Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Watershed Evaluation of Beneficial Management Practices (WEBs)

Thomas Brook

Nova Scotia

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Government of Saskatchewan
Manitoba
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Nova Scotia Nouvelle-Écosse
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The Watershed Evaluation of Beneficial Management Practices (WEBs)

is a national project led by Agriculture and Agri-Food Canada (AAFC), with Ducks Unlimited Canada a key funding partner. Designed to measure the performance of selected agricultural beneficial management practices (BMPs) at a watershed scale, the project studies the impact of BMPs on water quality in seven micro-watersheds across Canada. Each site includes an on-farm economic assessment and a hydrologic modelling component, with integrated modelling occurring at two of the sites. WEBs was initiated in 2004 and will run to March 31, 2008.

The WEBs project has stimulated the formation of a network of living laboratories across Canada, bringing together hydrologists, economists, modellers and agri-environmental experts from government, academia and non-government organizations. The result is high quality applied research and exceptional opportunities for future collaboration in areas of common interest.

Beneficial management practices are science-based farming activities designed to help minimize potential environmental impacts such as sediment and nutrient runoff into water bodies. Prior to WEBs, the effectiveness of individual BMPs was evaluated largely on test plots or at a small field scale, with results extrapolated through modelling to the watershed scale. WEBs was created to address limitations to these evaluation methods by applying a suite of BMPs and studying their economic impact and effect on water quality at the micro-watershed level (i.e. approximately 300 hectares). The suites of BMPs have been specifically tailored to the unique conditions of each watershed.

The long-term history of conditions and trends is generally well understood at each of the seven WEBs watersheds, due to past activities and data collection by local watershed associations and multi-agency teams. It is anticipated that these sites will continue as long-term benchmarks for watershed health.

Environmental evaluations are being conducted through a range of validation techniques to determine the impact of individual and suites of BMPs on water quality at each watershed. Methods employed include historic benchmarking, paired watersheds, upstream and down-stream monitoring, and edge-of-field testing. All studies have been designed with in-field assessments, intended to yield scientifically valid and publishable results at the end of the project.

On-farm economic assessments are being conducted at all WEBs watersheds, using approaches that are best suited to the unique circumstances of each site. Through the development of economic models and impact assessment tools, economists will be able to determine the costs and benefits of BMP implementation scenarios. The socio-economic factors that might affect producers' decisions to adopt BMPs are also being examined.

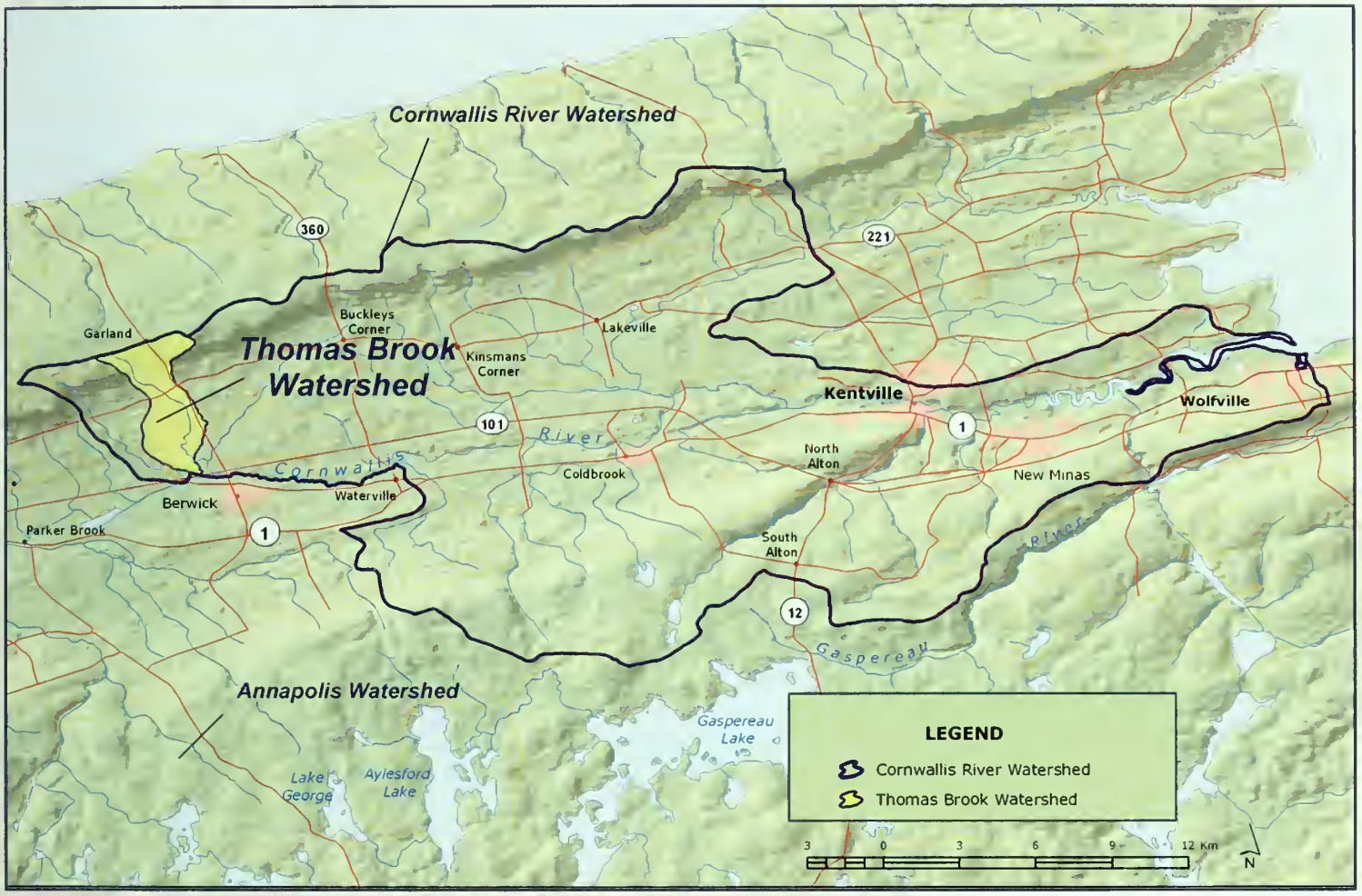
Hydrologic modelling is being conducted at each WEBs site in order to characterize watershed processes under baseline conditions and to examine the water quality benefits of BMP implementation. In most cases, models based on the Soil and Water Assessment Tool (SWAT) are being used to evaluate the impact of different BMP scenarios. These models are being modified to suit Canadian climatic conditions and to accommodate specific BMPs. The South Tobacco Creek, Bras d'Henri and Black Brook watershed sites are particularly well advanced in the process.

Integrated modelling is underway at the South Tobacco Creek and Bras d'Henri sites. This component incorporates hydrologic, environmental, economic and producer behavioural aspects into a multi-faceted decision tool at the micro-watershed and larger watershed scale. Models are being validated using actual watershed data, as opposed to data extrapolated from other studies.

● **WEBs Project Sites**

Thomas Brook Watershed

The 760-hectare Thomas Brook Watershed, a sub-watershed of the Cornwallis River Watershed, is located in Kings County, part of Nova Scotia's fertile Annapolis Valley. Agricultural intensity is greater in the lower reaches of the watershed and mainly consists of forages, cereals, specialized crops and livestock.



Agricultural production in the watershed is focused on crops such as grain, silage and grain corn, forages, nursery stock and strawberries. In addition there are livestock operations including dairy, beef and hobby farms. Urban expansion in the surrounding area has increased the watershed's rural residential population.

Thomas Brook is a small stream, with a main channel less than six kilometres long and rarely wider than two metres. It originates at the top of the steep forested escarpment of the North Mountain, and drains into the Cornwallis River which flows east to the Minas Basin. The brook is fed by rainfall, drainage from seasonal streams, and seepage originating throughout various geological formations along the North Mountain escarpment.

Much of the soil in the watershed is imperfectly drained. Shallow parent material, topography and the forest ecosystem affect drainage at the upper levels, and rapid runoff from snowmelt can lead to spring flooding. The coarse soils of the lower slopes and level portions of the brook are susceptible to leaching and summer moisture deficiencies. Drought-like conditions were in effect from 1996 to 2001.

Intense land-use pressure from both agricultural and residential sources has led to a decline in surface water quality in the Thomas Brook Watershed. Concerns include *E. coli* and phosphate loading. Recent investigations indicate that high nitrate-nitrogen concentrations in groundwater can seep into surface waters during the summer months. These findings have been the catalyst for the development of a Nutrient Management Strategy for the province of Nova Scotia.

Beneficial Management Practices

Three BMPs are being assessed within the Thomas Brook Watershed.

Reduced stream access for cattle

Fencing and off-stream watering have been installed to reduce cattle access to the stream, thus preventing cattle damage to stream vegetation, and manure deposition into the water body.

A 500-metre cattle exclusion fence was constructed adjacent to the stream above monitoring Station 2 (see map). A buffer strip was established between the fence and the brook having a minimum width of five metres for its entire length.

Fenced cattle pasture

Gravity-fed watering trough

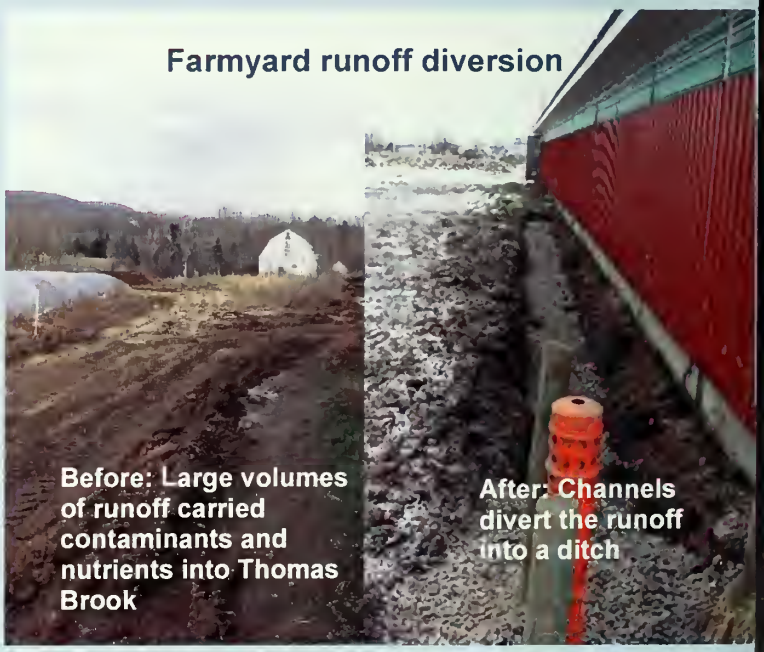
Because the pasture in this area is rotationally grazed, two moveable troughs are used to provide an alternative cattle watering source. This water supply is provided through a gravity-fed pipeline which originates from a spring at the base of the mountain. Water quality samples taken from upstream Stations 6 and 7 provide a control whereby the effectiveness of the cattle exclusion can be measured at Station 2.

Farmyard runoff management

A diversion channel has been installed to capture rainwater runoff from two barn roofs and adjacent drive lanes. A system of French drains and surface inlets diverts the rainwater flow into a tile drain system which bypasses the manure storage and handling areas, and discharges into a nearby riparian wetland. This diversion reduces the amount of manure-contaminated runoff from the farmyard, thereby resulting in reduced nutrient and bacterial transfer to the nearby stream.

Proper disposal of milkhouse wash water, which contains high total phosphorus and sulphuric acid, is a common concern for dairy farms in Nova Scotia. Treatment in containment wetlands elsewhere has been shown to reduce the potential impact on water quality. Milkhouse wash water that has been historically diverted into a local drainage area (located next to a natural riparian wetland) is being monitored at Station 8 to determine the downstream impact on water quality in Thomas Brook.

Farmyard runoff diversion



Before: Large volumes of runoff carried contaminants and nutrients into Thomas Brook

After: Channels divert the runoff into a ditch

the Thomas Brook Watershed

Nutrient management plans

Loading compost for surface spreading as part of the nutrient management regime

Nutrient loading from fertilizer application has been considered a major factor in the reduction of water quality within Thomas Brook. Nutrient management addresses the amount, form, placement and timing of application to crops. Nutrient sources such as manure, fertilizer or compost are applied in appropriate quantities to make up the difference between those nutrients present in the soil and what is required to optimize crop performance and soil condition. Optimum nutrient use minimizes leaching into surface and groundwater, improving water quality. Also, by implementing nutrient management plans, crop production is improved and input cost may be reduced.

Nutrient management plans developed by industry consultants have been applied to approximately 80 per cent of the cropland in the Thomas Brook Watershed, including most of the rotational cropland. Existing provincial guidelines were followed for soil sampling and the selection of crop nutritional needs.

- Monitoring stations
- Rainwater diversion
- Catchment area
- Drainage basin
- Fields with nutrient management plans
- Fields without nutrient management plans
- Reduced stream access

Monitoring Techniques

Water quality and quantity within the Thomas Brook Watershed are **monitored** at 10 monitoring station sites (as marked on the BMP map on the previous pages). Stations 1 to 5 were first established for the collection of background data, with additional sites added to facilitate more intensive monitoring.

Water sampling with automated samplers is carried out every six hours for nutrients and suspended solids at six sites unless freezing conditions exist. Weekly grab samples are collected for bacteria. Where automated samplers are not deployed, weekly nutrient grab samples are also taken. Additional samples are taken to characterize storm events. Samples are analyzed in the laboratory for total phosphorus, total nitrogen, nitrate, ammonia, pH, total suspended solids, coliform bacteria, and *E. coli*.

In-stream water quality measurements include dissolved oxygen, turbidity, salinity, pH, and conductivity. Manual measurements of depth and water velocity are taken to calibrate flow monitoring.

Samples taken from upstream Stations 1 and 6 provide a control, allowing notable increases in contaminant to be measured at downstream stations. The effectiveness of the entire suite of BMPs is tested at the watershed outlet (Station 5).

Picture above: Grab sampling at the watershed outlet at Station 5

Picture left: Station 8 at the milkhouse runoff ditch

In addition to surface water monitoring, **groundwater wells** established by the Geological Survey of Canada are sampled to assess the contribution of groundwater nitrates to surface water contamination.

Flow monitoring is typically undertaken at water control structures along the stream, utilizing road culverts and weirs with water-level recording sensors.

Meteorological equipment located at Stations 3 and 5 monitor rainfall, temperature, humidity, wind, and solar radiation on an hourly basis. Data is downloaded remotely through cellular modems.

Equipment in all station sites is housed in heated huts to enable year-round monitoring of water and weather.

Soil sampling is undertaken on a rotational basis for all fields under nutrient management plans. Samples are taken once every three years, as per provincial guidelines, on a field-by-field basis and analyzed for nutrient content. The results are used as part of the nutrient management process to calculate fertilizer application rates.

Greenhouse gas sampling is being conducted in partnership with the Nova Scotia Agricultural College to measure the effects of manure spreading and fertilizer applications in the nutrient management fields. Sampling is carried out along a field transect from the centre of the field to its edge, across the riparian buffer. Gas samples are taken in the winter, at pre-planting and post-planting, during the growing season and at post-harvest, and are analyzed for nitrogen dioxide (NO_2) content.

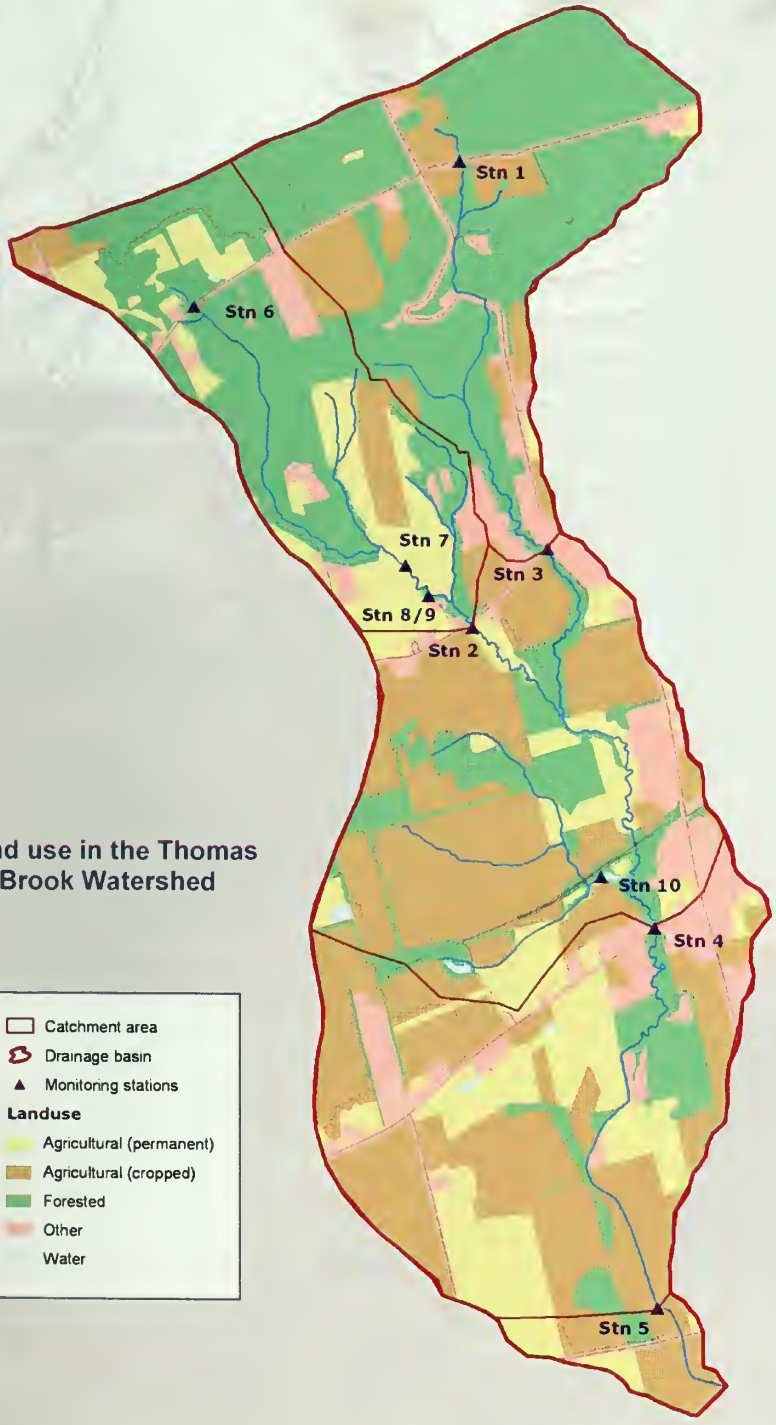
Pictures from left: Station 5 auto-sampler storage shed, equipped with a weather station; soil sampling in nutrient management field; greenhouse gas emission sampling; uploading water depth and temperature data from AquaRod at Station 2

Thomas Brook was assessed for **riparian health** from the headwaters to the outlet in 2006. The assessment was a pilot initiative for Nova Scotia, with the aim of evaluating riparian areas in an agricultural watershed. Employing the Alberta Riparian Habitat Management Society's Cows and Fish methodology, a scoring of riparian health was established by evaluating features such as land use, slope, riparian width, and plant types.

The assessment indicated there are some areas with poor riparian health, but most of the brook is fairly healthy. However, it should be noted the system of assessment is based on land formation and conditions in Western Canada.

The success of the assessment in the Thomas Brook Watershed has enabled the expansion of riparian assessment work to other watersheds in Nova Scotia.

Cows and Fish methodology has been used to assess riparian health in the Thomas Brook Watershed



Land use in the Thomas Brook Watershed

In addition to water quality monitoring, the Thomas Brook WEBs project includes a detailed **land-use assessment** (see left), that will form part of an extensive economic assessment of the relative costs and benefits of BMP implementation.

An economic farm optimization model is being developed in partnership with the Nova Scotia Agricultural College that will include riparian fencing and nutrient management plans.

A **hydrologic model** based on the Soil and Water Assessment Tool (SWAT) is also being developed through the Nova Scotia Agricultural College and Dalhousie University. This model has been calibrated successfully at the project site.

WEBs studies will lead to a greater understanding of the ecology of the Thomas Brook Watershed, thus bringing us a step closer to achieving improved water quality and a clearer picture of the value of BMPs for agriculture and the environment.

Methods and findings from this study may one day be applicable to larger watersheds and contribute to a better quality of life for more Canadians.

Project Partners

WEBs is a multidisciplinary project led by Agriculture and Agri-Food Canada, with Ducks Unlimited Canada a key funding partner. Various other provincial and federal government departments, universities, and conservation groups are also providing valuable cash and in-kind contributions. The support of local producers and watershed associations has greatly contributed to the project's success. The project's overall national budget totals more than $16 million.

Other participating partners in the Thomas Brook WEBs project include: Nova Scotia Agricultural College, Nova Scotia Federation of Agriculture, Nova Scotia Department of Agriculture, Dalhousie University, the Applied Geomatics Research Group of the Centre of Geographic Sciences and the Geological Survey of Canada (Natural Resources Canada). The local landowners are also a critical part of the project through their participation and cooperation with BMP implementation and evaluation.

Further Information

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