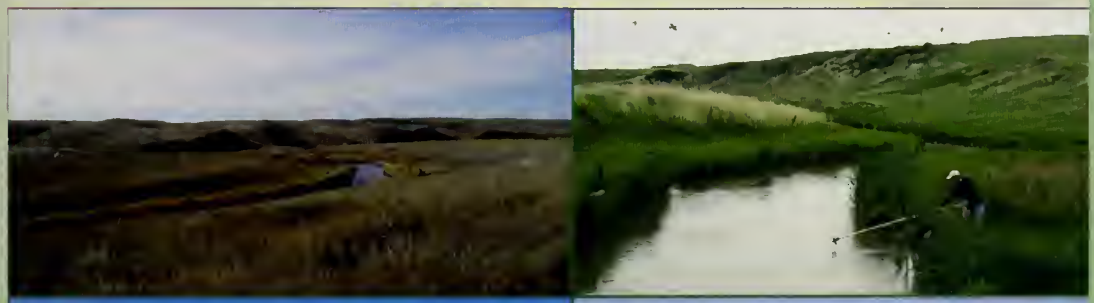
Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Watershed Evaluation of Beneficial Management Practices (WEBs)

Lower Little Bow River

Alberta



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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.

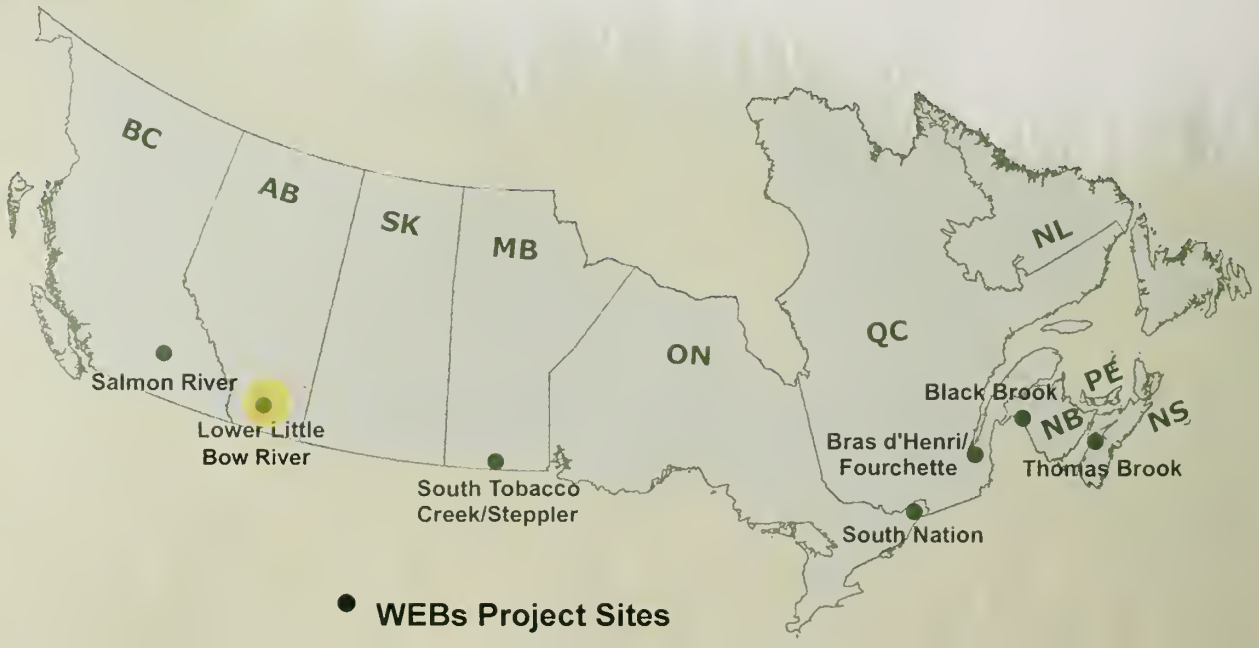
The long-term history of conditions and trends is generally well understood at each of the seven WEBs watersheds, due to past activities and data collection by local watershed associations and multi-agency teams. It is anticipated that these sites will continue as long-term benchmarks for watershed health.

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.

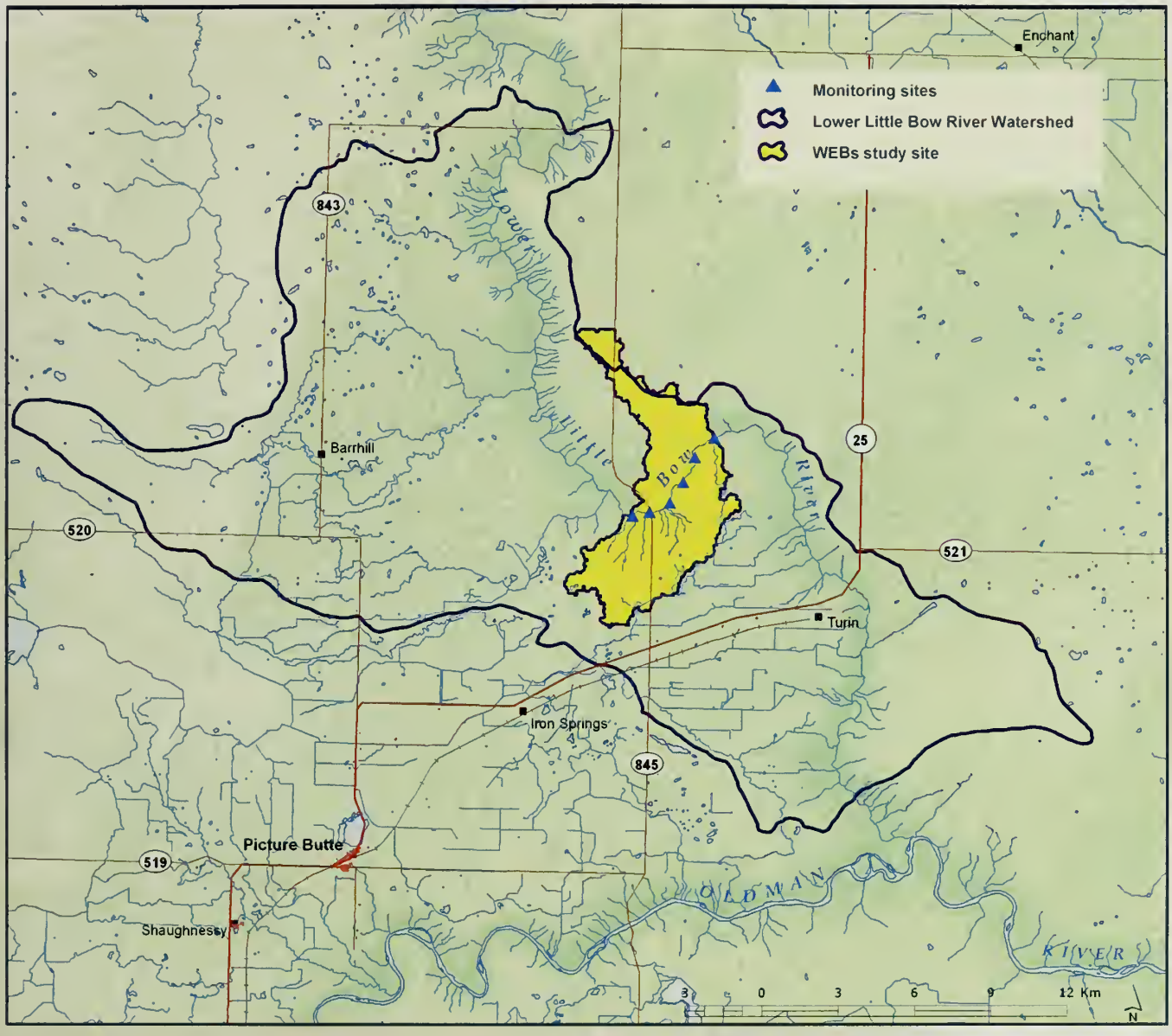
Hydrologic modelling is being conducted at each WEBs site in order to characterize watershed processes under baseline conditions and to examine the water quality benefits of BMP implementation. In most cases, models based on the Soil and Water Assessment Tool (SWAT) are being used to evaluate the impact 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.



Lower Little Bow River Watershed

The 55,664-hectare Lower Little Bow River Watershed is located within the Oldman River Basin in southwest Alberta. The Lower Little Bow River WEBs project focuses on a micro-watershed (2,565 hectares) north of Lethbridge.



Land use in the Lower Little Bow River Watershed includes a wide range of agricultural activities and intensities such as cow-calf operations on native range, dryland farming, intensive irrigated row crop farming, and intensive livestock operations. Currently, there are 13 farms within the study area.

Surficial geology consists mainly of glacial till. The upland terrain is undulating with slopes between two to five per cent. Soils in the watershed are primarily Dark Brown Chernozems, with some Regosols adjacent to the river.

The climate is dominated by strong chinook winds. Average annual precipitation is about 386 millimetres, of which approximately one-third falls as snow. Flows in the Lower Little Bow River are controlled by irrigation reservoirs and runoff often occurs from fall irrigation. Nutrients from manure and fertilizers, and bacteria from manure, are believed to be impacting water quality in the Lower Little Bow River.

Considerable background information is available on this watershed, much of it collected under the Oldman River Basin Water Quality Initiative.

Since 1999, Alberta Agriculture and Food has quantified phosphorus, nitrogen, fecal coliforms and *E. coli* in surface runoff at 10 monitoring stations along the Lower Little Bow River. Runoff from a micro-watershed within the basin was studied by Alberta Agriculture and Food from 2002 to 2005 as part of the provincial soil phosphorus limits study.

Beneficial Management Practices at th

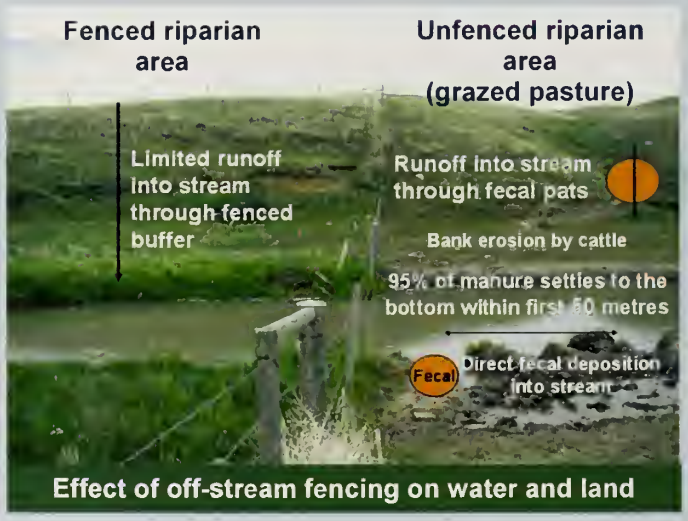
Five BMPs are being assessed within the Lower Little Bow River Watershed.

Off-stream watering with fencing

An 800-metre reach on either side of the river has been fenced to eliminate cattle access to the riparian area, and an off-stream watering system has been installed (see map for locations). Water quality is monitored both upstream and downstream of the fenced area. Riparian health of the reach was evaluated before and after fencing. A rainfall simulator is used to generate runoff.

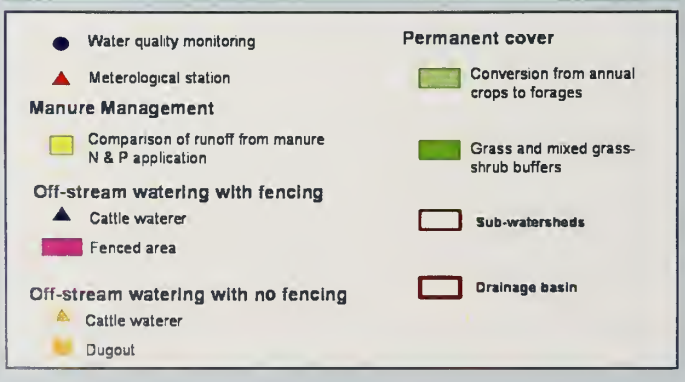
Off-stream watering without fencing

An off-stream watering system (see picture below) was installed at a summer and winter pasture used by 500 head of cattle. River water quality has been evaluated before and after BMP implementation, progressing downstream within the affected reach. A rainfall simulator is used to generate runoff adjacent to the river. Cattle behaviour and fecal pat distribution adjacent to the river have been evaluated before and after installation of the off-stream watering system.



Effect of off-stream fencing on water and land

The illustration on the left shows how cattle exclusion fencing reduces fecal contaminants into water systems at the Lower Little Bow River.



Lower Little Bow River Watershed

Buffer strips

The combined effect of vegetation type and buffer width on runoff water from irrigated fields is being evaluated using in-field buried runoff collectors and border irrigation experiments. The effect of buffer type on leaching of nutrients is being examined.

The picture on the left shows a grass buffer strip comprised of both tame and native grass. The pictures below show a buffer strip comprised of both grasses and shrubs.

A control buffer using only barley has also been established. Buffer strips at three widths (3, 6 and 9 metres) are being tested for their effectiveness in removing contaminants from surface runoff. The rationale for this BMP study is that the majority of studies have focused on the performance of wider buffer strips (over 30 metres), which are a less attractive option to producers.

Conversion of cropland to forages

Two fields under irrigated barley have been converted to forages. Field #1 (left) was converted to alfalfa in 2006.

Field #2 (left) was converted to alfalfa in 2005. A rainfall simulator has been used to generate runoff before and after conversion. The water quality of the runoff under barley (pre-BMP) is being compared to that of the runoff under forage (post-BMP).

Manure management

Previously, manure was applied based on the nitrogen (N) requirement of crops and, consequently, phosphorus (P) has accumulated in the soil. Few studies have documented the effects of runoff under N versus P-based manure applications. A rainfall simulator is being used to evaluate the effect of this BMP on N and P in runoff in small research-type plots.

Monitoring Techniques

Water quality and quantity within the Lower Little Bow River Watershed are **monitored** at six sites (as marked on the BMP map on the previous pages). Each monitoring station is equipped with stilling wells, float assemblies, and data loggers to measure river discharge. Four of the monitoring stations (LBW1, LB4-14, LBW4 and LB4) also feature data sondes (multi-parameter probes) which continuously monitor water quality variables.

Water samples from the Lower Little Bow River are collected manually on a weekly basis from April to October, and once a month during the winter. These samples are then sent to a laboratory for sediment and nutrient analysis. Samples taken from the upstream station, LBW1, provide a control, whereby any notable increases in contaminant can be measured at downstream stations. Samples are taken manually for bacterial analysis at the same frequency as the sediment and nutrient samples, downstream from the cattle access area.

Accurate water quality monitoring was impeded by a lack of sufficient precipitation to generate natural runoff in the watershed. However, the use of a Guelph rainfall simulator allows for the successful reproduction of a runoff event. The simulator is portable and has been used on most BMPs.

Picture above: Monitoring station at LBW3

Picture left: Guelph rainfall simulator

Originally, monitoring of the **buffer strips** was to consist of in-field runoff collectors positioned at defined distances from the upslope edge of the plots (0, 5, 15 and 30 metres). However, runoff collectors collected insufficient runoff due to a lack of precipitation, coarse textured (sandy) soils and low slopes.

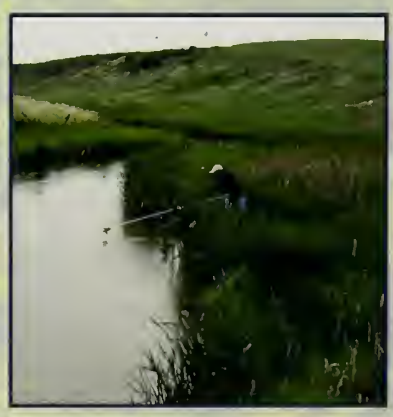
The methodology has been adapted to include results from border irrigation experiments, whereby narrow (1 metre wide) strips are being evaluated on the grass buffers at 3, 6 and 9 metre buffer widths, and on the mixed grass/shrub buffers at the 6 metre buffer width.

The plots are pre-wetted and then border experiments are conducted. High nutrient stream water is pumped and delivered to the upper end of each strip, with outflow collected and discharge volume monitored. The nutrient content at the outflow is compared to that of the inflow to assess the effectiveness of the buffer strips in filtering these nutrients. The original runoff collectors have been left in place and are sampled during times of heavy natural runoff.

The samples are analyzed for sediments, nitrogen (N) and phosphorus (P). High infiltration and low runoff in the buffer plots indicate the possibility of nutrient leaching through the root zone en route to the river. Soil samples are being collected to investigate this possible transport route. Soil has been sampled from 0 to 150 centimetre depths.

A meteorological station by LBW3 monitors rainfall, temperature, relative humidity, soil surface moisture, wind speed, barometric pressure and solar radiation on an hourly basis.

Pictures from left to right: On-site analysis of water samples at LB4-14, pre-wetting mixed grass-shrub buffer strip prior to border irrigation experiments, grab sampling at LB4, runoff collector in forage field



Cattle behaviour is being studied in the area with off-stream watering and without exclusion fencing. Observations were taken every five minutes from sunrise until sunset for three days during the summers of 2005 and 2006 (for pre- and post-BMP comparison).

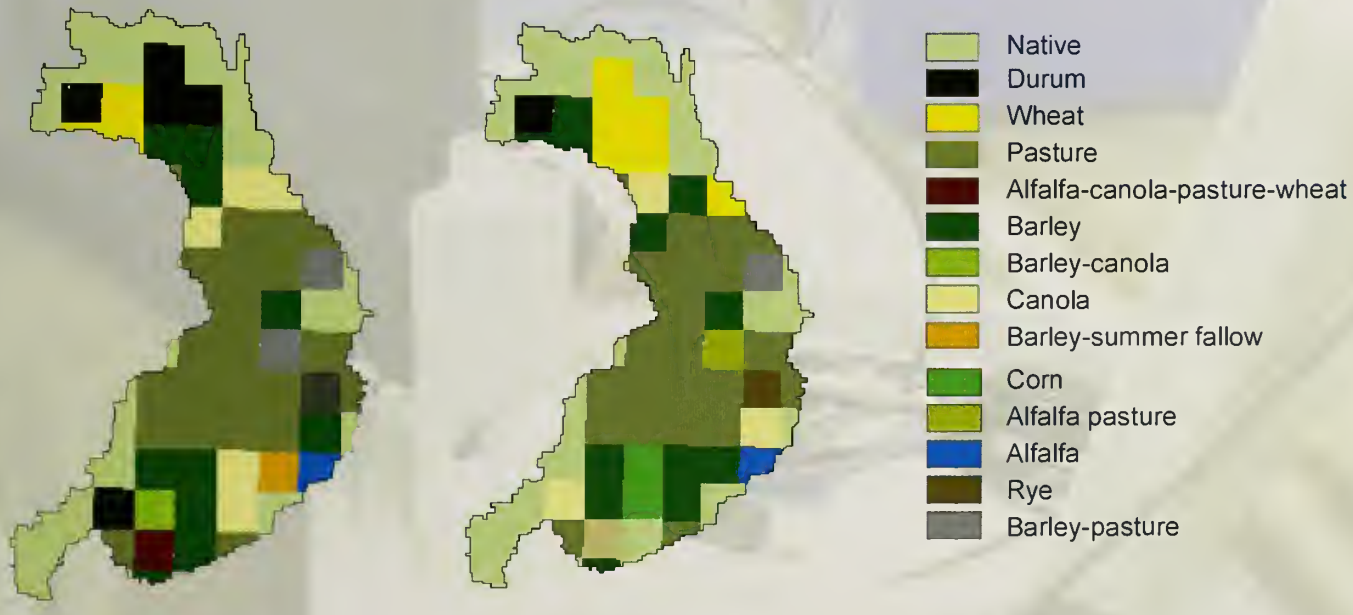
These observations were taken from a distance through binoculars so as not to influence cattle behaviour, and included such factors as the number of cattle in the river, the number of cattle drinking from the river, and the number of cattle on the riverbank. Fecal pat distribution surveys were also carried out both before and after the installation of the thermo-sink watering devices (completed in August 2005).

Daubenmire frames are used to determine vegetation and soil properties to relate these factors to runoff. Rangeland health assessments were carried out by Alberta Sustainable Resource Development in 2005 and by Alberta Agriculture and Food in 2007. Riparian health assessments were conducted by Cows and Fish (an initiative by the Alberta Riparian Habitat Management Society) in 2001 (prior to fencing) as well as in 2005 (post-fencing). Findings from these assessments will be used to evaluate the effectiveness of the BMPs. Soil samples are taken annually from both the cattle exclusion and grazed pastures and analyzed for N and P.

Cattle behaviour is being studied as part of the BMP assessment

Soil samples are collected from plots in the manure management field in the fall, and analyzed for N and P to determine manure application rates for the following spring. The manure itself is also analyzed for N and P content and weighed and applied to treatments by hand, at calculated rates.

The effectiveness of the entire suite of BMPs is being assessed at monitoring station LB4, which lies at the watershed outlet.



Land use 2005 **Land use 2006**

In addition to water quality monitoring, the Lower Little Bow River WEBs project includes a detailed **land-use assessment**. Land-use history has been gathered for the watershed (see above) and will form part of an extensive economic assessment of the relative costs and benefits of BMP implementation. Factors being assessed include calf and cow weight gains from off-stream watering and other analytical approaches. A farm-level simulation model is being developed at the University of Alberta that will include riparian fencing and grass buffer strips. A **hydrologic model** based on the Soil and Water Assessment Tool (SWAT) is also being developed, and has been calibrated successfully at the project site.

WEBs studies will lead to a greater understanding of the ecology of the Lower Little Bow River 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 Lower Little Bow River WEBs project include: the County of Lethbridge, Fisheries and Oceans Canada, Alberta Agriculture and Food, and the University of Alberta. This WEBs project maintains a strong linkage with the Rural BMP Team of the Oldman Watershed Council.

Further Information

For more information on the Lower Little Bow River Watershed project, please contact:

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