Report of the Action Committee for Sustainable Land Management

November 14, 2012

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Acknowledgments

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In addition, the Action Committee would like to thank Gary Linkletter (Chair of the PEI Potato Board) who attended all our meetings and provided his personal insight into the challenges which producers face in today's agricultural economy.

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Executive Summary

The Action Committee for Sustainable Land Management was established to examine the most recent fish kill at Barclay Brook and answer why current measures continue to fail to protect streams and rivers. The Action Committee assessed such factors as non-agricultural runoff, stream flow trends, fertilizer and pesticide usage, field topography, soil structure, soil conservation practices used, watercourse buffer zone status, and field headland areas.

The work of the Action Committee included meetings with producers in the Barclay Brook watershed, site visits to the Barclay Brook stream and adjacent farm lands, gathering information about past fish kill events in the watershed, an examination of the watershed's physical geography, and the condition of its streams and tributaries.

The Action Committee found that, on balance of probabilities, the cause of the fish kills in 2002, 2005, 2011 and 2012 was the runoff of water and soil contaminated with pesticides from agricultural fields in potato production during and immediately following heavy rainfall events.

While pesticide use was consistent with conventional farm practices for growing potatoes, the Action Committee concluded that additional soil conservation practices needed to be implemented in the Barclay Brook watershed. A preliminary watershed soil conservation management plan tailored to the specific needs of the Barclay Brook area was presented.

Producers with row crops adjacent to streams must carefully match their work plans and farm practices to ensure that agrichemicals do not move from fields.

A total of 18 recommendations were made by the Action Committee. These were aimed at reducing the risk of reoccurrence of fish kill events in the Barclay Brook watershed. The recommendations could as equally be applied to agricultural production across Prince Edward Island.

Three key recommendations were considered by the Action Committee to be pivotal to the future success of any responsible farm management strategy in at risk watersheds, namely

- the need to implement soil conservation practices in fields adjacent to watercourses,
- the establishment of an environmental fund for the removal of land from agricultural production that is prone to soil erosion and surface runoff, and
- the need to have agricultural engineers examine fields causing fish kills as soon as possible after an event.

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Introduction

The Action Committee for Sustainable Land Management was established in July 2012 to examine fish kills that have occurred in Barclay Brook, western Prince Edward Island (Figure 1). Fish kills have been reported on at least four separate occasions in the past ten years and the Action Committee was tasked with determining why measures taken thus far have failed to prevent a reoccurrence.

The mandate for the Action Committee was broad and included an assessment of such potential contributory factors as pesticide usage, field topography (slope height and length), soil structure, soil conservation practices in use, the status of buffer zones flanking the stream, the effectiveness of field headland areas in preventing runoff, and the uptake by producers of the Alternative Land Use (ALUS) program.

The Action Committee evaluated current land management activities and undertook a review of sustainable land management options. The findings of the Action Committee were used to make recommendations to government on best land management practices available to crop producers and landowners and extension of program measures in ALUS. Recommendations of the Action Committee were designed with a view to their being applied across Prince Edward Island, to better ensure intense rainfall events no longer adversely impact river and stream health.

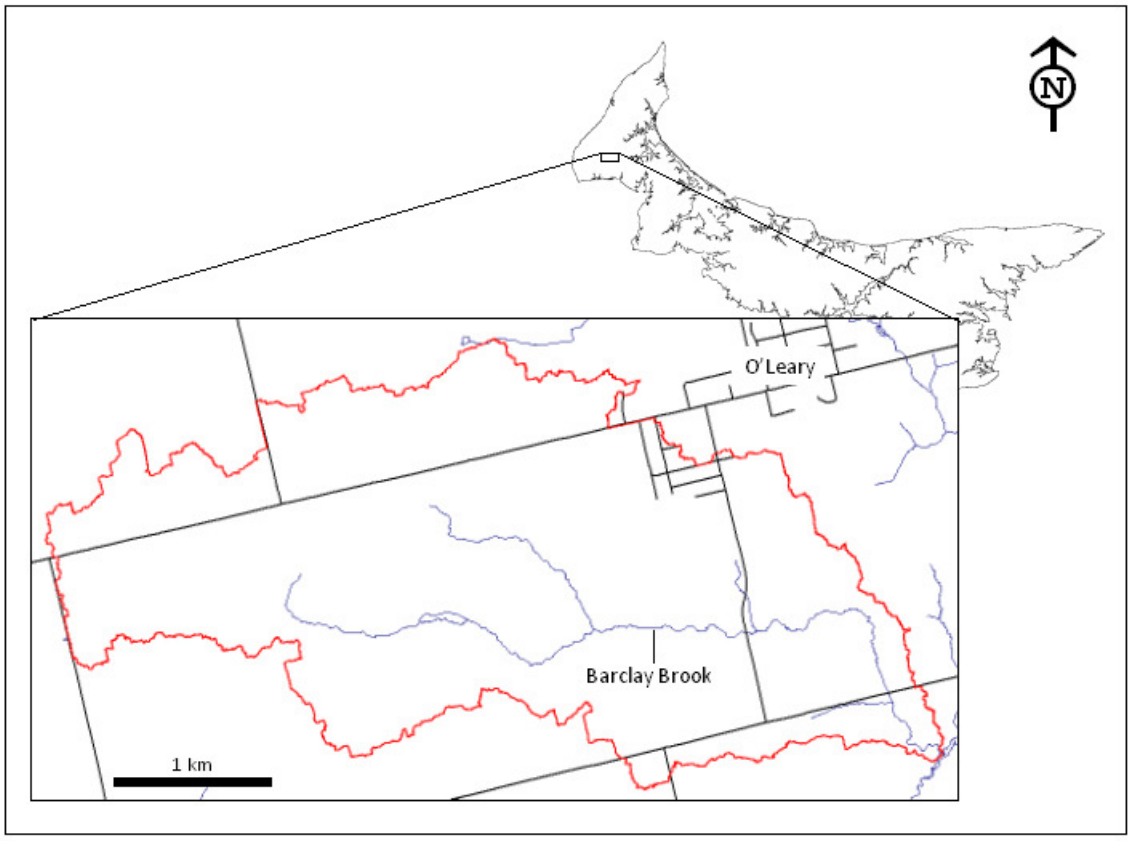

Figure 1. Barclay Brook and watershed

The Committee was a cooperative effort between the following agencies, namely the:

Prince Edward Island Department of Environment, Labour and Justice
Prince Edward Island Department of Agriculture and Forestry
Prince Edward Island Watershed Alliance
Trout Unlimited Prince County Chapter
Prince Edward Island Potato Board
Prince Edward Island Federation of Agriculture, and
CropLife Canada.

In addition, the Action Committee took advice from experts on issues including pesticide degradation, soil conservation, groundwater recharge and stream flow, and fish and fish habitat. The Action Committee also conducted site visits to the Barclay Brook watershed, and met with its agricultural producers. The broad level of participation in the work of the Action Committee by both supporting organizations and experts was essential to ensure that the Committee's recommendations will be both effective and practical.

This report summarizes the findings of the Action Committee and explains the rationale leading to the Action Committee's final conclusions and recommendations. The document is organized with individual conclusions and associated recommendations addressed subject by subject, and finishes with a summary of all the recommendations at the end of the report.

Watershed and Stream Conditions

Barclay Brook is a tributary to the Trout River located in western Prince Edward Island (Figure 1). The Trout River represents some of the best brook trout habitat in the province and is considered by several national angling publications as one of the top ten angling destinations in Canada.

The Barclay Brook has a watershed of 948 ha. A breakdown of land use is provided in Table 1. Stream flow during the summer follows a typical seasonal pattern, with declining flow rates related to groundwater base flow recession punctuated by higher flow rates due to rainfall events. The temperature in the stream is generally low due to the influence of its groundwater source and well within temperature tolerances for brook trout (between 1 and 22°C). In the summer of 2012, the temperature of the stream, measured near the Buchanan Rd., showed a maximum temperature of approximately 20°C in early August (data from the Prince Edward Island Department of Agriculture and Forestry).

The Committee observed that the streambed for the Barclay Brook is of two distinct types. Upstream from where dead fish were located in the 2002/2011 events, the streambed is comprised of small rocks and downstream the streambed is heavily silted with fine grain sediment.

Table 1. Land use in the Barclay Brook watershed (from Prince Edward Island Department of Agriculture and Forestry interpretation of 2010 aerial photographs).

Land Use Type	*Area (ha)*	*Percentage*
Agriculture	733	77%
Forest	85	9%
Wetland	34	4%
Developed Land	96	10%
Total	948	100%

Stream Flow Trends

There were no stream flow records for the Barclay Brook. To examine the likely long-term trends in stream flow, an analysis of local long-term groundwater levels was made by hydrogeologist for the Prince Edward Island Department of Environment, Labour and Justice (ELJ).

The ELJ monitors groundwater level on a permanent basis at wells located at Knutsford and Bloomfield (www.gov.pe.ca/environment/groundwater-levels). The long-term projection for groundwater levels at both monitoring wells is stable. Both wells had low water levels in 2012, approaching near historic lows due to low rainfall amounts during the season. It was concluded that stream flow rates in Barclay Brook for the summer of 2012 would also be expected to have approached historic lows.

The village of O'Leary is located partially within the Barclay Brook watershed. The village is served by a central sewer system and properties have individual wells for water supply. The central sewer system discharges to a different branch of the Trout River than the Barclay Brook. Thus groundwater well extractions from the Barclay Brook watershed in O'Leary were considered full withdrawals from the eventual groundwater base flow to the stream.

The ELJ assessment determined the likely volumes of water withdrawn from the groundwater aquifer would reduce the groundwater contribution to the stream flow by less than 6 per cent. Such a reduction in stream flow would not affect the quality of fish habitat.

Anecdotal evidence was provided that water levels in the Barclay Brook appeared lower than in previous decades. However, this is unlikely due to any decrease in groundwater contribution to stream flow, and more likely a result of in-filling of the stream bottom by siltation, which over the passage of time gives the appearance of less water.

Based on the evidence provided, the Action Committee concluded that groundwater pumping in O'Leary had little impact on the stream flow in the Barclay Brook.

Urban Surface Water Drainage

There are multiple tap drains and highway ditches that contribute surface water drainage to the Barclay Brook. The Action Committee noted that one drainage ditch, constructed to provide appropriate drainage to the O'Leary hospital parking lot, channelled water toward the Barclay Brook.

Drainage water from parking lots often contains oil, grease and toxic chemicals that have leaked from motor vehicles, silt and trash. While such discharges are important to water quality, this runoff is not generally associated with the type of acute fish kills observed in the Barclay Brook. Parking lot run off entered the Barclay Brook downstream of all but one of the fish kill locations. The Action Committee did not consider the issue further.

Weather

Weather patterns on Prince Edward Island are slowly changing as a result of long-term climate change. It is predicted that average summer temperatures will increase approximately 3°C by 2100. In contrast, total summer rainfall is not expected to change significantly, however, the 24 hour precipitation value (20-year return period) will increase by approximately 16 per cent (Richards and Daigle, 2011).

The probability of an event with a specified intensity and duration is called the return period or frequency. Recent studies have estimated that, by 2085, the intensity of 2 hour rainfalls with a 2 year return period will have increased by 29 per cent (AMEC, 2012).

The intensity and duration of rainfall events may have already started to change. A comparison of recent rainfall data from O'Leary (Shepherd, 2011) with historical data at the nearest station in Summerside (Environment Canada, 2012) showed an average increase of 12 per cent in rainfall of 5 min to 24 hours duration for a 2 year return period. While these are significant changes, current soil conservation methods should be capable of reducing soil loss which causes siltation of aquatic habitats.

Causes of Fish Mortalities in Barclay Brook

The Action Committee was made aware of five fish kill events on the Barclay Brook that occurred in 1967, 2002, 2005, 2011 and 2012 respectively. Since there is no comprehensive system for examining stream life on Prince Edward Island after large rainfall events, unreported fish kill events may have occurred. Virtually no factual information was available for the fish kill that occurred in 1967, and the Action Committee did not consider this event further.

For each of the four events since 2000, the Action Committee was able to determine the uppermost location in the Barclay Brook where fish kill events occurred (Figure 2). The uppermost point for the 2002 and the 2011 fish kills were the same. Locations for fish kills in 2005 and 2012 were entirely different from each and any other. The multiple fish kill sites at locations with different physical geographies suggests that a specific set of physical criteria did not contribute to all the fish kill events.

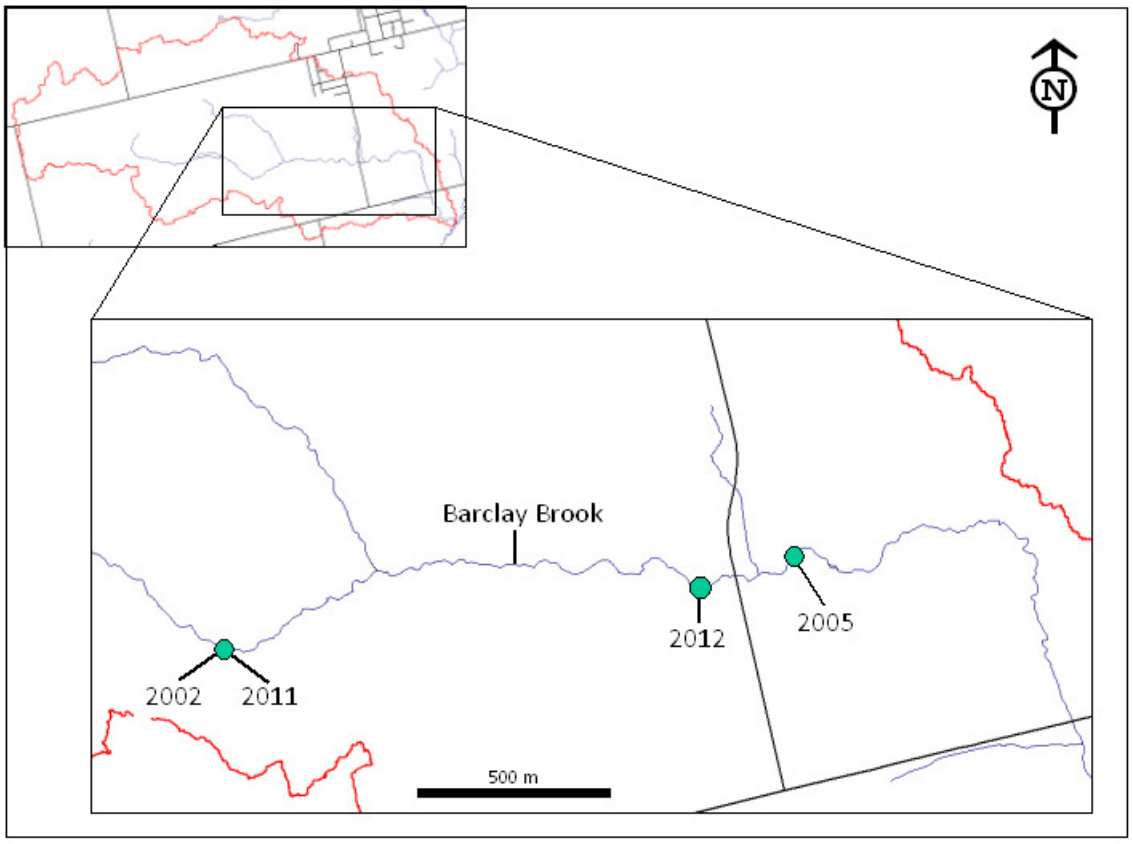

Figure 2. Approximate uppermost locations of dead fish found in the Barclay Brook for the years 2002, 2005, 2011 and 2012.

All four fish kills, since 2000, were associated with heavy rainfall events. Both the 2002 and the 2005 events occurred well before dead fish had been discovered. Consequently, any fish found were decayed well beyond the point where useful necropsy results could be gathered. As a result, fish specimens were not collected for necropsy following these two fish kill events.

Any delays in the time taken to sample water from watercourses where fish kill events have occurred are similarly counterproductive, since any causal agents would most likely have been transported downstream. As a result no water samples were taken in 2002 and 2005.

Fish necropsies were performed at the Atlantic Veterinary College following the 2011 and 2012 fish kill events. Fish were found to be well fed and not otherwise diseased. Fish death symptoms were considered consistent with either a lack of oxygen or the toxic action of some harmful substance that mimics oxygen starvation. However shortly after each fish kill, the water temperature and dissolved oxygen content in the Barclay Brook was within an optimal range for good fish health (Table 2) ruling out anoxia as a cause.

Table 2. Temperature and oxygen in the stream water of Barclay Brook at the Barclay Road shortly after fish kills in 2011 and 2012 (from the Dept. of Environment, Labour and Justice).

Parameter	*July 23, 2011*	*July 5, 2012*
Temperature (°C)	15.8	16.2
Dissolved Oxygen (mg/l)	8.6	8.6
Oxygen Saturation (%)	87	89

In both 2011 and 2012, pesticides were detected in moderate concentrations in water flowing into the stream and in downstream stream water samples. Pesticides were not detected in tissues of fish killed in the 2011 event. Results are not available for fish from the 2012 event. These results can occur when fast moving stream water rapidly moves the toxic chemical downstream before the event is discovered and fresh tissue samples can be collected. The toxicants are themselves quickly broken down by the fish's metabolism and no longer detectable, but the damage to the fish has been sufficient to cause death.

What causes the fish to die and why this occurred are related but separate questions. In all the cases studied, there was evidence of runoff water from the fields entering the stream following each rainfall event. However, there was no evidence of an agro-chemical spill or discharge of some other toxic chemical. Although no pesticides were detected in the tissues of fish samples that were taken, the Action Committee feels that on balance of probabilities, pesticide poisoning was the cause for both fish kill events.

Many of the fish kills that occurred in the past were a result of poor cultivation practices and crop management. These included the practice of cultivating fields up to the edge of watercourses in such a way as to facilitate soil erosion, soil runoff and pesticide contamination of the abutting watercourse.

The 2002 and 2005 fish kills had headlands planted in potatoes in adjacent fields that, in the Action Committee's opinion, would have promoted soil erosion and surface runoff. However, in the 2011 and 2012 fish kill events, there were no planted headlands in the suspect fields, yet there were still fish kills.

Buffer Zones

Riparian buffer zones are often defined as green vegetative zones along streams, rivers, estuaries, ponds, and lakes. Riparian buffer zones can have a very diverse selection of vegetation and provide numerous ecological and environmental benefits to the watercourses they border. Legislation was enacted in Prince Edward Island in 1999 establishing mandatory buffer zones around watercourses and some wetlands. A major revision of the rules was undertaken with the establishment of the Watercourse and Wetland Protection Regulations in 2008. At the time of the 2002 and 2005 fish kill events, buffer zones of 10 m were required for agricultural fields grown in row crops (such as potatoes) and having slopes of under 5 per cent

such as those found in the Barclay Brook watershed. Headlands are created at the ends of fields and used for turning farm equipment. In potato fields that are not adjacent to watercourses and wetlands, the headland is commonly planted in potatoes. In areas within 200 m of a watercourse or wetland, a grass headland needs to be established prior to and maintained during the potato crop year.

In 2008, the size of buffer zones for fields in agricultural crops (as well as under other land usage) was redefined to 15 m. The grass headland requirement was unchanged (www.gov.pe.ca/law/regulations/pdf/E&09-16.pdf).

Research in Prince Edward Island has shown that buffer zones will filter runoff water, intercepting nutrients, silt, pesticides and other contaminants. Pesticides concentrations in runoff were reduced by at least 52 per cent and 78 per cent in 10 and 30 m grass buffers respectively (Dunn *et al*, 2011). While these benefits are significant, buffer zones cannot trap all contaminants and fully protect aquatic habitat. In the four fish kills since 2000, fields adjacent to Barclay Brook had the prescribed buffer zone of either 10 or 15 m. Buffer zones can only be effective if runoff water passes through filtering vegetation without being channelled into large flows.

Grass headlands are designed to prevent water from being channelled as large flows. The 2002 and 2011 fish kills originated in the same field. In 2002, the headlands of this field were planted to potatoes but not the required grass headland. However, in 2011, this potato field did not have a headland planted in either potatoes or grass. In the two fields implicated in the 2005 and 2012 fish kills, the former did not have a grass headland while the latter field did. Consequently the Action Committee concluded that presence of a grass headland is not always sufficient to prevent surface runoff leading to fish kills and may need to be combined with other soil conservation measures.

The Action Committee notes that in the 2012 fish kill event there was a strip of bare soil between the ends of the potato rows and the grass headland. The Action Committee considered that this bare soil reduced the area available for filtering out both sediment and pesticides.

While the grass headland requirement in fulfillment of buffer zone regulations is clearly important, a field's soil and drainage characteristics, the height and length of the field's slope, and the crop cultivation practices used to farm that field will play a critical role in creating the conditions for excessive soil and water runoff that would overwhelm the filtering capacity of grass headlands and buffer zones. Consequently, the Action Committee believes that the bare stretch of uncultivated land alone was not the only factor contributing to the 2011 and 2012 fish kill events.

The Action Committee considered the potential benefits of using larger buffer zones as research has shown that the wider the buffer zone the greater the chance of removing pesticide contaminants from field runoff. However, it is clear that buffer zones alone cannot correct all drainage problems that can occur in fields. Where fields could benefit from

conservation practices and soil erosion control structures, these should be included as a part of standard management.

Recommendation

1. *The Action Committee recommends full compliance with the existing buffer zone and grass headland requirements found in the Watercourse and Wetland Protection Regulations.*

Agro-environmental Assistance Programs

The PEI Alternative Land Use Services (ALUS) Program is a voluntary, incentive based program offering annual financial incentives to Island crop producers and landowners for six specific environmental services that are "above and beyond" legislated requirements. Beginning in 2008, the program has been well received by the agricultural community as a means of doing more for the environment. While empowering farmers in conservation practices is not a new concept, Prince Edward Island remains the only Province in the country to adopt this type of agri-environmental program on a province-wide scale. To date, the ALUS program has approximately 400 producers/landowners providing services to the program. Across Prince Edward Island over 3,330 ha of land has been directly enrolled into the program. More importantly, this 3,330 ha improves land management decisions on over 60,000 ha of land. Some of the producers in the Barclay Brook are already participating in the program (Table 3 below provides a summary of ALUS activities in the larger Trout River watershed).

The Prince Edward Island ALUS program has an annual budget of one million dollars. The Province continues to partner with watershed groups and farm organizations to promote and implement the program. New incentives are being considered as the program will be undergoing a re-design as it moves into its second phase (5 year agreements) in the spring of 2013. Opportunities exist to achieve improved environmental outcomes from agricultural fields on the Trout River watershed through the PEI ALUS program.

Table 3. Agricultural land area enrolled under the ALUS Program in the Trout River (Roxbury) watershed (from the Department of Agriculture and Forestry).

ALUS Feature	*Area (ha)*
Tree planting and/or impacted buffer zone	7
Expanded buffer zone (beyond 15 m)	18
High sloped land retirement	4
Grassed headlands (further than 200 m from watercourse)	8
Soil conservation structures	9
Total	46
Other - Livestock fencing – exclusion from watercourses and wetlands	7, 711 m of fence

The Action Committee believes there is an opportunity to undertake a pilot project within the ALUS program in the Barclay Brook watershed. Research has shown that greater organic matter content will increase the adsorption of pesticides including the fungicide chlorothalonil (Patakioutas and Albanis, 2002) commonly used to prevent late blight disease in potato production systems. The pilot project's goal is to increase the amount of organic matter within the crop producing area of a field which in turn would reduce losses of pesticides in field runoff.

Recommendation

2. *The Action Committee recommends that the ALUS program undertake an organic matter pilot project in the Barclay Brook watershed.*

The Action Committee found that soil in some land backing onto the Barclay Brook has low organic matter levels as a result of intensive farm management practices leading to a greater likelihood of soil erosion and increased surface runoff. The Action Committee understands similar circumstances probably occur at locations throughout the province making watercourses more vulnerable to contaminated surface runoff.

Watercourses would benefit if these high-risk lands were taken out of production permanently. This is always an extremely difficult management decision for landowners to make, especially where land resources cannot be replaced. Handing over the ownership of these compromised areas to government would enable their removal from crop production so protecting the adjoining aquatic environment. Landowners would be compensated for their loss and could purchase more productive farmland to replace any lost production they might incur as a result. This would be part of an, ongoing process to address high-risk field sites across Prince Edward Island.

Recommendations

3. *The Action Committee recommends that the government establish an environmental impact fund in the amount of $200,000 per year to purchase 'at risk' agricultural land along watercourses to be managed by watershed groups for its natural capital.*

4. *The Action Committee recommends that watershed groups help identify vulnerable farmland along watercourses for possible purchase by the program.*

5. *The Action Committee recommends that the Department of Agriculture and Forestry assess land proposed for the program to ensure that it meets criteria for 'at risk' farmland that poses significant risk to neighbouring watercourses.*

6. *The Action Committee recommends the program purchases should be based upon local land prices plus a small additional amount to compensate the landowner for the inconvenience of securing replacement land.*

Recommendations (continued)

7. *The Action Committee recommends that additional funds be disbursed to watershed groups who accept the responsibilities of managing land under the program.*

Pesticides in Streams

Streams near agricultural fields where pesticides are applied are more likely to receive some level of pesticides via runoff following rainfall events. Unfortunately, with severe rainfall events, pesticide concentrations can become very high, and pose a threat to the health of aquatic life. Unfortunately, pesticide contamination of the aquatic environment has been found in numerous locations in North America (Helfrich, *et al,* 2009).

A summary of data from Environment Canada (Xing *et al*, 2012) has shown that pesticides are found in Prince Edward Island watercourses and more frequently following rainfall events. Pesticide concentrations in Prince Edward Island have been found above the Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life indicating their potential for harm to all forms of aquatic life. However, the studies' sampling protocols were not extensive enough to provide a picture of the full extent of pesticide contamination of Prince Edward Island's river systems

Pesticides Usage in the Watershed and their Properties

The pesticides used in the farmland surrounding the Barclay Brook are typical for crop rotations involving potatoes. In a typical potato year the crop would receive a seed treatment, a preemergent herbicide, a postemergent herbicide (if required), 10-15 fungicide applications, one insecticide treatment, and a desiccant to top kill the crop prior to harvest.

An effective fungicide program used for late blight disease prevention and management will rotate products such as chlorothalonil (Bravo/Echo) and mancozeb (Manzate/Dithane) every other application to reduce the likelihood of pesticide resistance developing. Other approved fungicide products may be used as well, but less often, and usually when disease pressure is high. Chlorothalonil and mancozeb are the most frequently used fungicides in the Barclay Brook watershed.

The environmental fate of applied pesticides depends on their solubility in water, soil mobility, persistence, and in certain cases, their toxicity. Solubility typically refers to the maximum amount of a pesticide that will readily dissolve in water, expressed in mg active ingredient (a.i.)/L. The greater amount of active ingredient that dissolves in water, the higher the risk it will be transported in water during a major rainfall event. Health Canada's Pest Management Regulatory Agency (PMRA) considers a pesticide to be water soluble when it can dissolve at a concentration of 10-100 mg a.i. / L. As examples, both chlorothalonil and mancozeb are considered to have sparingly low and low solubility respectively under the current PMRA classification system. This means that in fields meeting soil conservation objectives, both these

fungicides would present a low risk of dissolving in water and moving off site in elevated concentrations.

Pesticides are also attracted to soil particles and plant material in the soil. This attraction is described as adsorption and most often refers to the binding of a chemical to soil particles. It can vary according to soil type, soil pH and organic matter content of the soil. As organic matter content in soil increases, the bond between pesticide and soil particles increases to the extent that the pesticide can become irreversibly bound (Patakioutas and Albanis, 2002).

A pesticide with a low solubility typically has a high adsorption coefficient and is therefore at lower risk of being transported in water in large amounts because of how strongly it adheres to plant material and soil. If the soil remains in place, a pesticide bound to that soil will be at low risk of moving off site. Conversely, if the soil begins to move or run-off, the pesticide will move off-site with the soil. Because chlorothalonil and mancozeb both have a high adsorption coefficient under the PMRA classification system, they are considered highly mobile and mobile, respectively.

The persistency of a pesticide in soil is defined by the length of time it takes for half the pesticide to degrade. Factors influencing pesticide persistency include soil type, soil pH and soil temperature. A pesticide is considered non-persistent if it takes less than 15 days to degrade. However, the longer it takes for a pesticide to degrade the greater the risk it will be present in the environment and available to move off site during the cropping season. Chlorothalonil is considered slightly persistent while mancozeb is considered not persistent.

Pesticides are also categorized by PMRA for their toxicity to rainbow trout, based on acute concentration exposure. Categories range from very highly toxic (< 0.1 ppm), to practically non-toxic (>100 ppm). Chlorothalonil and mancozeb are considered very highly toxic and highly toxic, respectively. If both chemicals adhere strongly to the soil, and the soil remains in the field there is little risk posed to aquatic life. However, if the soil begins to move off site and into a nearby waterway there is a high risk that both pesticides may cause fish kills.

The amounts of pesticides that producers reported being used in the Barclay Brook watershed were all found to be within the label rates for each product. In some cases there may have been opportunities to utilize a lower risk product to address the crop issue at hand. This appears so in case of fungicides that must be applied regularly to prevent late blight. Chlorothalonil is often replaced with a product such as mancozeb. Where producers wish to alternate mancozeb with chlorothalonil, they can wait to use chlorothalonil, a higher risk product, when the potato canopy has become complete so lessening the possibility of pesticide reaching the soil during application.

Recommendations

8. *The Action Committee recommends that crop producers should regularly choose pesticide products that meet their field needs but have a lower risk for movement to and toxicity to fish in adjacent streams.*

9. *The Action Committee recommends that the Department of Agriculture and Forestry regularly examine its pesticide risk factsheet to determine whether there are newer pesticide products available that should be added.*

Agricultural Technology

The Action Committee noted two pieces of agricultural technology that can help reduce the movement from fields of soil material and any adsorbed pesticides. The first is the furrow dammer ('dammer dyker'), an implement that is mounted behind existing row hilling equipment. During the hilling operation, the furrow dammer places divots between the rows that catch water, encouraging it to soak into the ground instead of running off. While these divots cannot hold all of the water from a large rainfall event, research has shown that a significant reduction in the amount of water leaving a field can result (National Water Program, 2008); in one 70 mm precipitation event, the runoff from researchers' plots was reduced by 94 per cent by the presence of the divots.

The second technology uses Geographic Position Systems (GPS) to set up field rows. Precision farming of this nature produces potato rows that are exactly the same distance apart across the entire field. In potato fields, the crop canopy takes time to cover the rows and hills, so that pesticides applied using a conventionally calibrated sprayer, disperse pesticides on both the plant - the intended target - and the soil between potato rows.

GPS planted crops allow more precise application of pesticides. For example, by blocking off every second sprayer nozzle in the early part of the season, only half the amount of pesticide is applied, and it will fall onto the tops of developing plants in the hill and less so onto soil between the rows. This would reduce the amount of pesticide reaching the soil and lower the risk of field runoff causing fish kills.

Recommendations

10. *The Action Committee recommends that producers should be encouraged to use furrow dammers to reduce soil erosion by minimizing water movement in potato rows.*

11. *The Action Committee recommends that where possible, potato fields should be set up using GPS and then band sprayed for fungicide and insecticide applications to the tops of developing plants in the hill during the early part of the season prior to full canopy cover and row closure.*

Soil Classification and General Field Conditions

Soils along the Barclay Brook are moderately well to well drained with coarse loamy textures (sandy loam to loam). Soil mapping of the area identifies the soil types as Charlottetown and O'Leary Soil Series, typical of agricultural soils on Prince Edward Island. General soil landscape slopes range from 2 to 5 per cent. Soils of these types have been classified as suitable for a wide range of crops, forestry and grassland; however, high fine sand and silt content of these soils predispose them to erosion.

The Action Committee and soil and water engineers from the Department of Agriculture and Forestry conducted site visits to the Barclay Brook area to observe soil conditions, current land-use activities and existing beneficial management practices (BMPs). In addition, producers supplied soil analysis records for fields adjacent to the Barclay Brook to provide the Action Committee with an overall picture of 'soil health' in the area.

Soil analysis of the area indicated medium to high fertility levels, however organic matter values ranged from 1.8 to 3.0 per cent. An organic matter level of 1.8 per cent would be considered low while 3.0 per cent would be considered good. Soil tests from the Barclay Brook area indicated that, on many fields, the overall soil quality has been directly influenced by field management/rotation over the past 10+ years. With shorter crop rotations comes the expectation of poorer soil structure, higher soil erosion rates, reduced top soil depth and lower soil organic matter levels.

These characteristics are not apparent in all fields along the Barclay Brook. However, based on information gathered, the shorter crop rotation cycles used resulted in poor soil quality characteristics. Fields identified as having a two-year rotation with potatoes exhibited the poorest soil quality based on soil organic matter.

During August and September 2012, soil and water engineers from the Department of Agriculture and Forestry visited several fields near the uppermost location where dead fish were found in the 2012 Barclay Brook fish kill event. In one field, rill erosion between the potato drills was noted as well as soil loss from overtopping of potato drills in low lying areas of the field. Based on these site visits, it was determined that the soil loss issues observed could easily be addressed with changes in soil management and the implementation of soil conservation structures.

Barclay Brook is bordered by a well-vegetated riparian zone, in many cases, in excess of 15 metres in width. No encroachment of potatoes into the buffer zones was noted and no fields currently in potato production had headlands planted in potatoes. There was some evidence in two of the potato fields that there had been an area of bare soil between the end of the potato rows and the beginning of the grass, reducing the efficacy of the area as a filter. This situation was somewhat mitigated by the presence of the 10 metre grassed headland.

An inspection was conducted of the river bank close to the uppermost area where the 2012 fish kill is thought to have originated. 'Break-throughs' or 'blowouts' of the river bank were not evident and it was the opinion of the soil and water engineers that the effects of any runoff

were reduced by the grass headlands and the forested riparian zone. However, there was evidence along the river bank of the passage of 'channelled' flows of water (i.e. fine soil deposition and flattened vegetation in the direction of water flow) indicating that significant runoff had occurred.

It was observed that many hollows in the potato fields were not left in grass, but were planted. During intense rainfall events, such as the one that occurred on July 5, 2012, water would have collected in these areas and eventually the rows would breach, causing runoff. Such hollows would be a frequent contributor of silt into depositional areas or watercourses.

The topography of the fields studied had neither excessively steep slopes nor long slope lengths (less than 275 m). Many fields could significantly reduce existing soil loss levels by employing a minimal number of conservation structures, managing hollows and waterways more effectively and improving crop residue levels with reduced tillage and other techniques.

Based on site visits and information provided the soil and water engineers from the Department of Agriculture and Forestry developed a preliminary soil conservation plan for the Barclay Brook watershed, proposing various BMPs and soil conservation structures that would significantly reduce the transport of soil off-field (Figure 3).

Figure 3. Engineered soil conservation plan for the Barclay Brook watershed (provided by the Department of Agriculture and Forestry – See Appendix 3 for an enlarged version).

The Action Committee recognized that agricultural lands that are immediately adjacent to streams with a long history of acute fish mortalities require a higher standard of runoff control than fields that are not. Measures to reduce the erosion rates beyond those currently recommended or prescribed in legislation need to be employed.

A directed program to ensure that fields near streams meet enhanced soil conservation standards would reduce the risk of fish kills and protect fish habitat. While some would tend to ensure that this happens by the introduction of regulations, the Action Committee believes a better approach would be for farming organizations on Prince Edward Island to adopt enhanced soil management practices near watercourses as standard for their members.

Recommendations

12. *The Action Committee recommends that all crop production fields in the Barclay Brook watershed be farmed in a manner consistent with the goals and standards set by up- to-date soil conservation and soil protection methods.*

13. *The Action Committee recommends that individual landowners and crop producers should incorporate soil management practices necessary to meet soil conservation goals and standards in those fields near streams and wetlands across Prince Edward Island.*

14. *The Action Committee recommends that the Department of Agriculture and Forestry proactively seek out fields across Prince Edward Island vulnerable to soil erosion and runoff that are near or bordering watercourses, and engage with individual landowners and crop producers to design and implement soil conservation plans for erosion control structures and associated soil management practices for these fields.*

15. *The Action Committee recommends that the Department of Agriculture ensure that additional resources are available to prepare the necessary engineered management plans to adopt soil conservation practices at at-risk field sites in Prince Edward Island.*

Nitrate Pollution

Urea (used as a nitrogen source) is often used in potato production in Prince Edward Island to supplement the low fertility of Island soils. Urea is highly soluble in water and can be applied in solutions as a 'foliar feed'. The Action Committee is mindful that urea will breakdown into ammonia which is a known toxicant to fish. Ammonia is quite volatile and much of what is applied to fields in granular formulations evaporates into the air. Ammonia also changes fairly rapidly into nitrate which is not particularly toxic to fish. It was concluded by the Action Committee that urea would only be a risk to fish if there was a significant precipitation event shortly after a foliar application.

The application of nitrogen fertilizers to crops under intensive systems of cultivation may result in increased leaching of nitrate into groundwater which eventually flows into surface water.

There it can cause eutrophication in ponds and estuaries potentially leading to anoxic conditions that are destructive of fish habitat.

Since water oxygen levels were good and water temperatures favourable for fish life at the time of the fish kills in 2011 and 2012 (Table 2), death by anoxia was ruled out as a cause. Examination of 2012 spray records indicate that a foliar application of urea had only been applied to one field prior to the fish kill in that year and not immediately before the event.

In Prince Edward Island, nitrate toxicity is never a direct cause of death in fish. The long-term freshwater guideline for nitrate of 3 mg N/L (CCME, 2012) is derived to protect all aquatic wildlife including species more sensitive than fish. In the case of fish life, toxicity does not become a concern until concentrations are greater than 800 mg N/L, which are never found in streams in agricultural watersheds on Prince Edward Island. The Action Committee therefore concluded that nitrate pollution was not the cause of the fish kill in 2012.

Future Considerations

It is the consensus of the Action Committee that Prince Edward Island fish kills caused by pesticide contaminated soil runoff have to stop. Having said this, the Action Committee acknowledge that extreme weather events driven by climate change and the often unpredictable consequences of intense rainfall activity make this outcome, however desirable, almost impossible to guarantee.

The only way to prevent fish kills caused by pesticide runoff in Prince Edward Island would be to either to stop crop production altogether, or end the use of crop production methods that employ agrochemical products toxic to fish. Both solutions are untenable. The economic consequences of the first option would be economically devastating, the second impossible to implement since all agrochemicals have the potential to adversely impact the environment.

The Action Committee is also mindful that its discovery options were limited to historical data and field observations collected after the 2012 fish kill event had occurred.

Recommendations

16. *The Action Committee recommends that the Department of Agriculture and Forestry have agricultural engineers perform immediate in-depth examinations of the cropping practices used at any field implicated in a fish kill event.*

17. *The Action Committee recommends that the Department of Environment, Labour and Justice develop procedures to aid agricultural engineers in assessing fields that are implicated in fish kill events as soon as possible and preferably within a day of discovery.*

The Action Committee believes that an opportunity exists to improve the transfer of information to the farming community on key management practices needed to reduce the likelihood and severity of fish kills events in Prince Edward Island. The Prince Edward Island

Department of Agriculture and Forestry has long advocated the use of soil conservation methods, and it is hoped that the farming community will continue to incorporate these improvements into their management practices.

A new communications strategy is needed to reverse this implementation gap. Such a strategy might include the development of promotional and web-based material, agricultural training sessions, extension work, industry workshops, industry newsletters and the advocacy of mainstream media and key agriculture producer organizations.

Recommendation

18. *The Action Committee recommends that agricultural industry organizations and government should work together to expand education efforts to landowners and crop producers to increase their knowledge and implementation of those conservation management practices needed to prevent fish kills.*

Conclusions and Recommendations

The Action Committee for Sustainable Land Management believes that numerous producers across the Island have made significant changes to their operations in the last 12 years to reduce the risk of fish kills from pesticide runoff. Nevertheless, fish kills are still occurring and there is room for greater use of soil conservation practices and soil erosion control structures.

The Action Committee feels that increased protection can be delivered by a number of changes, particularly through the implementation soil conservation practices close to watercourses. The recommendations of the Action Committee in this report are considered to be equitable, financially feasible and eminently practical. Indeed, the primary recommendation of improving soil conservation management practices is a 'no-regrets strategy' that benefits landowner, crop producer and aquatic environment alike.

Producers with row crops adjacent to streams must carefully consider their work plans and farm practices to ensure their production practices are consistent with managing their field resource in an environmentally competent manner. In addition to soil conservation practices, two other key recommendations of the Action Committee are the establishment of an environmental fund to help remove high-risk land from production and the need to ensure that agricultural engineers immediately examine the field practices in any fields implicated fields in a fish kill event. These three key recommendations (bold in the following list) are considered by the Action Committee to be pivotal to the future success of any responsible farm management strategy in at risk watersheds.

Please find below a consolidated list of the Committee's recommendations:

1. *The Action Committee recommends full compliance with the existing buffer zone and grass headland requirements found in the Watercourse and Wetland Protection Regulations.*

2. *The Action Committee recommends that the ALUS program undertake an organic matter pilot project in the Barclay Brook watershed.*

3. ***The Action Committee recommends that the government establish an environmental impact fund in the amount of $200,000 per year to purchase 'at risk' agricultural land along watercourses to be managed by watershed groups for its natural capital.***

4. *The Action Committee recommends that watershed groups help identify vulnerable farmland along watercourses for possible purchase by the program.*

5. *The Action Committee recommends that the Department of Agriculture and Forestry assess land proposed for the program to ensure that it meets criteria for 'at risk' farmland that poses significant risk to neighbouring watercourses.*

6. *The Action Committee recommends the program purchases should be based upon local land prices plus a small additional amount to compensate the landowner for the inconvenience of securing replacement land.*

7. *The Action Committee recommends that additional funds be disbursed to watershed groups who accept the responsibilities of managing land under the program.*

8. *The Action Committee recommends that crop producers should regularly choose pesticide products that meet their field needs but have a lower risk for movement to and toxicity to fish in adjacent streams.*

9. *The Action Committee recommends that the Department of Agriculture and Forestry regularly examine its pesticide risk factsheet to determine whether there are newer pesticide products available that should be added.*

10. *The Action Committee recommends that producers should be encouraged to use furrow dammers to reduce soil erosion by minimizing water movement in potato rows.*

11. *The Action Committee recommends that where possible, potato fields should be set up using GPS and then band sprayed for fungicide and insecticide applications to the tops of developing plants in the hill during the early part of the season prior to full canopy cover and row closure.*

12. ***The Action Committee recommends that all crop production fields in the Barclay Brook watershed be farmed in a manner consistent with the goals and standards set by up- to-date soil conservation and soil protection methods.***

13. *The Action Committee recommends that individual landowners and crop producers should incorporate soil management practices necessary to meet soil conservation goals and standards in those fields near streams and wetlands across Prince Edward Island.*

14. *The Action Committee recommends that the Department of Agriculture and Forestry proactively seek out fields across Prince Edward Island vulnerable to soil erosion and runoff that are near or bordering watercourses, and engage with individual landowners and crop producers to design and implement soil conservation plans for erosion control structures and associated soil management practices for these fields.*

15. *The Action Committee recommends that the Department of Agriculture ensure that additional resources are available to prepare the necessary engineered management plans to adopt soil conservation practices at at-risk field sites in Prince Edward Island.*

16. ***The Action Committee recommends that the Department of Agriculture and Forestry have agricultural engineers perform immediate in-depth examinations of the cropping practices used at any field implicated in a fish kill event.***

17. *The Action Committee recommends that the Department of Environment, Labour and Justice develop procedures to aid agricultural engineers in assessing fields that are implicated in fish kill events as soon as possible and preferably within a day of discovery.*

18. *The Action Committee recommends that agricultural industry organizations and government should work together to expand education efforts to landowners and crop producers to increase their knowledge and implementation of those conservation management practices needed to prevent fish kills.*

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Appendix 1 - Action Committee for Sustainable Land Management Membership

Member	Organization
Bruce Raymond, Chair	PEI Dept. of Environment, Labour and Justice
Barry Thompson	PEI Dept. of Agriculture and Forestry
Dale Cameron	Trout Unlimited Prince County Chapter
Dave Thompson	CropLife
Greg Donald	PEI Potato Board
John Jamieson	PEI Federation of Agriculture
Shawn Hill	PEI Watershed Alliance

Appendix 2 - Press Release to Establish the Action Committee

Released July 23, 2012

Action Committee to examine measures for fish-kill prevention

Environment, Labour and Justice

A new action committee representing government, farmers and watershed groups has been formed to develop measures to prevent future fish kills in Prince Edward Island's waterways, Environment, Labour and Justice Minister Janice Sherry and Agriculture and Forestry Minister George Webster said Monday.

"Islanders want an end to fish kills in this province. In order to reduce the chance of future kills, we are asking people with expertise in land use, in agricultural practices and in water protection to look at our current protection measures and land use practices and to recommend ways they can be changed and strengthened to protect the water and wildlife resources that belong to all Islanders," Minister Sherry said.

"We want to move forward quickly to reduce the chance of fish kills and, in order to act as soon as possible, we are asking the committee to come back with its recommendations by September 14."

"This is a partnership of groups committed to a solution and to using Barclay Brook – where we have seen fish kills two years in a row – as a pilot for identifying problems and developing land use practices that will control the runoffs that lead to fish kills."

The Action Committee has been asked to examine the current land management practices used to prevent runoff events that result in fish kills and to consider upland management practices as well as whether regulations need to be further strengthened.

"Preventing fish kills is a priority for all Islanders, especially the agricultural community," said Minister Webster. "The Action Committee is an opportunity to build new relationships between government, farmers and watershed groups at a community level to work together on solutions. This committee will focus its efforts on developing a land management template for individual watersheds to prevent fish kills and protect the Island's natural resources."

"While current land management plans are protecting most of the land in Prince Edward Island, it's clear that some areas are more vulnerable than others," said Dale Cameron, member of Trout Unlimited Prince County Chapter. "This committee will look at watersheds as unique areas requiring their own individual land management plans."

"The PEI Potato Board is very pleased to be part of developing a collaborative solution to protect our waterways," said General Manager Greg Donald. "The agricultural community

understands its responsibility to employ good land management and sustainable farming practices to protect our resources."

As part of its work, the Action Committee will examine the recent fish kill at Barclay Brook to see why measures now in place were not able to prevent the recent fish kill.

BACKGROUNDER
Action Committee for Sustainable Land Management
Trout River Pilot, Prince County

Background:
Prince Edward Island has had another severe fish kill. While the frequency of fish kills has dropped since the peak years of 1999 and 2002, they continue to occur.

Buffer zones alone cannot be effective in addressing soil movement/runoff events that lead to stream and river pollution. Key to erosion control, and the associated contamination of rivers and streams, is a basket of sustainable land management (upland management) practices that include maintaining good soil structure, encouraging best cropping practice and instigating water control and drainage measures.

1. The Action Committee
An Action Committee for Sustainable Land Management is established by the Minister of Environment, Labour and Justice and the Minister of Agriculture and Forestry to examine the current land management practices used to prevent runoff events that result in fish kills. This will be carried out in a pilot scheme located in the Trout River watershed. The Action Committee is tasked with assessing best available options to reduce the adverse impacts from runoff events. The Action Committee will consider upland management practices as well as whether regulations need to be further strengthened. The value of incorporating alternative land use measures (ALUS program) – such as the incorporation of wider grass headlands – will also be examined.

The membership of the Action Committee is drawn from across government departments, producer and supplier organizations, and watershed groups:

Members: Bruce Raymond (Chair), Department of Environment, Labour and Justice; Barry Thompson, Department of Agriculture and Forestry; Shawn Hill, Executive Director, PEI Watershed Alliance; Dale Cameron, Trout Unlimited; Greg Donald, PEI Potato Board; John Jamieson, PEI Federation of Agriculture; David Thompson, CropLife Canada.

2. Examination of the Barclay Brook Fish Kills
The Action Committee will examine the recent fish kills at Barclay Brook to answer why current measures continue to fail to protect streams and rivers in some areas. The Action Committee will assess such potential contributory factors as pesticide usage, field topography (slope height and length), soil structure, soil conservation practices used, the status of the current buffer

zone area flanking rivers and streams, the effectiveness of field headland areas in preventing runoff and the uptake by producers of the ALUS program.

It should be noted that the Investigation and Enforcement Section will continue to investigate this month's Barclay Brook fish kill for potential non-compliance with existing legislation. The Action Committee work is separate and apart from that process.

3. Recommendations for Sustainable Land Management Practices in Barclay Brook of the Trout River Watershed

The Action Committee will evaluate current land management activities and undertake a review of sustainable land management options. The findings of the Action Committee will be used to make recommendations to government on the best land management practices including enhancement to BMP's, extension of program measures (ALUS) and potential regulatory options available. To ensure intense rainfall events no longer adversely impact river and stream health, protocols established by the Action Committee will be examined with a view to their being applied across Prince Edward Island on a watershed basis.

Timelines:

The Action Committee will begin its work immediately, and report back to the Ministers no later than September 14, 2012.

Appendix 3 – Soil Conservation Plan for the Barclay Brook Watershed (prepared by the Prince Edward Island Department of Agriculture and Forestry)

[diagram on following page]

Agriculture & Forestry
Resource Inventory & Modelling
Sept. 2012

Scale 1:6,500

This map is not intended for legal description or to calculate exact land dimensions.

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