reduction credits purchased from an NPS. In reality however, there are a number of factors – known and unknown – that disrupt this equivalence whereby the environmental impacts of the pollution discharge at the PS exceed the environmental benefits of the anticipated NPS pollution reduction in the natural environment. Such discrepancies, which can compromise the environmental objectives of a given WQT program, can result from scientific uncertainties in the effectiveness of BMPs, the location of trading partners within the watershed, and the timing and concentration of discharges. A higher trading ratio can be used to address these issues by requiring the anticipated pollution reduction to be greater than the known PS pollution contribution for a given trade. This ensures, at minimum, the environmental equivalence of trades or even a net environmental improvement depending on the ratio and the objectives of the WQT program.

## The Use of Trading Ratios in WQT

### *Scientific Uncertainties*

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 BMP 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 us to define a probable range of pollution reduction as opposed to a specific value. An appropriate trading ratio accounts for the range in values. Similarly,

2 Point source emissions are direct releases of pollution where effluent is discharged from a specific outlet into the water. Non-point source emissions are indirect or diffuse releases of pollution into a waterway that typically results from land-based activities within the watershed, or atmospheric emissions abroad.

## Establishing a Trading Ratio – Phosphorous Trading in the South Nation River

In 1998, Ontario's Ministry of Environment (MOE) implemented a total phosphorous (P) management program in the South Nation River watershed that required new municipal wastewater treatment plants to achieve a zero discharge of P to the watercourse, which could be obtained through the purchase of pollution reduction credits (O'Grady and Wilson, 2002). For the program, the province's first P trading scheme, the MOE chose a trading ratio of 4:1. Thus, an estimated 4 kg of P must be removed from NPS sources through the implementation of a verified BMP for every 1 kg of P that a wastewater treatment plant contributes to the waterway. This trading ratio was chosen to address scientific uncertainties, specifically a lack of knowledge regarding the amount of P delivered to the river and its tributaries, and the partitioning of P in the water (soluble vs. particulate). Based on a comparison of actual conditions at the time of implementation and predicted conditions following TPM implementation, the 4:1 ratio will achieve a net environmental benefit in the South Nation River with "adequate confidence" (The Conservation Authorities of Ontario, 2003).

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 (See Text Box – *Establishing a Trading Ratio – Phosphorous Trading in the South Nation River*).

It should be noted that the higher the trading ratio, the greater the expense for the purchaser of the water quality credits. Although economic issues are not discussed here, the trading ratio could compromise the suitability of WQT as a pollution management tool if the ratio is so high that a cost incentive no longer exists. This very significant factor underscores the importance of science, as reducing scientific uncertainties allows for lower 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 water quality credit trades by accounting for the influence of the given landowners' 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 Fischer-Vanden, 2004). Another possibility is to include trading zones, restricting the direction of trades into predefined zones of a river system or its tributaries (Tietenberg, 2001).

### *Establishing Equivalency Between Pollutants*

In relation to inter-pollutant trading (WQT that involves 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 (BOD)[3] – 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 BOD is the tradable commodity as opposed to the pollutants that affect BOD. The conversion ratios were set at 1:8 for phosphorous (i.e., 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.

Although incorporating two or more pollutant types in a WQT program can have potential for improving ecosystem health, a fundamental understanding of pollutant behaviour in the system of interest is essential to ensure that water quality objectives are being met. Furthermore, such trading would likely require a higher level of sophistication in both design and administration.

## Conclusion

The trading ratio is one of the elements of a WQT program that contributes to its flexibility as a pollution management tool, because it can be used to accommodate a number of different trading scenarios. As discussed, trading ratios can provide a means for dealing with the unavoidable variability that exists when managing pollution in the natural environment. An important consideration, and possible limitation to the use of this tool, is the increased cost associated with increasing the trading ratio. A WQT program will generally only be a suitable option if there is a cost incentive for trading, being a significant difference in the pollution abatement costs for potential trading partners.

## Further Reading

Conservation Authorities of Ontario. 2003. *Watershed Economic Incentives Through Phosphorous Trading and Water Quality*, Innovations in Watershed Stewardship.

Fang, F., and K.W. Easter. 2003. *Pollution Trading to Offset New Pollutant Loadings – A Case Study in the Minnesota River Basin.* Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003.

Morin, Anne. 2005. *Biogeochemical Considerations for Water Quality Trading in Canada.* Policy Research Initiative Working Paper, Ottawa.

O'Grady, D., and M.A. Wilson. 2002. *Phosphorous Trading in the South Nation River Watershed, Ontario, Canada.* South Nation Conservation Authority. <http://www.envtn.org/wqt/programs/ontario.PDF>.

Schary, C., and K. Fischer-Vanden. 2004. "A New Approach to Water Quality Trading: Applying Lessons from the Acid Rain Program in the Lower Boise River Watershed." *Environmental Practice* 6, no. 4: 281-295.

Tietenberg, T. 2001. "Introduction." Pp. xi-xxviii in *Emissions Trading Programs. Volume I. Implementation and Evolution.* Aldershot, England: Ashgate Publishing Limited.

3 The amount of oxygen freely available in water for aquatic life and the oxidation of organic materials.