Phosphorus Trading in the South Nation River Watershed, Ontario, Canada

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CONDENSED ABSTRACT

The South Nation River watershed has a regulated water quality trading program. By law, waste water dischargers must control their phosphorus (P) loadings into the receiving waters of the watershed, and all new wastewater systems are now choosing trading instead of traditional P removal technology.

Wastewater dischargers are buying P credits from rural landowners, primarily farmers. South Nation Conservation, a community based watershed organization, is the broker for P credits. The program is run by a multi-stakeholder committee, and all project field visits are done by farmers and not paid professionals.

INTRODUCTION

The South Nation River watershed is located southeast of Ottawa, Ontario Canada. The watershed is 3900 sq. km. in size, has a population of about 125,000, and is mixed farming with dairy and cash crop corn and soybeans predominant.

The South Nation River has peak flows of over 1,000 cu m/s in the spring freshet, and less than 20 cu m/s during summer low flows. There are currently 16 wastewater lagoons in the watershed (14 municipal, 2 industrial dairy). Provincial guidelines allow the lagoons to discharge their effluent at peak flows, primarily in the spring, for dilution of effluent to meet Provincial water quality guidelines.

The South Nation watershed exceeds Provincial water quality guidelines for P, which currently are 0.03 mg/L. Annual mean P concentrations for the main South Nation River are 0.07 mg/L in the upper reach, 0.126 mg/L in the middle, and 0.129 in the lower reach of the River. Watershed studies show that 90% of the P load comes from non-point sources (NPS).

The Provincial Ministry of Environment (MOE) is responsible for water quality and licensing the operation of wastewater treatment in the Province. According to Provincial policy, where water quality does not meet Provincial standards for a specific contaminant, no further degradation of water quality will be allowed for that contaminant. However, in the past MOE gave dischargers a permit to discharge P from their plants into the South Nation River and its tributaries, even though the watercourses did not meet Provincial water quality objectives. Beginning in 1998, the Ministry stopped issuing these permits and required all dischargers to have zero discharge of P from their plants. MOE imposed this standard on new construction only. Existing plants that continued to operate according to

their current permits required no changes to P loadings.

In the past, the only option for municipalities to meet this standard was improved wastewater treatment. However, it is not always technically feasible, physically possible, or socially desirable (because of costs) to meet the 0 kg standard.

MOE therefore created a new solution to remove P contributed by wastewater dischargers. Called Total Phosphorus Management (TPM), it allows dischargers to contribute P from their treatment plants, in contravention of Provincial policy, so long as they offset this increased P load by controlling P from non-point sources (NPS). MOE treats the watershed as a unit. Therefore, a treatment plant discharging P in the lower reaches of the watershed can pay for measures to reduce P in the upper reaches, or any other part, of the watershed.

Since NPS projects to reduce P are paid for by the discharger that contributes P, the TPM program is a true credit trading program, with dischargers required to buy P credits from rural landowners.

The amount of P credits that need to be bought depends on two factors. The first is the amount of P that the discharger contributes. For example, a village that expands their wastewater plant for an additional 3,500 people will add about 600 kg of P into the River. A recent landfill expansion added 25 kg of P.

The second is the ratio of P required by MOE to be removed. In theory, a discharger only needs to reduce P from non-point sources equivalent to the amount they contribute (i.e. a 1:1 ratio) from the wastewater plant in order to meet Provincial policy. However, MOE requires a 4:1ratio. That is, 4 kg of P must be removed from non-point sources for every 1 kg of P that the discharger contributes to the watercourse. This higher ratio is set because of the unique nature of the TPM program (it is the first of its kind in Ontario), lack of knowledge on how much P is first transported, then delivered, to watercourses, and the debate on how much of the P in the water is soluble vs. particulate.

The amount of P contributed by various non-point sources is determined by using formulae derived from studies in Ontario, Canada and elsewhere (The majority of these formulae and the attached references were produced by the Grand River Conservation Authority, Cambridge, Ontario.) The literature reveals that the range in results for individual practices is quite large, and the results are highly variable because calculating P lost or saved by agricultural management practices is a very complicated process.

Manure Management

The amount of P transported from a manure storage or barnyard depends on the size of the area contributing to the runoff as well as the number of animals contributing manure to the area. The number of days that the animals are on the yard or in the barn producing manure also needs to be factored into the calculation.

The formula uses the USDA (1992) calculation of the phosphorus excreted per animal and assumes that approximately 4.0% of the total excreted will be carried off site in runoff. The remaining 96% of the P excreted is assumed to remain in the manure. Proper application and utilization of the manure as a crop nutrient will ensure that this portion of the phosphorus is not available to runoff. Since all storage facilities constructed through the TPM program are assumed to prevent discharging to a watercourse, no delivery factor is applied.

Kg of P per year controlled by Manure Storage = # of animals x animal phosphorus factor x days x 0.04

Clean Water Diversion

Clean water diversions control manure runoff from barnyards, feedlots, and manure storage areas. It diverts clean water away from these areas using berms, eavestroughing or roofs. The number and type of livestock, size of yard and yard surface as well as the proximity to a watercourse will determine the amount of P delivered to a watercourse. The following calculation assumes that clean water diversion will control 2.0% of the P excreted from the animal. The number of days refers to the number of days that manure or animals are on the yard. The assumption is that this calculation will be applied to sites that are discharging to a watercourse and therefore a delivery factor is not applied.

Kg of P controlled per year by Clean Water Diversion = # of animals x animal phosphorus factor x days x 0.02

Milkhouse Washwater

The values in the literature range from a low of 17 kg to a high of 38 kg per year of phosphorus diverted from local watercourses by proper storage and handling facilities. The number of cows, volume of washwater, type of milking system, detergents and management in the milking parlor and milkhouse can affect the concentration of P in the waste water. The number of cows milked is used to determine the phosphorus contribution per milkhouse.

Based on values in the literature, the amount of P per cow per year ranges from 0.68 kg to 1.4 kg. The average of these values is 1.26 kg of P per cow per year. Using this value the following calculation will be used to determine the P contributions saved by implementing milkhouse projects.

P controlled per year by Milkhouse Washwater Projects = # of cows x 1.26 kg/year

Livestock Access

Information on the input of P from livestock access to watercourses is difficult to locate. There is a great deal of information about the effectiveness of buffer strips and riparian vegetation, but very little about direct livestock contributions. Using the US Soil Conservation Service assumptions, 2.0% of the P excreted is contributed to the watercourse. Until other values are found in the literature, this

assumption will be applied to other types of livestock. This calculation is limited to the amount of P excreted directly into the watercourse and not the amount of P that runs off from the pasture. This is influenced by the number of days that the animals have access have access to the watercourse. The calculation for P reduced by improving the riparian zone should be done separately using the buffer strip calculation.

Kg of P controlled per year by Livestock Access Restriction = # of animals x animal phosphorus factor x days x 0.02

Cropping Practices

There is some debate in the literature as to whether conservation tillage increases or decreases P delivery from cropped fields. Overall it appears that conservation tillage reduces total P although the soluble P delivery may increase. Practitioners generally agree that conservation tillage reduces soil loss and total phosphorus. Using the average P loss reduction for each practice presented by Draper (1997), conservation tillage reduces P loading by an average of 75% or 0.75 kg per hectare. Cover cropping reduces P loading by 0.4 kg per hectare annually.

P controlled per year by Conservation tillage = 0.75 kg x hectares

P controlled per year by Cover cropping = 0.4 kg x hectares

Buffer Strips

Buffer strips that are a minimum of 3 m wide appear to reduce P loadings by approximately 70%. Draper (1995) estimate that one ha of cropland contributes approximately 1 kg of P per year, therefore a 3 m buffer strip would control approximately 0.7 kg of P from every ha included in a buffer.

P controlled per year by Buffer Strip = 0.7 kg x hectares buffered

Nutrient Management Planning

The lowest P reduction reported in literature of nutrient management planning is 25 kg per hectare. Delivery of P to a watercourse depends on the slope, soil type, tillage method, vegetation cover and proximity to the watercourse. Not all areas contribute P to a watercourse. Because of their proximity to channels and streams as well as specific land characteristics, hydrologically active areas contribute most of the P even though they make up a small portion of the watershed. Studies by Wall (1978) confirm that approximately 10% to 20% of an agricultural watershed contributes the majority of the loadings to the stream channels. To provide a realistic estimate of P controlled by nutrient management planning only hydrologically active areas should be included in the calculation. To simplify the calculation, 10% of the hectares under a nutrient management plan will be assumed to be hydrologically active and therefore contributing phosphorus.

P controlled per year by implementing a nutrient management plan = 25 kg x hectares x 0.1

All of these formulae were calculated several years ago. Since then, there has been a great deal of work on calculating loadings. Since TPM is a regulatory program, it is necessary to have the most up-to-date formulae. A contract was recently signed with the University of Ottawa to update these formulae, and a peer group of US and Canadian experts were asked to review the material and provide direction to the University.

The actual cost of controlling each kg of P was determined by South Nation Conservation (SNC). SNC is a community based watershed organization set up to manage the natural resources of the South Nation River watershed. Over the last several years, and prior to the TPM program, SNC paid over $1 million in grants to rural landowners for hundreds of NPS control projects. Using the formulae above, it was possible to calculate the amount of P controlled for each of the projects. Since the total cost of each project was known, it was possible to derive an average cost of $300 (Cdn) for each kg of P removed. Obviously, some projects are more efficient at controlling P than others, however the $300 figure is accepted as accurate. Each year the figure is reviewed to determine if it should be adjusted due to rising costs.

The $300 also includes costs of project management (staffing, administration), water sampling, communications to promote the grants available to landowners, and yearly reporting. SNC must complete a yearly report showing the amount of P controlled that year, and allocating that P to one of the TPM dischargers.

Cost benefit studies done in the South Nation watershed show that the cost for complete removal of P using traditional wastewater treatment methods is around $2,000 (Cdn) per kg of P removed. Thus, using the 4:1 ratio, the cost to remove P using TPM is about $1,200 per kg. While dischargers have the option of using either TPM or enhanced wastewater treatment, all dischargers have chosen TPM since its inception.

The advantages of using the TPM approach are evident:

1. It saves local tax dollars since new wastewater treatment plants are not required to control P.

2. It saves government dollars, since wastewater treatment costs are lower, and fewer government grants are needed.

3. It puts money in the hands of farmers.

4. It achieves greater water quality benefits since NPS controls will prevent not only P from entering the water, but other nutrients and pathogens as well.

To enter into a TPM program, a discharger must agree to the 4:1 ratio, and must show to MOE their plans for reducing P. Each discharger has the option of starting their own NPS reduction program.

However, SNC is used by all because of its long established clean water grant program. MOE issues a legal certificate of approval that allows the wastewater facility to operate under a TPM program. Most TPM agreements have a four year deadline to reduce the full amount of P.

SNC, as the broker, is responsible for finding projects to fund with the dischargers money. Requests for projects are made through the local media and presentations to municipalities and farm organizations. All projects are voluntary, with no landowner forced to participate in the TPM program.

Neither SNC, nor the landowners as the recipient of the funds, have any legal responsibility should P targets not be met. This responsibility rests solely with the discharger who must prove to MOE that they are meeting their P reduction targets. With SNC's experience in grants for similar projects in the past, there is no forecasted shortage of P reduction projects for several more years.

The issue of responsibility for P reduction was a key issue to the success of the TPM program. Initially, the agricultural community opposed TPM. They had concerns with several components of the strategy including: offset ratio for P reduction; funding level per kilogram P; responsibility of landowners who accept funding to complete non-point projects; and the responsibility of the municipality/industry if the P offset was not achieved through non-point source reduction projects. The agricultural community felt the dischargers were being given a license to pollute, and that the perception would be that farmers were the cause of the problem if they were doing all the work and getting all the grants.

Extensive consultation with the agricultural community over three years achieved consensus on the roles and responsibilities for the various partners involved in the TPM program. This consensus became a Statement of Roles and Responsibilities document that was signed by the local agricultural organizations, Provincial government, and SNC. Consultation also resulted in a higher ratio for P reduction (4:1 instead of the initial 2:1), higher costs per kg P removed, and an evaluation and monitoring strategy to ensure the P load reduction is achieved.

The consultation process also created a multi-stakeholder committee that approves all projects. The committee is composed of farmers, industry, municipalities, farm organizations, and SNC. It reviews projects, and whether or not they meet the criteria for funding. All criteria, grant rates, and other water quality decisions are made by the committee. The committee receives funding from several different sources, all with slightly different funding criteria. It then decides if the landowner project meets the criteria for one of the grant programs.

A final result of the agricultural consultation was the use of farmers as field representatives to do all site visits. The agricultural community expressed some concern over using agency staff who might not understand current farming practices. Now, when a landowner wants to apply for a grant, they contact SNC, who then refers the call to one of several field representatives who then do the field inspection. The field representative then reviews the project and potential grants with the landowner, and determines if it is indeed eligible for grants. The field representative then makes a presentation to the multi-stakeholder committee, who rank projects based on improvements to water quality. This approach is unique amongst the water quality programs in Ontario. All other water quality programs

use full-time professional staff to do field inspections.

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