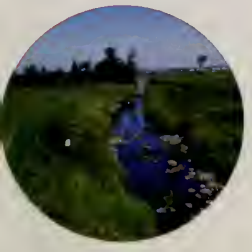
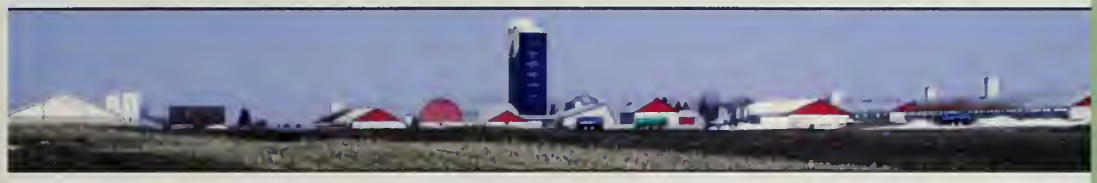
Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada



Watershed Evaluation of Beneficial Management Practices (WEBs)



Bras d'Henri/Fourchette

Quebec

British Columbia
Alberta
Government of Saskatchewan
Manitoba
Ontario
Québec
Newfoundland Labrador
Nova Scotia / Nouvelle-Écosse
New Nouveau Brunswick
Prince Edward Island
Yukon Government
Northwest Territories
Nunavut
Canada

Ducks Unlimited Canada
Canards Illimités Canada

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.

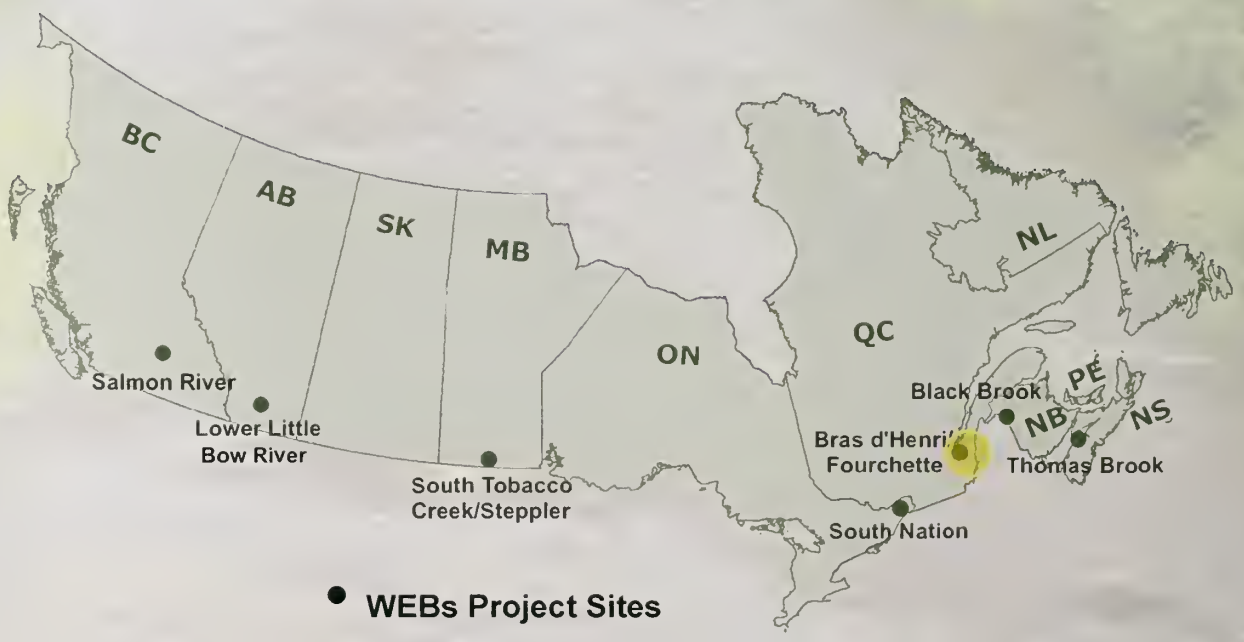
The long-term history of conditions and trends is generally well understood at each of the seven WEBs watersheds, due to past activities and data collection by local watershed associations and multi-agency teams. It is anticipated that these sites will continue as long-term benchmarks for watershed health.

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.

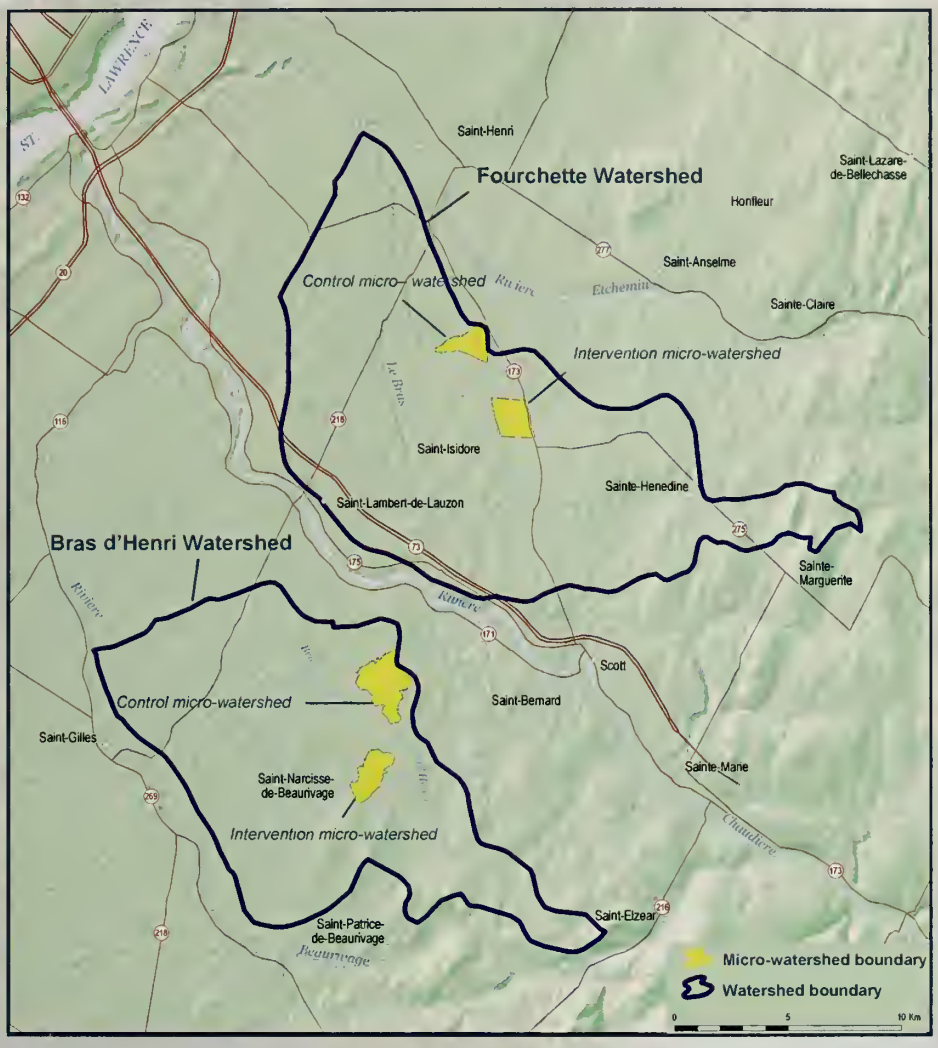
Integrated modelling is underway at the South Tobacco Creek and Bras d'Henri sites. This component incorporates hydrologic, environmental, economic and producer behavioural aspects into a multi-faceted decision tool at the micro-watershed and larger watershed scale. Models are being validated using actual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



● **WEBs Project Sites**

Bras d'Henri / Fourchette Watersheds

The WEBs study occurs within two sets of twin micro-watersheds (approximately 300 hectares each); one pair in the Bras d'Henri Watershed (map below) and the second pair in the Fourchette Watershed.



The Bras d'Henri River, which drains a 150-square-kilometre area, originates in the foothills of the Appalachian Mountains and flows through the fertile St. Lawrence Lowlands in the Beaurivage Watershed of the Chaudière River. This watershed supports one of the highest concentrations of animal production in Quebec, and nearly two-thirds of the area is cultivated.

The Fourchette feeder is part of the Le Bras Watershed (drainage area 222 square kilometres), a tributary of the Etchemin River. Water quality within the Etchemin River Watershed ranks as the second poorest in Quebec in terms of its phosphorus load.

The Bras d'Henri and Fourchette watersheds are a rich source of existing water quality, soil quality and agricultural management practices data. Water quality monitoring has been conducted in the Bras d'Henri River since 1988, with hydrometric measurements taken since 1972. Expertise in hydrologic modelling and cost-benefit studies of surface and sub-surface drainage practices at the sub-watershed level dates back to 1995. A team of federal, provincial and university researchers exists in the region.

The selection of the Bras d'Henri intervention and control micro-watersheds was based on a comparison of hydrological and geophysical parameters, including topography, land use and pedology.

The Fourchette twin watersheds study, administered by the Research and Development Institute for the Agri-Environment (IRDA), has been underway since 2001. It has established a significant relationship in the export of non-point source sediments and nutrients (nitrogen and phosphorus) from the two micro-watersheds. As an established watershed study, with a very similar mandate to that of the Bras d'Henri WEBs project, it was logical for the two studies to be linked together under the WEBs umbrella. AAFC manages the Bras d'Henri project, and IRDA continues to manage the Fourchette project.

It is anticipated that the symbiotic relationship developed between IRDA and AAFC will result in an increased understanding of nutrient and pathogen transport mechanics as well as the development of technology transfer techniques. Research in this network of four micro-watersheds located in the same agri-climatic region should confirm temporal trends in water quality improvements resulting from BMP implementation.

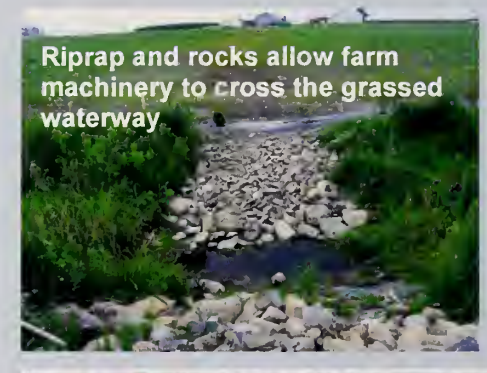
Beneficial Management Practices at the B

Four BMPs are being assessed in the Bras d'Henri and Fourchette WEBs project. The surface runoff intervention micro-watersheds and are being measured at the micro-watershed outlets. The reduced Watershed only and cover 30 per cent of the cropped land within the intervention micro-watershed. T intervention micro-watersheds are then being compared with those of the control micro-watersheds,

Surface runoff control

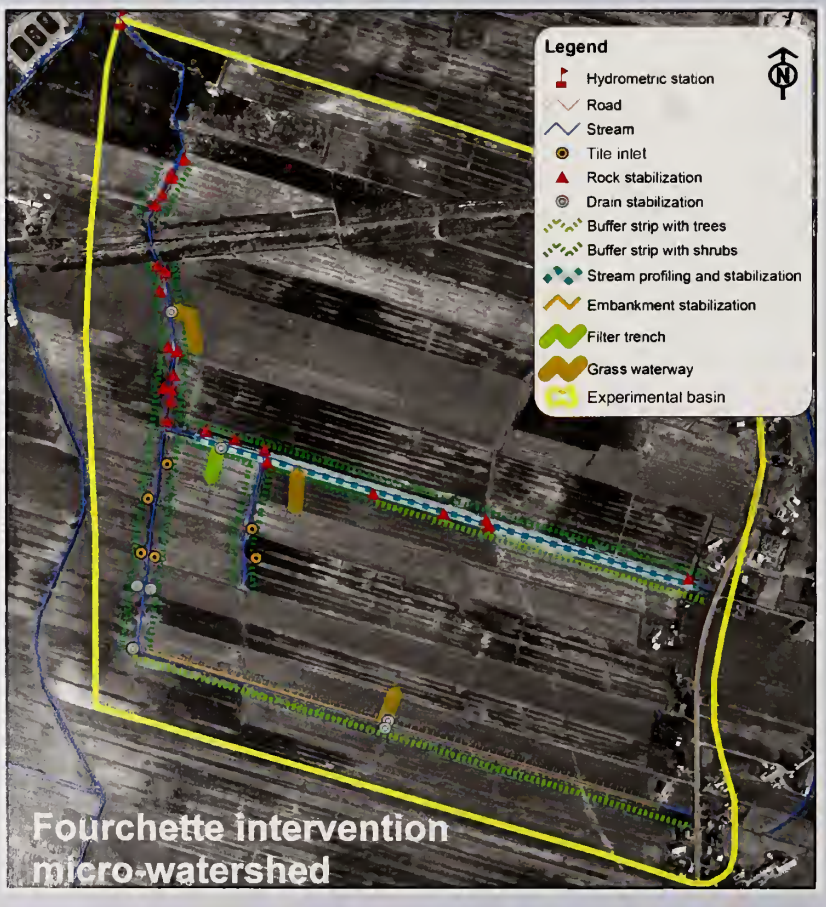
Sediment and contaminant transport from agricultural soils to ditches and streams is exacerbated locally by steep unstable streambanks, continuous annual cropping, and a general lack of soil-water erosion-control measures. Efforts to address this issue include producer education, establishing riparian buffer strips, reducing the side slope of stream and ditch banks, protecting tile-drain outlets and establishing grass waterways and filter trenches.


Riparian buffer next to graded ditch in the Fourchette micro-watershed


Riprap and rocks allow farm machinery to cross the grassed waterway

Re-grading the ditch banks in the Bras d'Henri micro-watershed

Bras d'Henri interv micro-watershe



Fourchette intervention micro-watershed

Crop rotation


Alfalfa crop

Image from PFRA photo library

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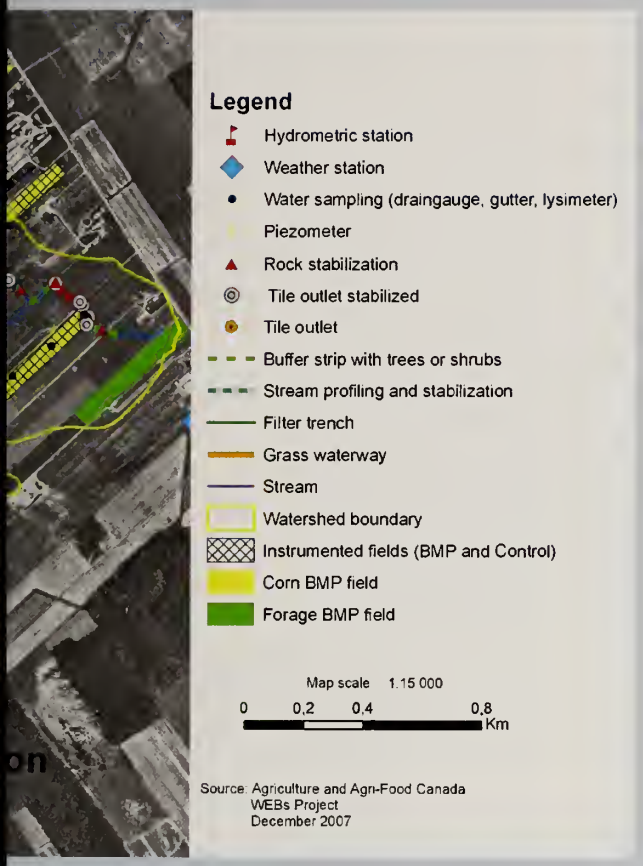
trol and crop rotation BMPs are being implemented in both the Bras d'Henri and Fourchette bicide use and hog-slurry application BMPs are being implemented in the Bras d'Henri e BMPs are being assessed through edge-of-field testing. Results from the analysis of the ere BMPs have not been implemented, to assess the effects of all the BMPs on water quality.



Hog slurry management

Provincial regulation: Hog slurry must be applied using a spreader equipped with a low boom with splash plates to reduce odour emissions

Application of slurry with trailing hoses mounted on the low boom, and followed by rapid incorporation, minimizes ammonia volatilization and odour emissions

Most of the nitrogen present in liquid hog manure is in the form of ammonia, which is prone to volatilization immediately following field application. Atmospheric ammonia deposition has been linked to soil acidification and has also raised human-health concerns. Volatized ammonia can also travel extensive distances from the site of slurry application. For these reasons, broadcast application of hog slurry was banned in the province in 2005. Provincial guidelines now recommend the use of a spreader with a low ramp. Although an improvement on the traditional broadcast method, the low ramp still leads to ammonia volatilization.

In order to reduce the amount of nitrogen loss through manure spreading in the Bras d'Henri Watershed, the hog slurry is applied to forage and corn through the use of a spreader that has trailing pipes or hoses. The slurry is shallow-incorporated shortly after application. In addition, the slurry is applied to post-emergent crops, so that plants can optimize phosphorus and nitrogen uptake, which further reduces the risk of water and air pollution.

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Reduced herbicide use

A weed-control program on corn fields involves reducing the use of herbicides. Testing has been underway since 2005 on an AAFC-developed herbicide reduction decision-support system (DSS). The DSS is based on the use of an *intervention threshold;* when favourable conditions are met in a particular field, the DSS recommends no herbicide treatment and allows weeds to grow.

The idea of intentionally leaving weeds in the field can be difficult for many producers to accept. However, under certain experimental conditions, DSS use has helped reduce the use of herbicides by as much as 30 per cent. Further evaluation of the system will indicate whether farmers can use it under actual working conditions, whether reducing herbicide use has an impact on crop yields, and whether there are any economic or environmental benefits.

Other practices are also being tested, including mechanical weeding and better management of different herbicides and their application (e.g. sprayer calibration). Atrazine use was reduced in 2007 and the weed pressure was evaluated in BMP fields in order to make recommendations for 2008.

The DSS involves the diagnosis of digital photos of post-emergent crops

Monitoring Techniques

Water quality and quantity within the Bras d'Henri control and intervention micro-watersheds, and the Fourchette control and intervention micro-watersheds are monitored at each outlet (as marked on the BMP map on the previous pages). In addition, interactions at the field-stream interface are monitored within the Bras d'Henri intervention micro-watershed.

Water quality is being monitored at the micro-watershed outlets by automated multi-probes for temperature, turbidity, electrical conductivity, pH and oxidation reduction potential (also referred to as ORP or Redox). In addition to the multi-probes, water samples are drawn hourly from the outlet stream using auto-samplers. Samples are collected every two days, and every four days composite samples are analyzed for various forms of nitrogen and phosphorus, as well as other nutrients. Every eight days composite samples are analyzed for herbicide concentrations.

Water samples are collected manually for *E. coli* count and *Salmonella* (presence or absence) within 24 hours during nine hydrologic events split in two rainfalls as follows: two samples before the spreading of slurry, three after spreading, two at base flow (low water table in summer), and two during water recharge in fall.

Picture above: Flow calibration at the Bras d'Henri intervention micro-watershed outlet

Picture left: 48-hour composite sampling of stream water sub-samples, Bras d'Henri

Edge-of-field studies are being carried out at the Bras d'Henri intervention micro-watershed. Ten fields are under instrumented study, with six fields under corn (three receive BMP treatment and three are control) and four under forage (two receive BMP treatment and two are control).

Crop yields in the BMP fields are being compared to those of the control. Other comparisons are being made between soil and water quality. Water sampling is undertaken during nine rainfall events throughout spring, summer and fall (as described above). Drainage water is collected from below the root zone using drain gauges, suction cup lysimeters and secondary tile drain collector outflows. Surface runoff is collected using adapted gutters. These samples are analyzed for nitrogen and phosphorus forms and major ions.

In addition, water sampling for pathogens, herbicides and microbiological biodiversity is carried out at the edge-of-field level during six rainfall events per year.

Meteorological stations, installed at the two Bras d'Henri micro-watershed outlets, are equipped with sensors for monitoring air and soil temperatures, relative humidity, mean vapour pressure, wind speed and direction, net radiation, soil water content, precipitation and snow depth. These variables are used to calculate the water balance and soluble runoff.

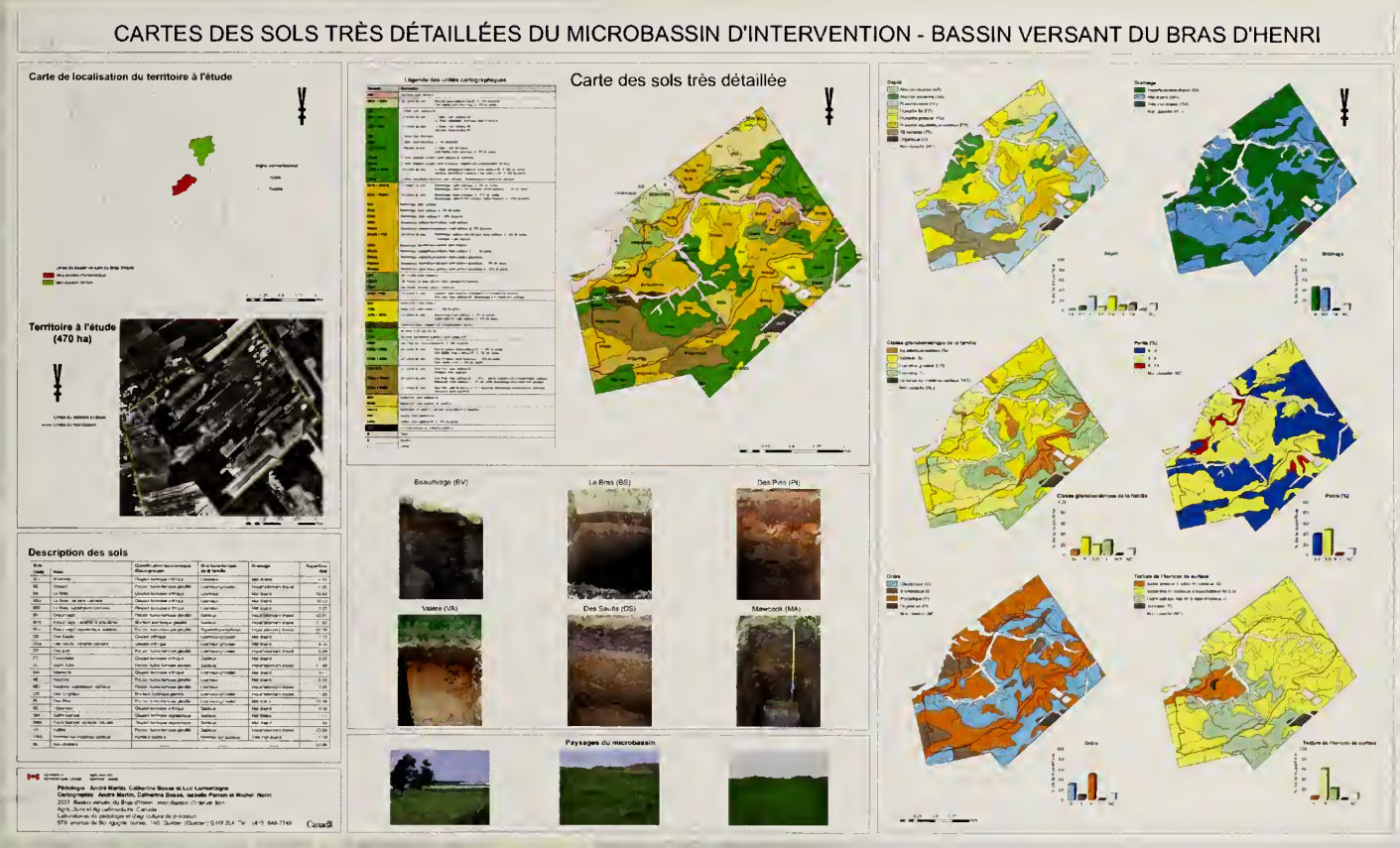
Pictures from left to right: Flow calibration and sampling at Bras d'Henri control micro-watershed, meteorological station and auto-sampler at Bras d'Henri control micro-watershed, water and sediment sampling at spring melt, observation well at the Fourchette control micro-watershed—the observation well is used to characterize water quality under the snow and ice cover

An extensive **soil survey** (see figure below, in French) has been undertaken for the Bras d'Henri and Fourchette Watersheds. It is anticipated that the results of the survey may increase understanding of the processes of nutrient and sediment transport, as well as temporal trends relating to pedology and to water quality.

Beyond the study's ongoing environmental evaluations, McGill and Laval Universities are also collecting economic data to develop a benefit-cost analysis for the BMPs implemented within the Bras d'Henri Watershed. Gaining an economic perspective on the four new management practices that the WEBs project has introduced will help researchers determine the financial practicality of promoting the wider adoption of various BMPs.

Sampling to classify soil profiles in the Bras d'Henri Watershed

1:15,000 scale soil map of the Bras d'Henri intervention micro-watershed



Hydrologic modelling is also being conducted to assist in quantifying the water quality benefits of the BMPs and to project these effects across larger watersheds. The Bras d'Henri Watershed is one of two WEBs project sites where data from economic and hydrologic models are being fed into an **integrated model**. The Institut national de la recherche scientifique, Eau, Terre et Environnement has designed an integrated model (GIBSI) to generate various BMP scenarios for the Bras d'Henri Watershed. This information is being used to demonstrate economic and environmental tradeoffs, both at the farm and watershed scales.

WEBs studies will lead to a greater understanding of the ecology of the Bras d'Henri and Fourchette Watersheds, 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 Bras d'Henri and Fourchette WEBs project include: Producers and counsellors of the agri-environmental club (Club de fertilisation de la Beauce); the Research and Development Institute for the Agri-Environment (IRDA); Institut national de la recherche scientifique Centre Eau, Terre et Environnement (INRS-ETE); Québec Ministry of Agriculture, Fisheries and Food; Québec Ministry of Sustainable Development, Environment and Parks; Environment Canada; Geological Survey of Canada (Natural Resources Canada); the Government-Related Initiative Program of the Canadian Space Agency; McGill University; and Université Laval.

Further Information

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AAFC# 10315E *Disponible en français* *January 2008*