Conservation ONTARIO
Natural Champions

PROTECTING
ONTARIO'S DRINKING WATER

Cost-Benefit Analysis
Source Water Protection Beneficial Management Practices

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Source Water Protection involves protecting both the **quality** and **quantity** of surface and groundwater sources.

Cost-Benefit Analysis
Source Water Protection Beneficial Management Practices

Farming has a long and successful history in the province of Ontario. We need to continue to support this important industry and at the same time ensure the health of both our environment and people.

Agricultural Beneficial Management Practices (BMPs) such as crop rotation, buffers, soil testing and cover crops are used by many individual producers today to protect the quality and supply of our water from lakes, rivers, and groundwater. BMPs act as barriers to prevent or decrease the contamination of water by nutrients, pesticides, and pathogens.

A key threat to drinking water sources is the impact of nitrogen from both agricultural and urban land uses. High nitrate levels are particularly dangerous for infants less than six months.

We grapple today with the challenges of ensuring a clean sustainable supply of drinking water for a growing Ontario population. The use of beneficial management practices on a broader scale by farmers, other landowners, and land managers can help to offset local impacts of nitrogen on municipal drinking water sources.

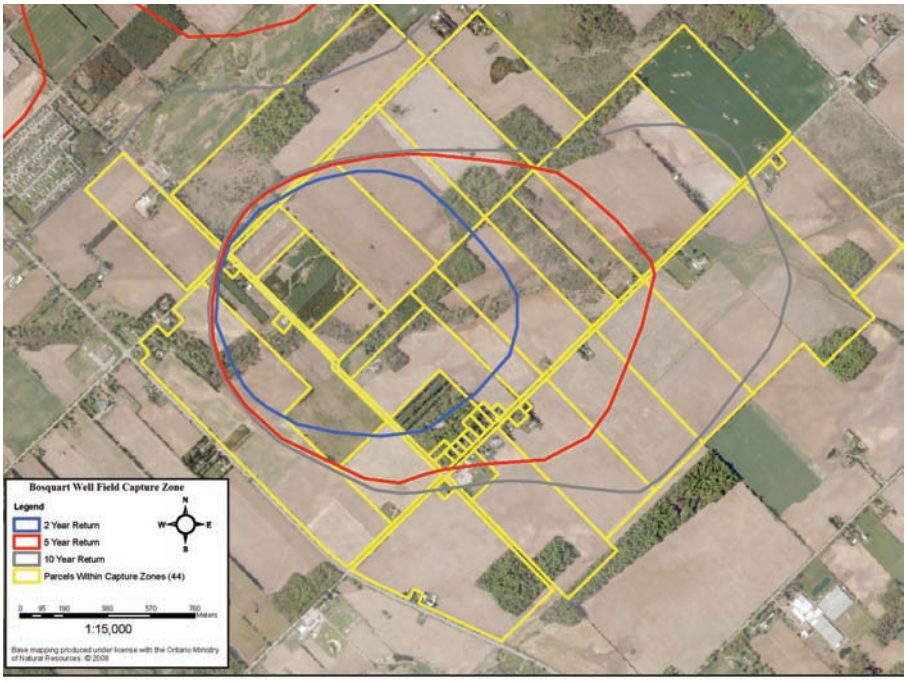
Why do we need to protect sources of drinking water?

Approximately 75% of Canadians get their drinking water from surface water sources such as lakes and rivers. The remainder use groundwater sources. While municipal treatment systems are able to treat raw water, it is cheaper and safer to make sure that the water is clean right at the source. As well, once groundwater sources become contaminated, it can be very costly – and sometimes impossible – to clean them up.

Evaluating a Cost Effective Approach - The Study

In 2008, the George Morris Centre was commissioned to conduct a study within one Ontario municipality in order to help understand the costs and benefits of using source protection beneficial management practices to protect important surface and groundwater sources of drinking water. The report is entitled "Cost-Benefit Analysis of Agricultural Source Water Protection Beneficial Management Practices" and was funded by the Agricultural Adaptation Council. Study partners also included Conservation Ontario and the St. Clair Region Conservation Authority. Additional technical support was provided by Dr. Jane Sadler Richards (Cordner Science), Murray Ostrander (Waterloo Numerical Modelling Corp.) and Tom Muir (private consultant).

The results of this study have important implications for municipalities, watershed practitioners such as Conservation Authority staff or provincial staff, and policy makers. This fact sheet provides an overview of the study and the results, however, the full report provides detailed results, lessons learned, and policy implications. This report is also available at Conservation Ontario's website at www.conservationontario.ca (What We Do > Watershed Stewardship > Innovations in Watershed Stewardship).



Bosquart Well Field Capture Zones

Plainfield sand in Strathroy area

Snapshot of the Study Area: Town of Strathroy-Caradoc

Strathroy - Caradoc FAQs

- primarily rural municipality of 20,600 people
- located 40 km west of London
- Caradoc Aquifer is mainly comprised of fine textured sand
- groundwater sources provided the supply for all Strathroy-Caradoc's domestic, commercial, and industrial uses until 2005 when a pipeline source came on line
- a drinking water pipeline was built from Lake Huron and is the primary water supply system which serves the communities of London, Lambton Shores, North Middlesex, South Huron, Bluewater, Middlesex Centre, Lucan-Biddulph, and Strathroy-Caradoc from a water treatment plant located east of the village of Grand Bend in South Huron
- prior to the pipeline, 13 well or well points in seven well fields served the community of Strathroy-Caradoc and many drinking water advisories were issued because of nitrate contamination in the raw drinking water
- this study focused on the Bosquart Well Field which included 17 farms and 35 households within a 10 year capture zone

What's So Bad About Nitrate?

Nitrate is a form of nitrogen that easily escapes from the plant root zone or septic beds, and gets into surface and groundwater. It is not unusual to find small amounts of nitrate in well water, but levels can rise in farming areas where fertilizer is used, or in neighbourhoods where there are a significant number of septic systems.

How was nitrogen being managed?

Farmers and householders who were surveyed within the Bosquart Well Field capture zone indicated they had used the following practices to manage nitrogen between 1994 and 2007:

- ✓ corn-bean rotation
- ✓ minimum tillage systems
- ✓ soil testing
- ✓ band or side-dress application of nitrogen

Problems with Water Quality

The Strathroy-Caradoc area experienced water quality issues associated with elevated iron and manganese conditions. As well, high levels of nitrate were identified in municipal well water. In the Bosquart Well Field, one of several within the Strathroy-Caradoc system, the source of the high nitrate levels was probably due to agriculture.

The main concern was around the water quality within the groundwater in the Caradoc Aquifer.

In order to respond quickly to residents' concerns about the quality of drinking water, the Lake Huron Primary Water Supply System constructed a 26 km pipeline in 2005 at a cost of approximately $16-$20 million. The pipeline runs from the Huron pipeline near Ailsa Craig to Strathroy.

Approach - The Study at A Glance:

The purpose of this study was to understand the costs and benefits of using beneficial management practices to manage nitrogen in source water protection within an agricultural landscape.

The costs of implementing a series of BMPs were estimated and then compared to the cost of constructing and maintaining the pipeline.

In carrying out the study, researchers:

- conducted a search to identify an appropriate case study
- reviewed relevant scientific literature
- surveyed landowners to document nitrogen management practices from 1994 to 2007
- developed a detailed nitrogen budget for each farm field within the capture zone
- estimated relative nitrogen loads from farm fields and in drinking water using different nitrogen management scenarios and a nitrogen groundwater transport model
- conducted a cost-benefit analysis of the different scenarios and the actual pipeline option

The final report provides results, conclusions, policy implications, and recommendations.

Applying the Science

Based on survey results, local conditions, and nitrate challenges in the drinking water, the following two BMP scenarios were developed based on the idea of *Right Rate, Right Time, Right Place and Right Advice*.

1. **Rate Case** – included practices that ensured nitrogen was available to the crop when and in the amount needed e.g. nitrogen soil testing, sidedress application, crop consultant advice
2. **Rotation Case** – included all rate case practices plus added a cereal and cover crop to the rotation to re-distribute nitrogen needs and sources i.e. winter wheat underseeded to red clover

Nitrogen Budgeting and Nitrogen Transport Model

The relative effectiveness of the BMPs was determined using a nitrogen budget to estimate the amount of nitrogen that could leach below the root zone and escape into the groundwater. As well, a nitrogen transport model was developed and applied to estimate the change in nitrate concentrations in the drinking water obtained from the groundwater at the Bosquart Well Field. The nitrogen transport model simulated the best estimate of nitrate reduction by the BMPs.

Using a hydrogeologic simulation, both scenarios were successful in reducing the Long Term Potentially Leachable Nitrogen (LPLN), however the Rotation Case was the most successful.

A comparison of nitrogen budgets showed:

- a 39% drop in nitrogen available to leach into the groundwater below the crop root zone when the Rate Case scenario was used
- a 48% drop in nitrogen available to leach into the groundwater below the crop root zone when the Rotation Case scenario was used

A computer model simulating nitrate movement through groundwater in the Bosquart Well Field capture zone showed:

- a 24 - 36% decrease in the concentration of nitrate in drinking water drawn from groundwater sources when the Rate Case scenario was used and;
- a 30 - 48% decrease in the concentration of nitrate in drinking water drawn from groundwater when the Rotation Case scenario was used.


Corn


Red Clover


Soybeans


Winter Wheat

Determining if the BMPs are cost efficient

The study also analysed the costs of BMPs, in terms of foregone profit per acre before and after adoption of BMPs, to determine if they would be a beneficial option for farmers to adopt. The cost benefit analysis used crop enterprise budgets from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). The enterprise budgets provided an estimate for variable costs and fixed costs for individual crops on a per acre basis. The prices for each commodity were also obtained from OMAFRA. The crop budgets were based on conventional tillage practices.

The two BMP scenarios resulted in marginal costs compared with existing crop practices identified in the producer survey. And, while the Rotation Case decreased nitrogen concentration and loads to a greater extent than the Rate Case, the cost of implementing the Rate Case was the lower of the two.

Since either approach satisfied nitrate standards in drinking water, it can be concluded that the Rate Case is preferred to the Rotation Case based on economics.

Recommended BMPs for Nitrogen Management

- Use more efficient types of fertilizers
- Use only as much nitrogen as the crop needs
- Test soil and plants to determine needs
- Prevent runoff from manure and other nutrient materials
- Rotate crops and reduce tillage to improve soils
- Create buffer strips and erosion control structures to manage runoff
- Plant cover crops
- Ensure better timing of ploughing pasture
- Improve livestock management
- Implement precision farming
- Store fertilizers properly
- Ask for advice & guidance if trying something new

Protecting Important Sources of Drinking Water

Nitrogen in agricultural and urban landscapes occurs in fertilizers, septic systems, and barnyards. Groundwater and surface water sources such as aquifers, rivers, and lakes can get contaminated by nitrogen in water that runs over landscapes or seeps under ground. Using practices such as planting vegetation strips along shorelines, constructing wetlands, rotating crops, using low nitrogen fertilizer and repairing older septic systems are examples of beneficial management practices that help prevent contamination of private and public drinking water sources from nitrogen.

Lessons Learned
Are BMPs Effective *and* Cost Efficient?

If BMPs are implemented with adequate lead time, they can be an effective and low-cost way of protecting groundwater and drinking water in regions that anticipate nitrogen contamination problems.

The results also suggest the following in terms of policies to manage drinking water quality. First, if BMPs are to be used in drinking water quality management, the results suggest appropriate levels of incentives or payments for participation. Second, the results offer the insight that multiple BMPs can present solutions to nitrate management in groundwater, and that some BMPs are more appropriate and less costly than others. Third, the view emerges that crop consultants may play a significant role in successful adoption of BMPs as they guide farmers into nitrogen management strategies that are unfamiliar to them. Fourth, implementing BMPs are important for protecting private individual and public sources of drinking water.

Strathroy-Caradoc Study Area

In the context of the Strathroy-Caradoc study area, if the BMPs had been adopted more widely, they would have proven to be very effective in reducing nitrate concentrations in the drinking water obtained from the Bosquart Well Field (simulated as 24 to 36% in the Rate Case and 30 to 48% in the Rotation Case). The BMPs would also have been effective in reducing nitrogen loads (estimated as 39 and 48% respectively) leaching from cropland to groundwater in the capture zone of this well field.

Further, had either of these BMP alternatives been implemented in the early 1990's, in effect they would have constituted a lower cost solution to the nitrogen management situation in the town's drinking water compared with the pipeline.

Nitrogen budgets proved to be a useful framework for estimating relative nitrogen levels and long-term leaching rates to the groundwater.

This study is significant and largely unique in its linking of existing crop-nitrogen management practices, nitrogen-water modeling of alternative BMPs, and economic analysis of the BMP and existing drinking water management. This extends the knowledge base from existing agronomic practices to feasible alternatives for drinking water management, and evaluates the costs. This approach should find ready application elsewhere.

Partners in Protecting Ontario's Drinking Water

George Morris Centre
www.georgemorris.org

Founded in 1990, the George Morris Centre is a Canada-wide, not-for-profit organization based in Guelph, Ontario. An independent think-tank, the Centre provides industry decision-makers with critical information and analysis on issues affecting the Canadian agri-food sector.

The Centre's mission is to provide quality dialogue on relevant policies and issues to encourage innovations that enhance excellence in agriculture and food sector. The Centre focuses on Public Policy Research, Strategic & Applied Analysis and Education.

Agricultural Adaptation Council
www.adaptcouncil.org

The Agricultural Adaptation Council (AAC) is a non-profit coalition of 73 Ontario agricultural, agri-food and rural organizations. Established in 1995, AAC allocates federal and provincial government funding to support new and innovative projects to benefit the sector and currently administers Agriculture and Agri-Food Canada's Advancing Canadian Agriculture and Agri-Food Fund. In Ontario, this program is known as CanAdvance.

Waterloo Numerical Modelling Corp.
www.wnmcorp.com

Waterloo Numerical Modelling Corp. is an environmental consulting company that specializes in evaluation, assessment, and analysis for environmental and subsurface issues. In addition to site characterization, we apply numerical methods and integrated Geographic Information Systems (GIS) in solving a wide variety of groundwater issues ranging in scale from site specific to large, complex three-dimensional systems. We have vast experience in all sectors of the business; water resources, commercial, industrial, mining. Whether the problem is groundwater flow, contaminant assessment or transport, selection/assessment of remedial methods or environmental impact assessment we have the answers.

Conservation Ontario
www.conservationontario.ca

Conservation Ontario is the umbrella organization that represents Ontario's 36 Conservation Authorities. Conservation Authorities are local, watershed management agencies that deliver services and programs that protect and manage water and other natural resources in partnership with government, landowners and other organizations.

St. Clair Region Conservation Authority
www.scrca.on.ca

The St. Clair Region Conservation Authority is located in southwestern Ontario and includes the Sydenham River watershed and thirteen smaller watersheds draining directly into southern Lake Huron, the St. Clair River and northeastern Lake St. Clair.

The Conservation Authority implements programs to reduce the risk to life and property from flooding and erosion; water and land stewardship; forestry; wildlife habitat creation and outdoor recreation.

Cordner Science
www.cordnerscience.com

Cordner Science is a science-based, consulting business that specializes in Ontario's rural environment. It develops and implements environmental monitoring and research programs, provides scientific analysis and review of information, and assesses the impact of current or proposed practices on the rural environment. Cordner Science prepares auditable scientific reports aimed at meeting our clients' needs, including review and litigation support.

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To view the full report go to: www.conservationontario.ca
(What We Do>Watershed Stewardship>Innovations in Watershed Stewardship)