APPENDIX A

MINISTRY OF ENVIRONMENT

– EASTERN REGION POSITION

TOTAL PHOSPHORUS MANAGEMENT

IN THE

SOUTH NATION RIVER WATERSHED

MINISTRY OF ENVIRONMENT – EASTERN REGION POSITION
TOTAL PHOSPHORUS MANAGEMENT
IN THE SOUTH NATION RIVER WATERSHED
(Internal Document)

- The Eastern Region of the Ontario Ministry of Environment has identified the South Nation River Watershed as an area of concern because of degraded water quality due to excessive phosphorus levels.

- As a result, the Region has taken the position that no further increase in phosphorus loadings will be accepted from the establishment or expansion of industrial or municipal sewage system discharges.

- All applications to expand or establish a sewage system discharge to the South Nation River or its tributaries must include:

  i) a plan to maintain a zero increase in phosphorus loading through treatment and removal of phosphorus at the source or;

  ii) a plan to offset the increased phosphorus load by a factor of four to one or greater through phosphorus controls at a location(s) other than the source.

RATIONAL

The South Nation River with a drainage area of 3,900 square kilometers is one of the most extensive watersheds in Eastern Ontario. Since there is only an 85 meter drop within its 175 kilometer course the natural drainage within the basin is very poor.

The land use in this watershed is dominated by agriculture, with 60% of the land devoted to this activity; primarily field crops (corn and hay) in support of dairy livestock operations. Urban and industrial development account for 5% of the land use.

Many of the villages within the watershed are experiencing growth in both residential and commercial developments as a result of their proximity to Ottawa and the construction of and upgrading of highways (e.g. Highway 417).

The surface water quality of the South Nation River Basin is poor due to sedimentation and excessive loadings of nutrients such as phosphorus and nitrate. The sedimentation problem is caused by floods, landslides and stream bank erosion. Nutrient and bacteria levels are far in excess of Provincial Water Quality Objectives. About 90 to 95% of the nutrient load comes from erosion and the leaching action of surface water runoff from urbanized lands, fertilized fields and livestock operations. About 5 to 10% comes from municipal and industrial sewage system discharges.

The MOE interim Provincial Water Quality Objective (PWQO) states that excessive plant growth in rivers should be eliminated at a total phosphorus concentration below 0.030 mg/L. Annual mean phosphorus concentrations for the South Nation River ranges from 0.07mg/L at Chesterville, increasing to 0.126mg/L at Casselman and further increased to 0.129mg/L at Hwy 17. That is, total phosphorus levels that are 2 to 4 times above the PWQO.

Within the South Nation Watershed, the MOE Eastern Region is willing to support the expansion or establishment of sewage works and the associated increase in TP loading if, as part of the approval, the proponent agrees to implement a program that achieves a net improvement in water quality. This type of program, called "Total Phosphorus Management" (TPM) must meet the following conditions.

(1) The sewage works must employ a high level of technology for phosphorus treatment. For the South Nation River, we have defined this level of treatment as meeting a total phosphorus compliance limit of 1 mg/L for the expansion of existing sewage works and 0.5mg/l for the establishment of new sewage works.

(2) There must be a net environmental benefit to the South Nation River. We have defined this benefit as an actual 4:1 Phosphorus loading offset. That is, for every kilogram increase of Phosphorus (measured as total phosphorus) above the existing load, four kilograms must be removed from the watershed. For new STP discharges, four kilograms must be removed from the watershed for every kilogram discharged

(3) The TPM program implementation structure must be sufficiently well designed and documented to provide a high level of confidence that the 4:1 offset will actually be achieved. When the degree of confidence in the calculation of the phosphorus off-set is low, a higher off-setting ratio must be employed.

(4) The TPM program must include a monitoring and assessment component to document and verify phosphorus loading reductions.

(5) Off-setting measures must be long term in nature. Examples of these types of projects are: establishment of buffer strips to reduce the impacts of land run-off, treatment of existing stormwater discharges, treatment of milkhouse wash-water, cattle fencing, etc.

(6) As part of the TPM proposal, local water quality must be protected from other constituents contained in the treated wastewater discharge.

APPENDIX B

SOUTH NATION RIVER

WATERSHED WATER MANAGEMENT

STRATEGY: TOTAL PHOSPHORUS MANAGEMENT

"STATEMENT OF ROLES AND RESPONSIBILITIES"

SOUTH NATION RIVER WATERSHED WATER MANAGEMENT STRATEGY: TOTAL PHOSPHORUS MANAGEMENT (TPM) *Statement of Roles and Responsibilities*

Several groups within the South Nation River watershed have come together to set out the roles and responsibilities for the implementation of the Total Phosphorus Management (TPM) component of the South Nation River Watershed Water Management Strategy. These groups include: South Nation Conservation's "Clean Water Committee"; several farm organizations; municipalities; industry; provincial government organizations (Ministries of Environment and Agriculture, Food & Rural Affairs); and some watershed landowners. A contact list for the members of the groups is attached to this document. A backgrounder on the South Nation River Watershed Water Management Strategy: Total Phosphorus Management (TPM) is also attached to this document for more information.

The TPM approach is being tested as a pilot program in the South Nation River (SNR) Watershed. This approach is based on a broader, more flexible view of pollution control that relies on point source dischargers to work with landowners within the watershed to improve water quality. TPM looks to achieve greater reductions in contaminant loading than can be realized through the application of costly treatment technology. The TPM approach requires a 4:1 offset ratio, 4 kilograms of non-point source phosphorus (measured as total phosphorus) must be removed annually for every 1 kilogram of phosphorus contributed annually by point sources.

Municipalities/industries in the South Nation River watershed who are expanding their sewage works (systems) have the option of implementing non-point source measures to offset any increase in phosphorus load by a 4:1 ratio or implementing higher, more costly phosphorus treatment to maintain the loading at current levels.

Several other phosphorus management pilot approaches are being explored throughout Ontario. The Regional Municipality of Waterloo, in partnership with the Agricultural Adaptation Council and Grand River Conservation Authority, has initiated the Rural Water Quality Program. The aim of the program is to control sediment, bacteria, nutrient loads to the surface watercourses and bacteria and nitrate impact on groundwater. Work is underway as part of the Lake Since Environmental Management Strategy (LSEMS) to explore the practicality of implementing a total phosphorus management program in the Lake Simcoe drainage basin. A major objective of LSEMS is to reduce phosphorus loading to Lake Simcoe by 25% in an attempt to restore a self-sustaining cold-water fishery. The Ministry of Environment and the Ontario Ministry of agriculture, Food & Rural Affairs have agreed to facilitate the implementation of the Remedial Action Plan (RAP) Stage 2 recommendation to reduce tributary loading of phosphorus to the Bay of Quinte. Total Phosphorus Management will be included as a component of a comprehensive water quality approach to deal with rural and non-point water pollution.

The Ministry of Environment (MOE) will evaluate the effectiveness of the various provincial pilot TPM approaches after 10 years of implementation. Due to the nature of phosphorus in the environment, trends in phosphorus reduction will not be evident for several years. Baseline phosphorus data exists for the SNR as far back as 1967, as part of the Provincial Water Quality Monitoring Network (PWQMN) and South Nation Conservation's (SNC) Watershed Characterization Network. Historically up to 28 sites were sampled throughout the year as part of these two monitoring programs. SNC, in partnership with the MOE will utilize PWQMN and SNC's Watershed Characterization monitoring data to determine annual phosphorus loading trends. The SNC and its partners are in the process of testing an Agricultural Non-Point Source (AGNPS) computer model. The test phase, on the North Castor River Watershed, was completed in August 2000. The AGNPS model will be used to predict phosphorus loading reductions for best management practices proposed under the SNC Clean Water Program. The model will allow the Clean Water Committee to direct funding to the most cost effective water quality improvement projects. The AGNPS model can also be used to evaluate the TPM approach.

The following sets out the agreed upon roles and responsibilities of each party involved in the implementation of the TPM approach:

Ontario Ministry of the Environment (MOE)

- The MOE is the regulatory agency responsible for managing water quality in the province of Ontario. As such, the MOE sets the terms and conditions for the approval (licensing) of sewage works.

- The MOE is charged with ensuring that all sewage works comply with the requirements contained in their Certificates of Approval (licenses). This is done through the review of monitoring reports, inspections and audits of sewage works and records specific to the sewage treatment facility.

- With respect to the implementation of TPM, the MOE must ensure that the required phosphorus offsets are attainable before the Certificate of Approval is issued.

- The MOE is responsible for analysis of the Provincial Water Quality Monitoring Network (PWQMN) data and the establishment of water management tools.

- The MOE will coordinate a meeting of the South Nation River Watershed TPM working group at the end of the first year of the program implementation and then every five (5) years afterwards or more frequently as required to evaluate and revise, if necessary, the TPM approach for the watershed.

- The MOE will evaluate the TPM approach, implementation process, and effectiveness in achieving the targeted phosphorus loading reductions at the end

of each provincial pilot TPM program and after 10 years of TPM program implementation.

- The MOE provides one (1) member on the South Nation Conservation Clean Water Committee.

Municipalities/Industries

- Both municipalities and industries must provide appropriate treatment of their wastewater and in so doing they are responsible for the design, construction, maintenance and compliance of their sewage treatment plants.

- If TPM is included as part of the approval for their expansion or establishment of new sewage treatment plants, municipalities and industries must sign a letter of agreement committing to provide the necessary funding to offset any increase in phosphorus loading to the watershed as defined in the Ministry of Environment – Eastern Region Position: Total Phosphorus Management in the South Nation River Watershed.

- A resolution from Council committing the municipality to a TPM program is required before the Certificate of Approval is issued.

- Municipalities/industries who sign letters of understanding with South Nation Conservation for the delivery of the TPM approach will appoint on(1) member to the Clean Water Committee as a representative.

- As operators of sewage works, municipalities and industries must comply with the appropriate environmental laws and regulations governing sewage treatment, including the provision of annual compliance reports.

- Municipalities and industries are also compelled under TPM to provide annual reporting of TPM payments, and the estimated annual phosphorus offset achieved.

South Nation Conservation (SNC)

- SNC will sign letters of understanding with municipalities/industry to deliver a TPM program to offset phosphorus loading through non-point source projects incorporated into the Clean Water Program, which is developed and delivered by the Clean Water Committee.

- SNC will incorporate TPM funds from partner municipalities and industries into the existing Clean Water Program for distribution to landowners completing non-point source water quality improvement projects.

- SNC will dispense grant funds to landowners who have completed approved non-point source water quality improvement projects under the Clean Water Program.

- SNC will produce an annual report for each TPM partner. The report will include estimated non-point source phosphorus loading reductions, summary of best management practice (BMP) projects completed, Clean Water Program budget, summary of water quality monitoring initiatives, promotion and education initiatives for the Clean Water Program, and an evaluation of the Clean Water Program.

- SNC will monitor baseline water quality (PWQMN and Watershed Characterization stations) within the South Nation River watershed in partnership with the MOE.

- SNC will provide staff to support the Clean Water Program and administer Clean Water Committee directives, and will also provide Clean Water Program Representatives to conduct Program application site visits.

- SNC will chair the Clean Water Committee and will appoint two (2) members from the SNC Board of Directors to sit on the Clean Water Committee.

- SNC will review all documentation and coordinate final inspections for projects, as required, to ensure projects are completed as approved by the Clean Water Committee (e.g. septic systems would not require an inspection by SNC, the Health Unit already does a final inspection).

- SNC will use the Agricultural Non-Point Source (AGNPS) model to predict and evaluate non-point source loadings from the implementation of best management practice projects under the Clean Water Program. The model will aid the Clean Water Committee in prioritizing projects and directing funds to the most cost effective water quality improvement projects.

Clean Water Committee (CWC)

- This committee, made up of SNC Board members, provincial government agencies (MOE, OMAFRA), farm organizations, local farmers, municipalities and industry, administers TPM monies on behalf of the point source dischargers (municipalities and industries).
- The CWC will administer TPM funds on behalf of the point source discharger and incorporate the funds into the existing Clean Water Program. The administration of funds will include:

    - Setting of the grant rates for funding of BMP projects, establishing the guidelines under which these projects are approved, reviewing landowner applications, and approving projects (see Clean Water Committee's current Clean Water Program – Application Process, Grant Structure and Project Guidelines); and

- Promotion of the Clean Water Program (CWP) to landowners to encourage voluntarily implementation of best management practices projects on their land.

Ontario Ministry of Agriculture, Food & Rural Affairs (OMAFRA)

- OMAFRA will provide technical assistance to landowners completing non-point source water quality improvement projects.

- OMAFRA will provide input and information to the CWP through representation of one (1) appointed member on the Clean Water Committee.

- OMAFRA will provide input and information to the South Nation River Watershed TPM working group through the representation on the group.

- OMAFRA will provide information on OMAFRA's available programs.

- OMAFRA will work with other Ministries involved in TPM to ensure the agriculture and rural issues are understood and considered when decisions are being made.

- OMAFRA will continue to work with established partners and the Environmental Farm Plan (EFP) program – while program funding exists.

- OMAFRA will continue to promote BMPs from water quality improvement perspective.(e.g. nutrient management planning).

Landowners

A landowner can be a person or persons or commercial enterprise who is a registered landowner, or who has a signed lease with a property owner within the South Nation River watershed. Their involvement in CWP is voluntary and their participation is not compelled by an environmental law.

- Landowners who volunteer to participate in CWP through the establishment of a BMP project on their property are responsible for ensuring:

  -That their application for funding and their project meets the terms and conditions defined in the Clean Water Committee's current Clean Water Program – Application Process, Grant Structure and Project Guidelines which includes landowner eligibility criteria and the application review process;

  -That their project is properly designed to achieve true water quality protection and enhancement. The Clean Water Committee does not infer

that a project is structurally adequate. This is the responsibility of the landowner and/or their contractor, engineer, or consultant; and

-That the BMP project is completed as designed and all appropriate permits and approvals are obtained.

- The landowner must agree to maintain the completed project in proper working order for at least 5 years.

- Landowners are not bound, legally or otherwise, to attain the predicted phosphorus offset through the establishment of a BMP on their property.

- The phosphorus offset that a municipality or industry is legally required to meet through the approval of their sewage works is not binding on a landowner who is voluntarily participating in the CWP. The landowner's obligations are restricted solely to the completion and maintenance of the BMP project for a minimum of 5 years (as defined in the current Clean Water Program – Application Process, Grant Structure and Project Guidelines).

The signatures of the working group members are attached to confirm the agreement of the above statement of the roles and responsibilities for the South Nation River Watershed Water Management Strategy: Pilot Total Phosphorus Management.

Signatures

Gordon Garlough, Eastern, Ont. OFA, Provincial Director (Dundas)
Earl Pollock, Ministry of Agriculture, Food & Rural Affairs, Regional Manager
Alvin Runnalls, North Dundas, Councillor
Terry Otto, Ontario Federation of Agriculture, Executive Member
Albert McKeown, SNC Clean Water Committee, Chair
Keith Matthie, Ontario Soil and Crop, Past Director of Grenville, Dundas, Stormont & Glengarry
Floyd P. Dingwall, North Stormont, Deputy Reeve
B.R. Ward, Ministry of the Environment Eastern Region, Director
Kevin Grave, South Nation Conservation, Chair, South Nation CA.
Mary-Ann Wilson, South Nation Conservation, Acting General Manager/Secretary Treasurer

APPENDIX C

PHOSPHORUS SOURCE

ACCOUNTING METHODOLOGY

FOR THE

RURAL WATER QUALITY PROGRAM

Prepared by
the Grand River Conservation Authority

PHOSPHORUS SOURCE ACCOUNTING METHODOLOGY FOR THE RURAL WATER QUALITY PROGRAM

Background And Assumptions

This document outlines a method of calculating the relative amount of phosphorus kept out of a watercourse by various agricultural best management practices implemented by the Rural Water Quality Program. A cursory review of the literature has been conducted to assess the current state of knowledge concerning the potential phosphorus reduction values associated with implementing best management practices. The literature reveals that the range in results for individual practices is quite large, and the results are highly variable. The following discussion provides a range of values found in the literature for each source and the assumptions used to arrive at the formula for use in the Rural Water Quality Program

Calculating phosphorus lost or saved by agricultural management practices is a very complicated process. There are many variables that determine phosphorus delivery to a watercourse. This method of accounting for phosphorus uses the best available information for the local area as a starting point. The Nith River Assimilation Study (1996) estimated that each hectare in the Upper Nith River contributes 1.3 kg of total phosphorus to the river annually. There are 56,000 hectares in the Upper Nith River Watershed, this represents a total contribution of 73,000 kg of phosphorus per year. Since this is an aggregate figure that incorporates all sources of phosphorus, some assumptions must be made and will be detailed individually for each practice.

Draper and Weatherbe (1995) estimate that cropland accounts for a loading of approximately 1 kg of phosphorus per hectare per year. This assumption will be used to determine the phosphorus reduction achievable from cropland best management practices. Accounting for phosphorus reductions achievable from livestock sources also requires a number of assumptions. These assumptions will be detailed for each practice.

It is assumed that each project completed through the Rural Water Quality Program delivered phosphorus to surface water. It is important to note therefore that the calculations derived assume delivery to a watercourse.

Manure Storage Facilities and Containment of Barnyard and Feedlot Runoff

There is a great deal of discrepancy in the literature relating to the amount of phosphorus discharged from manure runoff. Unfortunately the values in the literature are difficult to compare since they originate from different sizes of yards and different animal types. The following summary attempts to provide a base to compare some of the findings from the literature.

- Vanderholm et al (1979) measured an average of 64.1mg/l of total phosphorus in 2,453 m^3 runoff from a dairy farm. This yielded 157 kg of phosphorus per year leaving the yard as runoff.
- Edwards et al (1983) measured runoff over 3 years from a 241m^2 beef feedlot housing 56 cattle. They found approximately 31 kg/year of phosphorus moving off the yard.
- Brown et al. (1989) reported concentrations of phosphorus in barnyard runoff ranging from 7-30 mg/l, although they provide no annual volume or annual load of phosphorus.
- D.W. Draper & Associates (1997) estimate that proper manure storage and manure spreading practices can control the phosphorus generated from a storage area. Draper and Associates calculate the phosphorus content of barnyard runoff as Barnyard Runoff = (# animal units) 0.7 kg. To provide some perspective this calculation can be compared to the 31 kg of phosphorus in runoff from 56 cattle reported by Edwards et al. (1983). Using the Draper and Associates formula runoff from a 56 head beef feed lot would contain 39 kg of Phosphorus per year.

The amount of phosphorus leaving a barn yard where manure is stored or livestock is kept relates to the number of livestock that generate the manure. Different livestock types excrete different amounts of phosphorus. To provide a more detailed accounting, the amount of phosphorus excreted per animal should be calculated. The USDA Field Handbook (1992) provides the phosphorus content as excreted per 454 kg (1000 lb.) for the following livestock types:

Type of Animal	**Average Weight per Animal (kg)**	**Phosphorus Factor Kg of Phosphorus produced per day per 454 kg (1,000 lb) of body weight**	**Animal Phosphorus Factor Kg of Phosphorus produced per day per animal (average weight x P factor/454 kg)**
Dairy Cow	591	0.031	0.04
Dairy Heifer	408	0.018	0.016
Veal Calf	91	0.013	0.026
Beef Cow	545	0.048	0.057
Beef Feeder	294	0.048	0.031
Beef Finisher	408	0.048	0.043
Sows and Litters	181	0.068	0.027
Dry sows and boars	136	0.025	0.007
Weaner Pigs	16	0.072	0.0025
Feeder Pigs	55	0.072	0.008
Laying Hen	1.8	0.140	0.0005

Type of Animal	Average Weight per Animal (kg)	Phosphorus Factor Kg of Phosphorus produced per day per 454 kg (1,000 lb) of body weight	Animal Phosphorus Factor Kg of Phosphorus produced per day per animal (average weight x P factor/454 kg)
Pullet 0.68		0.108	0.0001
Broiler Breeder	3.0	0.154	0.001
Broiler 0.68		0.154	0.0002
Turkey	Depends on age	0.127	
Duck 3		0.136	0.0009
Sheep 36		0.031	0.002
Horse 454		0.022	0.022
Rabbit – Fryers Does and Bucks	1 4	0.006 0.006	0.00001 0.00005

Based on the USDA figure, a herd of 56 beef cattle would excrete approximately 1200 kg of phosphorus per year. Although this amount is in the manure produced, not all will be transported in the runoff. Edwards et al calculated 31 kilograms per year of phosphorus to runoff. It is not possible to compare these values to Vanderholm et al (1979) since the animal numbers are not provided. Draper and Associates (1997) suggest that an average of 40 kg of phosphorus will be transported in runoff annually. This represents approximately 4.0% of the total phosphorus excreted by the livestock using the USDA values.

It is obvious from the literature that the amount of phosphorus transported from a manure storage area 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. Since it is difficult to reach consensus based on the literature reviewed, it is suggested that the following calculation be used. This calculation uses the USDA calculation of the phosphorus excreted per animal and assumes that approximately 4.0% of the total excreted will be carried off site in runoff. This is a very conservative assumption. The remaining 96% of the phosphorus excreted remains 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 RWQP are assumed to be 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 diversion is a low cost remedial alternative for control of manure runoff from barnyards, feedlots, and manure storage areas. The purpose is to reduce the volume of runoff generated by diverting clean water away from manured areas using berms, eavestroughing or roofs. With barnyard and feedlot facilities the number and type of livestock, size of yard and yard surface as well as the proximity to a watercourse or

conduit (i.e. tile drain) will determine the amount of phosphorus delivered to a watercourse. The phosphorus load reduction expected from limiting barnyard runoff is roughly proportional to the volume of clean water diverted. Load reductions of 50% to 90% are reported in the literature.

D.W. Draper & Associates (1997) estimate that lot runoff controls alone, without proper manure storage facilities, will control roughly half of the phosphorus lost in runoff. The rest of the phosphorus must be controlled through proper manure storage and manure spreading practices. Assuming that 4.0% of all phosphorus excreted is lost in runoff, clean water diversion alone will only control 2.0% of all phosphorus excreted.

The following calculation incorporates the findings from the literature and conservatively assumes that clean water diversion will control 2.0% of the phosphorus 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

As with the previous sources of phosphorus, there is a considerable range in calculated phosphorus load from improperly managed milkhouse waste systems. The following illustrates some of the phosphorus loadings reported in the literature.

- D.W. Draper & Associates (1997) Bay of Quinte phosphorus reduction program uses the CURB model calculation of 35 kg/year per milkhouse. This is based on an average herd size of 25 head which represents 1.4 kg of phosphorus per cow.
- Barker & Young (1984) measured 145mg/l of total phosphorus in milkhouse effluent. This represents an annual phosphorus load of 26 kg of phosphorus per year from a 25 cow herd or 1.0 kg of phosphorus per cow per year.
- The USDA Agricultural Waste Field Handbook uses values obtained from research at Cornell University in 1979. From a milkhouse and milking parlour they found 0.37kg of phosphorus per 3785 litres of wastewater. This equates to 17 kg per year from a 25-cow herd or 0.68 kg of phosphorus per cow per year.
- A more recent program in Wisconsin (Finlayson, 1995) reported that 227 kg of Phosphorus had been kept out of local waterways by 6 farmers who had diverted their milk house washwater to manure storage units. This equates to 38 kg of phosphorus per farm. The herd numbers were not provided.

In summary, 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 parlour and milkhouse are factors that can affect the

concentration of phosphorus in the wastewater. When sizing milkhouse treatment and storage facilities, the Ontario Ministry of Agriculture, Food and Rural Affairs uses the number of cows as an indicator of the volume of water used in the milkhouse and as a surrogate for the other management factors. Following this precedent, the number of cows milked will be used to determine the phosphorus contribution per milkhouse.

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

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

Livestock Access

Information on the input of phosphorus 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. A number of studies were located and results summarized.

- Results from one GRCA demonstration project found that concentrations of phosphorus decreased by 90% when 60 cows were restricted from 700 metres of watercourse. When the livestock had access to the watercourse the average downstream concentration was 0.27 mg/l. After fencing, the average concentration was 0.03 mg/l. This improvement is achieved not only by the prevention of defecation by the livestock but also the revegetation of eroded banks and access areas, which contribute phosphorus from soil erosion, and overland flow. The reduction in phosphorus observed indicates that phosphorus is either removed from the system or is deposited.

- In a 13 year study conducted at the North Appalachian Experimental Watershed near Coshocton, Ohio, Owens et al., (1996) illustrated the effect of fencing on sediment losses. In this study 17 beef cows were pastured on 28.2 ha for 7 years with access to a small watercourse. The watercourse was fenced and monitored for another 6 years. After fencing, the annual soil loss dropped from 2.5 to 1.4 metric tonnes per hectare, representing a 40% reduction as a result of restricting the livestock. Unfortunately this study did not report the decrease in phosphorus loading although it can be assumed to be of a similar magnitude.

- A Soil Conservation Service Factsheet (1994) quotes studies showing that a cow spends an average of 5 minutes per day in a stream (if it is accessible). The factsheet goes on to say that each cow will defecate approximately 200 kg of manure directly into a stream per year. Assuming the USDA factors for manure excreted, this

represents approximately 0.4 kg of Phosphorus per cow per year or 0.001 kg per day per cow. For example, a 50 cow herd would contribute 20 kg of Phosphorus directly to a watercourse annually. Based on the USDA calculation 50 beef cows excrete a total quantity of 1051 kg of phosphorus per year. The amount of phosphorus contributed to the stream represents approximately 2% of the total amount excreted by the herd.

- The Clean Up Rural Beaches Model is used in the Schafer et al report (1996). Phosphorus loads from livestock access are calculated as kg of phosphorus/defecation (0.0012kg) x probability of defecation in stream (0.18) x number of waterings per day (2.5) x days of access x percentage of time in the pasture x number of animals. If 50 beef cattle were restricted from a watercourse for 150 days the reduction in phosphorus would be 4.5 kg. The Bay of Quinte report simplified this formula to be that the phosphorus load equals the number of animals x unit load of phosphorus (0.13 kg/grazing season). Using this equation, eliminating 50 cattle from a watercourse would result in a reduction of 6.5 kg of phosphorus.

The Soil Conservation Service (SCS) calculation provides the greatest flexibility for calculating the contribution based on the number of days on pasture. None of the literature looks at the contribution of other types of livestock on pasture. Using the SCS assumptions, 2.0% of the amount of phosphorus 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 phosphorus excreted directly into the watercourse and not the amount of phosphorus that runs off from the pasture. This is influenced by the number of days that the animals have access to the watercourse. The calculation for phosphorus 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 phosphorus delivery from cropped fields.

- Gaynor and Findlay (1995) report that although conservation tillage reduced soil loss by 49% (0.89 tonnes per hectare), concentrations of soluble phosphorus increased by 2.2 times. The increase in soluble phosphorus was accounted for in subsurface drainage.
- Langdale et al., (1985) reported dramatic increases in soluble phosphorus but an overall reduction in total phosphorus due to lower runoff volume from fields in conservation tillage.
- Andraski, Mueller and Daniel (1985), found that relative to conventional tillage, phosphorus in runoff was reduced by an average of 63% by no-till and 58% by chisel plow.

Overall it appears that conservation tillage reduces total phosphorus although the soluble phosphorus delivery may increase. Practitioners generally agree that conservation tillage reduces soil loss and total phosphorus.

D.W. Draper and Associates et al., (1997) produced the following table on the impact of tillage practices on erosion.

System	Soil Loss Reduction	P Loss Reduction
No-till systems	75% - 90%	60% – 90%
Ridge-plant systems	75% - 90%	60% - 90%
Reduced Tillage- Chisel plow and disc-chisel	30% - 90%	60% - 90%
Cover Cropping	40% - 60%	30% - 50%

So and Singer (1982) measured unit area loads for the Grand River Basin. Each hectare in the Upper Nith was found to contribute 1.3 kg of total phosphorus per year. Since this is an aggregate figure that incorporates all sources of phosphorus some assumptions must be made to partition the sources. Draper and Weatherbe (1995) estimate that cropland contributes a loading of approximately 1 kg of phosphorus per hectare per year. The phosphorus enrichment ratio reported in the Nith River Assimilation Study (1996) suggests that phosphorus loads to surface water is closely related to sediment discharge.

Using the average phosphorus loss reduction for each practice presented by Draper, conservation tillage reduces phosphorus loading by an average of 75% or 0.75 kg per hectare. Cover cropping reduces phosphorus 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 are generally assumed to be effective in reducing phosphorus loadings from adjacent land use. Effectiveness of buffer strips is dependent on the uniformity of the flow, the width of the buffer, the slope and the vegetation. The following are a few of the results found in the literature.

- Robinson, Ghaffarzadeh and Cruse (1996) found that the initial 3.0 metres of a vegetated filter removed more than 70% of the sediment from runoff, while 9.1 m removed 85%.
- Coyne et al. (1995) reported that grass filter strips 9m wide trapped more than 99% of the soil in surface runoff.
- Dillaha et al., (1986) found that a 9.1 m filter strip removed 91% of the incoming solids and 69% of the phosphorus from feedlot runoff.
- Osborne and Kovacic (1993) found that surface flow of phosphorus is reduced by 61% to 83% in grass riparian zones with widths between 5m and 27m wide.

- In 1993 the GRCA CURB program monitored a 1400 m long buffer strip, 6 m wide on both sides of a watercourse. Phosphorus concentrations measured downstream of the site were at least 50% lower than the concentrations measured upstream of the buffer strip. This illustrates that buffers can significantly reduce the concentration of phosphorus in the water.

Based on the literature, buffer strips that are a minimum of 3 metres wide appear to reduce phosphorus loadings by approximately 70%. Draper and Weatherbe (1995) estimate that one hectare of cropland contributes approximately 1 kg of phosphorus per year; therefore a 3 metre buffer strip would control approximately 0.7 kg of phosphorus from every hectare included in a buffer.

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

Nutrient Management Planning

The Draper and Weatherbe (1995) report indicates that 38% of the farms in Waterloo over apply phosphorus. Nutrient Management Planning is an important part of phosphorus control. Nutrient Management Planning ensures that nutrients are applied in a method that reduces risk to surface and ground water. A number of studies have shown that the phosphorus content of soil directly influences the loss of phosphorus in runoff (Daniel et al., 1994).

- Hamlett and Epp (1994) showed that improved nutrient management can reduce the loss of phosphorus from 20% to 70%. They also conclude that improved nutrient management combined with conservation tillage or soil erosion structures can result in phosphorus reductions of up to 99%.
- The State of Maryland estimates that average reductions of 46 kg of phosphorus per hectare can be achieved through the implementation of nutrient management plans (EPA, 1993).
- The Chesapeake Bay drainage basin states reported that the average reduction of total phosphorus was 36 kg per hectare for the 45,720 hectares with nutrient management plans in place (EPA, 1993).
- Phosphorus reductions achieved under the USDA's Water Quality Program with nutrient management plans ranges from 25 to 95 kg per hectare. The average phosphorus reduction was 58 kg per hectare (EPA, 1993).

The lowest phosphorus reduction that is reported in the surveyed literature of nutrient management planning is 25 kg per hectare. To be conservative this value will be used. Delivery of phosphorus to a watercourse depends on the slope, soil type, tillage method, vegetation cover and proximity to the watercourse. Not all areas contribute phosphorus to a watercourse. Because of their proximity to channels and streams as well as specific land characteristics, hydrologically active areas contribute most of the phosphorus even though they make up a small portion of the watershed. Studies by Wall et al, (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

phosphorus 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**

Summary

The following table provides a summary of the proposed formulas to calculate the annual phosphorus savings that accrue from implementing best management practices through the Rural Water Quality Program. Average weight of animals and phosphorus factors are taken from the USDA calculations, all other factors are farm/project specific.

Best Management Practice	**Calculation Kg of P per year controlled**
Manure Storage Facility	**# of animals x animal Phosphorus factor x days x 0.04**
Clean Water Diversion	**# of animals x animal Phosphorus factor x days x 0.02**
Milkhouse	**# of cows x 1.26 kg/year**
Livestock Access	**# of animals x animal x Phosphorus factor x days x 0.02**
Conservation Cropping	**0.75 kg x hectares**
Cover Cropping	**0.4 kg x hectares**
Buffer Strip	**0.7 kg x hectares**
Fragile Land Retirement	**0.7 kg x hectares**
Nutrient Management	**25 kg x hectares x 0.1**

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APPENDIX D

SUMMARY OF WATERSHED (AGNPS)

PROJECT TO PREDICT OUTCOMES

DUE TO

IMPLEMENTING AN AGRICULTURAL

AND

NON-FARM BEST MANAGEMENT PRACTICES.

SUMMARY OF WATERSHED (AGNPS) PROJECT TO PREDICT OUTCOMES DUE TO IMPLEMENTING AN AGRICULTURAL AND NON-FARM BEST MANAGEMENT PRACTICES.

PROGRESS REPORT SEPTEMBER, 2001.

1.0 Introduction

Since April of 1999 the multi-stakeholder Clean Water Committee (CWC) has been testing an Agricultural Non-Point Source (AGNPS) computer model within a subwatershed of the South Nation River. The project was designed to assess the model's effectiveness at predicting water quality reactions to land use change and to test the model's ability to identify appropriate land management practices for water quality improvement. Upon completion of the pilot study in August 2000, the CWC has begun the expansion of the AGNPS model to the entire South Nation River watershed.

2001 Clean Water Committee Membership Affiliation Organizations:

- Ministry of Environment
- North Stormont Township
- Nation Municipality
- Village of Casselman
- North Dundas Township
- Parmalat
- Local Farmers
- Ontario Ministry of Agriculture, Food & Rural Affairs
- Dundas Federation of Agriculture
- Grenville Land Stewardship Council
- Ottawa Rural Clean Water Program
- Ottawa Federation of Agriculture
- Soil & Crop Improvement Association

1.1 AGRICULTURAL NON-POINT SOURCE (AGNPS) MODEL.

The AGNPS model presents the user with a means of objectively evaluating non-point source pollution within a watershed. The model works on a cell basis. These cells are uniform square areas that divide up the watershed. This division makes it possible to analyze any area in the watershed. The basic components of the model are hydrology; erosion; sediment transport; and transport of nitrogen and phosphorus.

Data required for the model is classified into two categories: watershed data and cell data. Watershed data includes information that applies to the entire watershed and to the storm event to be simulated. Cell data include physical information describing each of the cells as well as information based on the land practices in the cell.

The model provides outputs on hydrology, with estimates of both volume and peak runoff, and on sediment, with estimates of upland erosion, channel erosion, and sediment yield. Along with these, the user will receive estimates of the pollutants nitrogen (N) and Phosphorus (P). The outputs can be examined for either a single cell or the entire watershed.

2.0 Data Collection And Calibration Of Model.

2.1 Watershed Information.

Background data that falls under the category of 'watershed data' includes; land use, soil type, topography, and hydrology. Through various partnerships the CWC has acquired up to date land use, soil, and topographic digital maps from Agriculture and Agri-Food Canada. The Ministry of Natural Resources through the Provincial Hydrology Project has provided flow maps. A South Nation Conservation (SNC) GIS Technician has added this digital information to the AGNPS model.

In order to verify that the data that was provided to us is correct and up to date a Water Quality Technician conducted a 'windshield' survey of the watershed during the summer of 2001.

2.2 Storm Event Water Quality Data.

For the model to accurately predict the amount of phosphorus, nitrogen, and sediment loading that occurs during storm events due to overland flow, surface water quality monitoring stations have been established. Currently there are three storm event water quality-monitoring stations within the South Nation River watershed.

A monitoring station has been located at the mouth of the North Castor River since the spring of 1999. During the summer of 2001, stations were installed at the mouth of the South Nation River near Spencerville and near the outlet at Plantagenet. The two latter stations were located next to existing stream gauge stations to aid in the collection of flow measurements.

The purpose of these monitoring stations is to record precipitation rates, water levels, and to collect water samples during a storm event. Storm events must be of 1" or greater of rainfall to ensure that analysis data is accurate and reliable. Samples are collected from the beginning of a storm event (river level rising) through the peak of the storm and during the tail end of the event (river level falling). The Ministry of the Environment as an in-kind contribution conducts laboratory analysis of the samples. Data provided by these samples will provide information on when the majority of phosphorus, nitrogen, and sediment enter the watercourse. All of the data collected at the monitoring stations will be used to calibrate the model to current water quality conditions within the South Nation River watershed.

Due to the lack of major storm events (>1" rainfall) during the spring and summer of 2001, limited data has been collected thus far. Therefore the monitoring stations will be in operation during the spring, summer, and fall of 2002. Data from this portion of the project will be incorporated into the model during the fall of 2002.

2.3 Baseline Water Quality Data.

Baseline water quality data for the South Nation River watershed has been acquired through the Ministry of Environment's (MOE) Provincial Water Quality Monitoring Network and the SNC Watershed Characterization Network. On a monthly basis (from April to November) surface water samples are collected at 18 stations along the South Nation River and all major tributaries. Data from many of these stations dates back to the early 1960's. Baseline water quality data will be added to the model during the fall of 2001 and any additional information during the fall of 2002.

2.4 Nutrient Use and Land Management Practices Survey

As previously mentioned the AGNPS model predicts the amount of phosphorus, nitrogen, and sediment loading due to overland flow. The amount of phosphorus and nitrogen carried with the sediment depends upon the soil type and current land use within a cell. For certain land uses (farms, golf courses, residential, etc) it is essential to determine the amount of fertilizer that is applied. This information is currently being collected through a "Nutrient Use and Land Management Practices" survey (copy attached). SNC's CWP and Ottawa's Rural Clean Water Program representatives are conducting the survey.

Watershed residents and businesses are being asked to provide the CWC with information on the type of fertilizer being used (formula, form), the rate at which it is being applied, and during which season. Land management practices are also being recorded (no till, conservation tillage, etc), as these will have an effect on the amount of sediment and nutrients that are carried in overland flow.

Information collected through the survey will be used to calibrate the fertilizer application rate based on land use and to fine-tune individual cells. This aspect of the model calibration will be completed during the winter of 2001.

If in the future land use or cropping practices change dramatically within an individual cell (e.g.; forest cover to residential, erosion point to buffer strip) this information can be corrected through dialogue boxes built into the AGNPS computer model.

3.0 TECHNOLOGY TRANSFER

To date this project (South Nation Watershed Computer Model) has been promoted at three environmental conferences. During February 2001 the project was presented to the Canadian Association on Water Quality conference at the Canadian Centre for Inland Waters in Burlington Ontario. At the Canadian Water Resources Association conference at the University of Guelph the project was presented as part of a session dedicated to the various applications of the AGNPS model. The project was also presented to local agencies and residents at the St. Lawrence River Institute of Environment Sciences conference in Cornwall, Ontario. During September 2001 the South Nation Watershed Computer Model project will also be displayed at the 2001 International Plowing Match in Navan, Ontario. The project and the contributions made by our partners have also been featured in local newspapers; copies can be found in Appendix C.

APPENDIX E

SAMPLE TOTAL PHOSPHORUS

MANAGEMENT AGREEMENT

SAMPLE TOTAL PHOSOPHORUS MANAGEMENT AGREEMENT

Date

Address

Dear Mayor,

This letter outlines the details of the understanding between (Township) and the South Nation River Conservation Authority ("SNC") for the delivery of funds from (Township) to SNC to be used for certain non-point source projects which will reduce phosphorus contributions to the South Nation River and its tributaries.

1. Subject to the requirements set out in this letter, (Township) will provide a maximum of $(xxx) ("the Funds") compensation payable to the SNC. Funds are to be used solely for the purpose of implementing various non-point source projects which will reduce phosphorus contributions to the South Nation River and its tributaries. (Township) will make this contribution in installments over a period of (x)years commencing in (date, year) and ending in (date, year) .

2. The funding will be administered by the SNC through its SNC Clean Water Program.

3. SNC will make every reasonable effort, in consideration of the Funds it receives from(Township), that the Funds will be used in such a way as to remove (xx) kilograms of phosphorus annually from the South Nation River and its tributaries over a maximum of (x) years through the completion of non-point source projects such as septic systems, milkhouse washwater treatment, buffer strips and manure storage. Phosphorus reduction projects that benefit the Township of North Dundas will be given priority.

4. The Funds will be administered with a minimum of (xx)% for project grants, and the remaining (xx)% for program delivery, promotion, education, monitoring and reporting.

5. The SNC Clean Water Program will be monitored by a Clean Water Committee ("Committee") that will provide direction and approval of projects consistent with the requirements of this letter. This Clean Water Committee will have one or more representatives from each of the following: Ministry of Environment, Ontario Ministry of Agriculture, Food and Rural Affairs, farmers, SNC and the appropriate local governments.

6. (Township) is invited to appoint a representative to sit on the Clean Water Committee.

7. SNC will monitor water quality in the South Nation watershed during the Term and, in particular, will monitor the phosphorus levels in the South Nation watershed.

8. SNC will report phosphorus load reductions due to the non-point source projects completed, on a project-by-project basis and in a manner which is acceptable to(Township), acting reasonably, prior to (date) of each year. If (Township) is not satisfied that the phosphorus levels are being reduced as required under this letter, it may terminate this agreement on 30 days notice to SNC. SNC will provide financial reports to (Township) prior to (date) of each year outlining in detail how the funds have been applied during the previous year of the term. SNC will provide any further evidence of how the funds have been applied as may be reasonably required by (Township) from time to time. This obligation to provide financial reports and supporting evidence shall survive termination of this understanding for a period of 6 months. If (Township) is not satisfied that the Funds are not being properly administered it may terminate this arrangement on 30 days notice to SNC.

9. SNC will use all reasonable efforts to encourage local farmers, and others who may need to be involved to ensure the success of the projects described in this letter, to cooperate with the Clean Water Committee whenever necessary throughout the Term.

10. In the event that any cause reasonably beyond the control of either party prevents such party from complying with any provision of this arrangement, then such party shall be excused from complying with such provision for so long as such cause exists, provided that in the event that such cause continues to prevent such party from complying for a period of 30 days, then either party shall have the right to terminate this arrangement effective upon giving notice of termination to the other party.

11. Either party may terminate this arrangement in the event of a material breach of any of its provisions by the other party upon 30 days written notice to the other party.

12. If this arrangement is terminated at any time for a reason other than a material breach by (Township), any Funds which have not been administered as of the date of termination shall be returned to (Township) forthwith.

13. This arrangement is terminated when the funds are fully allocated with the expectation that there is a minimum of (xx) kilograms of phosphorus removed annually.

14. (Township) shall not have any responsibility or any liability whatsoever for the administration of the funds, or for the implementation, construction and operation of the projects which are carried out hereunder, or for any damages, losses, expenses and costs arising out of such projects, except as expressly set out and agreed to in writing by (Township) and SNC agrees to hold harmless and indemnify (Township) in this regard. However, (Township) does acknowledge that it has an appointee who is on the Clean Water Committee, which from time to time, advises SNC and reviews project proposals.

15. Each party hereby represents to the other that it has full right, power and authority to enter into this letter of understanding.

We look forward to working with you to implement the Clean Water Program.

Sincerely,

South Nation River Conservation Authority

Agreed to this _____day of _____, year
per:
Chairman.

per:
General Manager/ Secretary-Treasurer.

Township

Agreed to this_____ day of _____, year.
per:
Mayor.

per:
Township Representative

cc: Ministry of Environment, Kingston

_____

APPENDIX F

2001 CLEAN WATER COMMITTEE

MEMBERSHIP

Name	Affiliation
	Ministry of Environment
	North Stormont Township
	Nation Municipality
	Village of Casselmann
	North Dundas Township
	Parmalat
	Ontario Ministry of Agriculture, Food and Rural Affairs
	Dundas Federation of Agriculture
	Grenville Land Stewardship Council
	Ottawa Rural Clean Water Program
	Ottawa Federation of Agriculture
	Soil & Crop Improvement Association
	Local Farmers