# An Adaptive Management Plan to Reduce Nitrates in the Upper Watersheds of the Southwest River

## Southwest River Nitrates Stakeholders February 2013

A Committee of the Kensington North Watersheds Association

Summary

This plan is the creation of residents, farmers and developers from the watersheds in the upper reaches of the Southwest River, an estuary in the North/Central area of Prince Edward Island. In October, 2010, the Kensington North Watersheds Association (KNWSA) and the Wheatley River Improvement Group, two community watershed organizations, were approached by the Dept. of Environment, Energy & Forestry, the Dept. of Agriculture, and the PEI Federation of Agriculture and asked to create a community based plan for their respective areas to reduce nitrates in groundwater and surface water.

KNWSA created a committee of stakeholders from the area to review information available and create such a plan. Over the following 18 months, a great deal of information was reviewed and scenarios were created. Modeling was completed by technical experts on the group's scenario requests for further contemplation by the Nitrate Stakeholders Committee.

Several months of vigorous discussions followed on a wide range of modeled scenarios. We selected the Adaptive Management model for creating a plan[1], in order to accommodate the ongoing developments in research in agronomy and on the movement of nitrates in groundwater and surface water.

[1] Adaptive management (AM), also known as adaptive resource management (ARM), is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously meets one or more resource management objectives and, either passively or actively, accrues information needed to improve future management. (http://en.wikipedia.org/wiki/Adaptive_management)

## Section 1 - Background

### Vision

The vision of the Southwest River Nitrate Stakeholders Committee is "to achieve and maintain low levels of nitrates in the project area's groundwater and surface water, in order to protect human health and to minimize the effect of nitrates on local ecosystems."

### A) Stakeholders

The following is a list of people that were identified as stakeholders for this process and report.

- Jim Evans, landowner and businessman, Burlington, Committee Chair;
- Trent Caseley, farmer, landowner, Spring Valley,
- Steven van der Veen, farmer, landowner, Margate,
- Bill Pidgeon, retired fisherman, KNWSA Board Member, Spring Brook
- Sheldon Stewart, developer, landowner, Kensington,
- Kendall Brown, Farm Manager, Cavendish Farms, New Annan,
- Carl Adams, landowner, KNWSA board member, Spring Valley,
- Greg Donald, Executive Director, PEI Potato Marketing Board, KNWSA board member, Tuplin Creek,
- Brian Cousins, farmer, landowner, Spring Valley,
- Myles Hickey, farmer, landowner, former KNWSA board member, Darnley,
- Bradley Mills, farmer, landowner, Durant Creek – Miscouche,
- Dr. John Robertson, cottage owner, Southwest River-Summerside,
- Jared Wright, Farm Department, Cavendish Farms, New Annan.
- Barry Murray, Executive Director, Kensington North Watersheds Assoc.

### B) Project Partners

Prince Edward Island Federation of Agriculture, represented by Jennifer Roper and Stephanie Veenhuis

### C) Technical Advisors

PEI Dept. of Environment, Labour & Justice:

- Sean Ledgerwood, Watershed and Subdivision Specialist,
- Bruce Raymond, Manager of Watershed and Subdivision Planning,
- George Somers, Manager of Drinking Water, Land and Systems Protection,
- Cindy Crane, Surface Water Biologist,

- Qing Li, Hydrogeologist

Dept. of Agriculture and Forestry

- Erica MacDonald, Agriculture Environment Development Officer,
- Barry Thompson, Manager / Agriculture Resource Development Co-ordinator

Agriculture and Agri-Food Canada

- Yefang Jiang, Senior Hydrogeologist, Agri-Environmental Services Branch

D) The Pilot Area

The maps below shows the location of the pilot area in relation to PEI. The pilot area represents approximately 0.7% of PEI's land area.

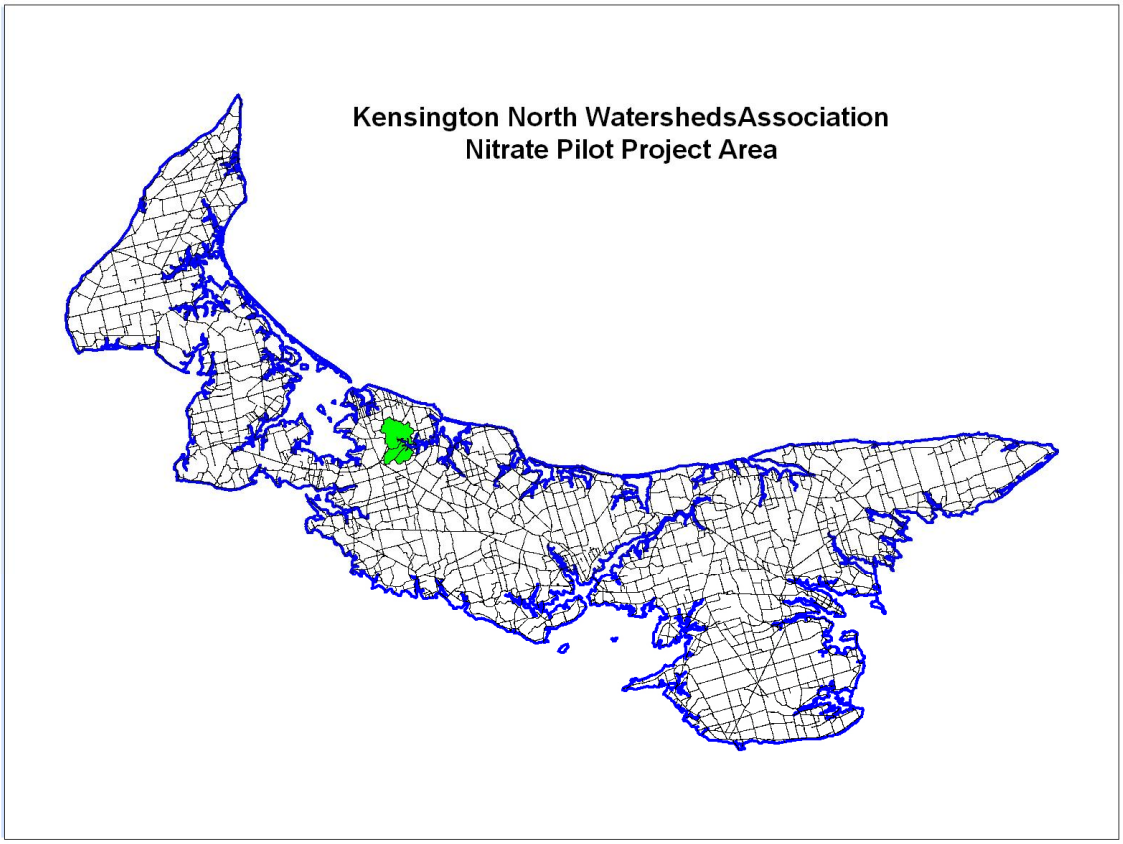


Figure 1 - Southwest River (Spring Valley Brook & Eel Creek), Tuplin Creek, and Durant Creek watersheds, Provincial Perspective

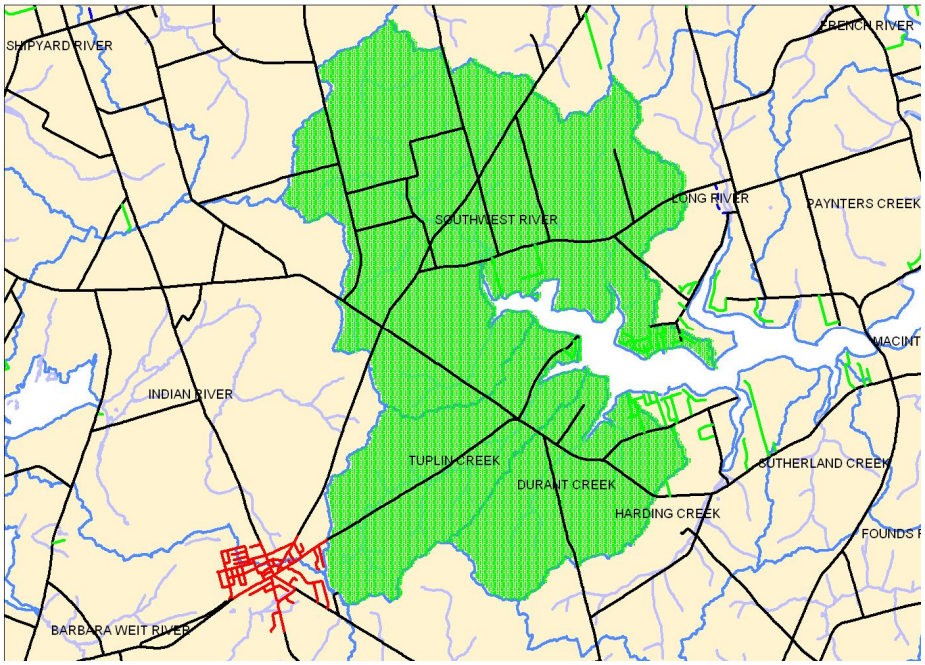

Figure 2 - Southwest River (Spring Valley Brook & Eel Creek), Tuplin Creek, Durant Creek

After reviewing the watersheds along the Southwest River, three sub-watersheds of the Kensington North Watersheds area were selected. The pilot project watersheds are illustrated in Figures 1 and 2 above.

It has been documented that anoxic events occur in the estuaries of Long River and Harding Creek, just outside the project area, as well as other estuaries further downstream. The areas selected for this pilot project represent the furthest reaches of the Southwest River, where the anoxic activity is the most severe. We are working with the assumption that land use in these watersheds will largely determine the levels of anoxic activity in the upper Southwest River. The lessons we are learning in this process will be largely transferable to neighboring watersheds.

Southwest River

The watershed currently designated as the Southwest River is made up of three small drainage basins along with some direct-to shore area, those being the Spring Valley Brook, Eel Creek, and an unnamed stream along the south shore west of Tuplin Creek. It is generally portions of the old school districts of Spring Valley, Irish Town, Burlington and Margate.

Tuplin Creek

Tuplin Creek has a short estuary at Thompsons Point and extends west toward the Town of Kensington. It contains parts of the school districts of Margate and Kensington.

Durant Creek

Durant Creek runs mostly parallel to Tuplin Creek along its eastern border. It contains parts of the school districts of Margate and Clinton.

E) Land Use

The table below shows some approximate land use statistics for the 3 pilot watersheds.

| | Southwest River | Tuplin Creek | Durant Creek |
|---|---|---|---|
| Area (ha.) | 2,390 | 740 | 735 |
| Agriculture % | *72.7%* | 77.0% | 76.9% |
| Developed % | *8.3%* | 10.7% | 6.7% |
| Forest % | *16.5%* | 8.2% | 15.0% |
| Wetland % | *2.5%* | 4.1% | 1.4% |
| Seasonal Cottages | 46 | 9 | 16 |
| Undeveloped Seasonal Lots[2] | 82 | 17 | 19 |

Table 1 - Land use in the pilot area watershed, Source: PEI Corporate Land Use Inventory, 2000 and PEI Environment, Labour and Justice

F) Common themes

There appear to be some common themes related to the nitrate issue that are shared throughout the 3 pilot watersheds, such as:

- High percentage of land use in agriculture, featuring potatoes in the crop rotation
- No central sewage systems
- No industry or industrial waste
- Relatively low forest cover
- Sandy soils, rapid movement of groundwater
- Shallow estuaries, small tide range, poor water exchange
- Recreational properties along the shore of the Southwest River.

G) Drinking Water

The table below shows some nitrate concentration values in the 3 pilot watersheds. Although these are just a sample of some of the wells in the area, it does indicate that there are some high nitrate values in the area.

[2] The values for "undeveloped seasonal lots" are approximate, and were calculated by searching for lots under 2 acres that do not have civic addresses.

| | Average N – Nitrate Level (mg/L) | Maximum N-Nitrate Value (mg/L) | Number of Samples |
|---|---|---|---|
| Southwest River | 4.62 | 13.2 | 29 |
| Tuplin Creek | 5.45 | 10.3 | 27 |
| Durant Creek | 5.16 | 7.5 | 7 |

Based on private well data in year 2008 to 2011

Table 2 - Nitrate concentrations in drinking water wells in the pilot area. Source: PEI Environment, Labour and Justice Drinking Water Quality Application (http://www.gov.pe.ca/environment/index.php3?number=1040595&lang=E)

Some other information regarding drinking water wells and nitrate concentration include:

- The guideline for nitrate in drinking water quality is a concentration of 10 mg/L
- In recent years, on average for PEI,
  - 3.5 to 4.5% of wells exceed 10 mg/L guideline
- In some PEI watersheds, as many as 10 to 15% of wells or more of wells may exceed the drinking water guideline
- Well water values may not reflect exact average groundwater values as:
  - Wells shut out some of the shallower water
  - Most wells are close to septic systems
  - Treated water can bias the database

H) Surface Water

The following graph shows the breakdown of nitrate loadings from various sources based on modeling the crops, rotations, forest cover, septic systems, and other nitrate inputs. The actual amounts from various sources may vary from this graph, but not by a great amount. The graph is useful in demonstrating where we as a community may most effectively place our efforts and resources to reduce the impact of nitrate leaching.

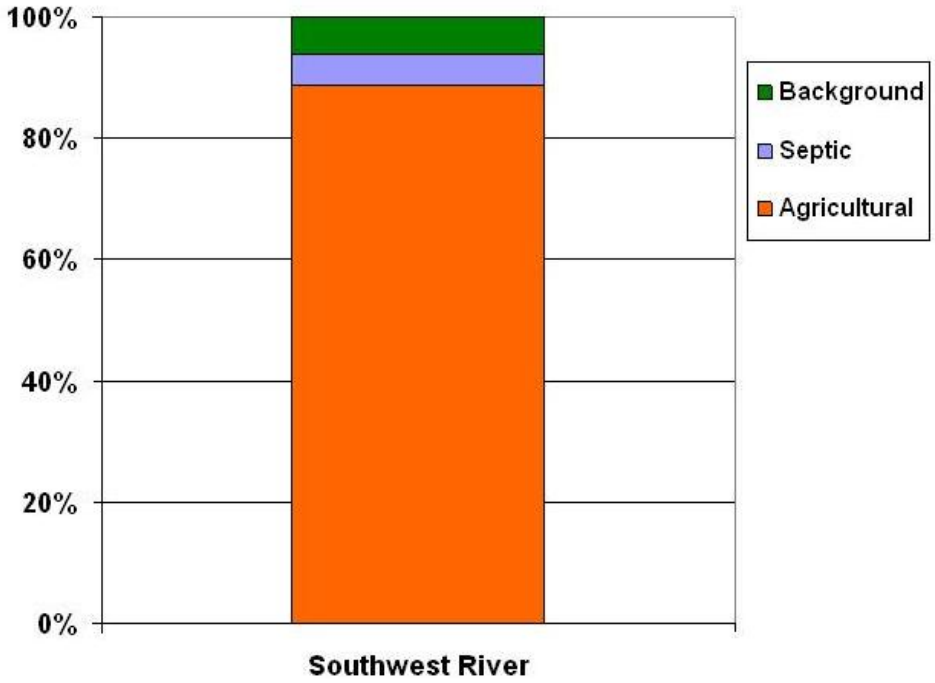

Figure 3 - Sources of nitrate loading in pilot watersheds. Source: PEI Environment, Labour and Justice.

I) Resource Values

Natural resources are valuable to society, and until recently they were not usually seen in a monetary value perspective. Economic values can be attached to the resources that are negatively affected by excessive nitrates.

- Risk of damage to commercial and recreational fisheries, potential cost unknown. The committee supports a two week delay of the eel fishing season in the Pilot Area, as the quality of eels and return to fishermen is noticeably reduced in late August, and improves dramatically in September after the peak of the anoxia prone season.
- Risk of reduction of property values due to anoxia related odours and shoreline -The difference of dollar value of a shoreline property with occasional anoxia compared to a more pristine shoreline in a different area is difficult to assess. Realtors recognize that knowledgeable buyers are aware of the impact of anoxic events on a location's swimming and shoreline use potential, and factor in such information when making property purchases, usually by reducing the potential value of the property.
- Risk to human health – cost of nitrate removal technology (roughly $1,500 per well) or a new, deeper well to a cleaner aquifer (roughly $3,000 per well, not a permanent solution)

The cost of inaction may be compounded with the effects of climate change. Although many variables will be involved for which we currently have insufficient knowledge, the predicted longer growing season, accompanied by increased agricultural activity may increase nitrogen use. (source: Economic Implications of Increasing Nitrate in Groundwater due to Climate Change, Prince Edward Island, Canada, George Somers, PEI Dept. of E, E & F, Martine Savard, Resources Naturelles Canada, Commission Geologique du Canada).

## Section 2 Measurable Objectives

Target for the Pilot Area

Data was provided to the Stakeholders on the current load of leached nitrates in ground water and surface water. Potential targets were discussed.

In order to reduce nitrates in drinking water to an amount that is considered low risk (that being no more than 3% of wells exceeding Health Canada's drinking water guideline of no more than 10 mg /litre of NO3-N), the total load to the watersheds must not exceed 12.5 kg N/ha/yr.

The current load in the pilot area is 22.5 kg N/ha/yr. This means that a reduction of almost 50% of Nitrogen inputs would be required to meet Health Canada's guideline under current conditions. Our committee of stakeholder concluded that this may remain as a long term goal (greater than 15 years), but in order to have a goal that is realistic and possible to achieve over the midterm (10 – 15 years) a compromise was necessary.

Discussions were also held regarding a target that would deal with anoxic events in the estuary. Several targets were discussed (e.g. no anoxic events, some anoxic events, etc).

*Target:* 16.34 kg $NO_3^-$-N /ha/yr  *Current Load:* 22.5 kg $NO_3^-$-N /ha/yr

In PEI an anoxic event is defined as a condition where oxygen is completely depleted and areas of discolored and foul (sulfur) smelling water are present (Figure 2). No attempt is made to define the spatial extent or duration of the event.

The target above would reduce the frequency of anoxic events in the estuary from "certain" (4-5 anoxic events every 5 years) to "likely" (2.4 anoxic events every 5 years

and a reduction in the number of wells expected to exceed 10 mg NO3 – N /litre from 14.0% to 4.7% . This is the target the committee chose.

Key Indicators

The following key indicators can be observed and quantified to compare nitrate levels and observe trends over a period of several years.

- Nitrate readings in well water.
- Frequency of anoxic events
- Nitrate readings in surface water.

## Section 3 The Effects Of Actions On Indicators

Many different actions have been modeled and discussed. The following is a summary of the different modeled scenarios and their implications on the total nitrates load. There were several other situations that were modeled and afterwards dismissed by Stakeholders as having insufficient evidence that they would have an impact.

A) Land Use

i) Modified Crop Rotation. Lengthy and passionate discussions were held on crop rotation, especially in regards to potatoes. There were about 223 ha (550 acres) of land in a 2 or 2.5 year potato rotation (2006 – 2009). If we change these to a 3 year rotation there would be a net reduction of 0.6 kg N/ha/yr. In this plan, a three year is defined as potatoes, barley under seeded with clover, clover.

ii) Retirement of Marginal Land. Based on an estimate of 40 ha. of marginal land in potato production, if that land were to be retired to pasture or forest, there would be a decrease of nitrate loading of 0.41 kg N/ha/yr.

iii) Reforestation. If the current level of forested land increased from 20% to 25%, an increase of 38.85 ha., and assuming that the land that was to be reforested was previously pasture/grass land, and not potato land, the decrease of nitrate loading would be 0.08 kg N/ha/yr.

Although the contribution of wetlands to nitrate removal is difficult to model, there is wide belief in literature that such an affect is real. Trees and shrubs in riparian zones are a sink for nitrates.

iv) Spring Ploughing. Assuming that the amount of spring ploughing of sod could be increased to 30 % of 3 yr. rotation land, there would be a decrease of nitrate loading of 0.08 kg. N/ha.

v) Catch Crops. More research is required concerning catch crops. While nitrate capture is a concern, so is erosion and wire worm. A comprehensive approach to managing soil with catch crops is required by our agricultural sector.

B) Potato Varieties

i) Prospect Potato Variety. If 33% of the current potato crop was planted with Prospect, there would be a reduction of 3.0 kg N/ha/yr. If 50% of the current potato crop was planted with Prospect, there would be a reduction of 4.5 kg N/ha/yr. If 70% of the current potato crop was planted with Prospect, there would be a reduction of 6.3 kg N/ha/yr. The contribution of low nitrogen impact potato varieties in reducing the nitrate leaching load on watersheds is significant. The possibilities of further meaningful gains in this area are significant.

ii) Nitrogen Fixing Variety. One of our request for modeling was based on all the potatoes grown were of a variety that fixed its own nitrogen, and required a nominal 25 units of N to start growth, there would be a reduction of 18.2 kg N/ha/yr. Such a variety does not yet exist. This request was originally made under the assumption that it would require a Genetically Modified variety to achieve such performance. This is a very long term scenario, as neither has such a variety been made available, nor has consumer acceptance of GMO products permitted such a variety to become popular.

Since this request was made, a local potato plant breeder has bred through traditional breeding a potato variety that has nitrogen fixing capabilities. The symbiotic relationship that this variety has with nitrogen fixing bacteria is a major breakthrough in plant breeding. This may or may not be the particular variety that achieves commercial success, but the breakthrough has been made, and nitrogen fixing capacity has been proven possible to achieve through traditional breeding. This is no longer a very long term possibility, but now is a very real possibility in the foreseeable future.

The success of low nitrogen load varieties of potatoes may be the best hope for nitrate reduction in the pilot area. Great efforts may be required by all sectors to establish such new varieties.

C) Knowledgeable Nutrient Management

"AgriLogic Software is recognized by the PEI government and growers as a comprehensive tool that will help farmers manage nutrients on a whole farm and watershed basis. There is a significant amount of data entry that must be done for each farm. Data for each farm, once compiled and processed by the software, should be analyzed by an agronomist in order to utilize the best nutrient management practices that will reduce nitrate leaching for that farm.

In order for this process to be used to its fullest, an agronomist must be available to assist farmers with data entry, interpretation, and with on-farm decisions and research. We request that assistance be provided by the Govt. of PEI to hire an agronomist for the farms in the pilot area.

The reduction in nitrate leaching achieved from having the majority of agricultural land in the pilot area captured in AgriLogic and assistance from an agronomist is difficult to estimate, although the overall contribution could be very significant. Nitrate savings would vary from farm to farm, as nitrate leaching levels would vary from farm to farm. Some changes in management techniques that would achieve nitrate reduction would be easier to implement than others, and it is important producers are exposed to a number of different options."

The Department of Environment, Labour and Justice has just provided modeling results regarding the potential of knowledgeable nutrient management. The results indicate that a potential nitrate reduction of 3.2 kg N/ha/year (14.4% reduction) could be achieved if all the current potato land (1787 ha) in the Southwest River watershed underwent knowledgeable nutrient management. This would result in the nutrient load to the watershed being reduced to 19.3 kg N/ha/yr, down from 22.5 kg N/ha/yr – a significant decrease.

It is unclear whether all farms within the area could achieve these aggressive results; however it does provide an estimate of the potential nitrate savings.

D) Septic Systems, Minimum Lot Size

We recommend that for new development that properties be designed to not exceed 12kg/ha/yr of leached nitrates (our long range target), using whatever combination of system solutions that are appropriate, and that support be available so that property values are not negatively affected by addition regulation.

In order to meet this long term target, the possible solutions include:

a) With a standard septic system, lot size would need to be at least 0.8 ha in size. Any smaller, and the resulting load would be greater than the target.
b) If new lots were to include septic systems that include nitrogen removal, a lot would have to be at least 0.4 ha in size. This assumes that septic systems with nitrogen removal will remove approximately 50% of the nitrogen.
c) Although current regulation does not permit black water (human waste) to be stored in a holding tank and then removed periodically with a pump truck, and grey water to be routed through a septic field, this possible arrangement appears to be both logical and cost effective. It would also require a smaller than 0.8 ha. minimum lot size. Regulation changes will be required to accommodate such a system.

We recommend that property owners that wish to install nitrate removal technology or a separate black water holding tank receive financial support from the Government of PEI so as to not put them at an economic disadvantage in order to comply with lower leaching targets.

E) Sea Lettuce Control

This committee acknowledges the findings of the Sea Lettuce Harvest Pilot Project Report, April 2012, regarding the merits of sea lettuce removal. Current technology does not permit sea lettuce to be removed from an estuary in a cost effective manner, or in quantities sufficient to have a significant effect on the frequency or intensity of anoxic events. The severe discomfort that property owners in the immediate vicinity of anoxic events experience cannot be overlooked. It is understood that even with very aggressive nitrate reduction measures, our estuaries will experience anoxia for several years.

We request that the Province continue to work with watershed groups and communities, and continue to experiment with sea lettuce removal technologies. In addition, we request that financial support be pledged by the Province towards sea lettuce removal along the shorelines where accumulation occurs during an anoxic event. This will reduce the severely unpleasant, short term impact of anoxia on local residents. This amount could be in the range of $400 per occurrence (when extremely odour or otherwise unpleasant conditions prevail). One or two occurrences per year is probable, and there are only 2 or 3 locations that would be accessible for equipment for this task. KNWSA would assist in the permitting process if removal of material is required.

F) Education and Awareness of Nitrate Issues, Solutions, and Developments

Getting the message out over the true extent and severity of our nitrate situation, and what we as a community are doing about it will be important to the success of the plan. Watershed groups, farmers, and governments must work together to get the message out what is being done and what still needs to be done. Public meetings, fact sheets, on-farm demonstrations are all possible tools that will be needed to change the way we all think about nitrates.

## Section 4 Nitrate Load Reduction Plan

The flowing table lists the various tasks that are being recommended by the Stakeholders Committee.

| Task | Responsibility | Timeline | Potential Load Reduction |
|---|---|---|---|
| A) Land Use | | | |
| Reduce potato acreage under 2 or 2.5 yr. crop rotation | Dept. of Ag, create incentives for soil conservation (ALUS) | Farmers – uptake, implement Commencing in 2013 | 0.6 kg N / Ha |
| Retirement of Sensitive Land | Dept. of Ag. – improve land retirement incentives (ALUS) | Farmers & landowners – uptake, implement Commencing in 2013 | 0.41 kg N/ha/yr, plus hedgerow amounts, etc. |
| Reforestation of marginal land, hedgerow improvement & creation. | Dept. of Ag & Forestry, ALUS type incentive for planting trees on marginal land, creation of incentive for planting and maintaining high quality hedgerows. | Farmers & Commencing in 2013 | 0.08 kg N/ha/yr. |
| Continued work by Watershed group to reforest riparian zones and restore wetlands, assist in other planting programs (land retirement, hedgerows) | Employment Development Agency – timing of job programs for early season plantings<br>KNWSA – tree planting<br>Dept. of Ag & Forestry – supply trees | Commencing in 2013 | included above |
| Spring ploughing – this debate must become part of a larger discussion with regards to wireworm, catch crops, soil conservation, as well as nitrogen credits. | Govt., Farmers, Researchers, non-government groups | Commencing immediately | 0.08 kg. N/ha. |
| Catch Crops – increased research into effective catch crops for nitrate capture and more | Dept. of Ag., Ag Canada, Industry, & Farmers | Commencing immediately | Unknown, possibly considerable |

| Task | Responsibility | Timeline | Potential Load Reduction |
|---|---|---|---|
| B) Potato Varieties | | | |
| Prospect – increase use of Prospect variety or other low nitrogen use varieties where possible in high nitrate watersheds – such as the SWR pilot area | Potato processors, farmers and landowners | by 2014 | unknown, possibly high |
| Plant Breeding for Low N Consuming Potato Varieties | Industry, Governments, farmers & landowners | have a new Low N variety in use by 2020 | unknown, possibly very high |
| C) Knowledgeable Nutrient Management | | | |
| Hire an Agronomist to assist Pilot Area | Govt of PEI, farmers | by spring of 2013 | 3.2 kg N/ha |
| D) Septic Systems, Minimum Lot Size | | | |
| Minimum Lot Size with standard septic system shall be 0.8 ha | Amendment to regulations pertaining to subdivisions and development, Dept. of E., L. & J | | would not contribute to load reduction, but would prevent a load increase |
| In order for lots to be 0.4 ha. in size, Subsidies for Septic Nitrate Removal Technology, and Separate black water storage systems (for pumping). Black water storage requires regulation changes | Amendment to regulations pertaining to subdivisions and development, Dept. of E.,<br>Subsidy program by PEI Government | Regulation changes and creation of subsidy program by 2014 | would not contribute to load reduction, but would prevent a load increase |
| E) Sea Lettuce Removal | | | |
| Periodic review of new technology, development of appropriate technology | Dept. of E., L. & J, Watershed and Aquaculture groups, communities | on an ongoing basis | no effect |
| Removal of sea lettuce from shorelines where it is causing the greatest discomfort due to odour. | Residents, watershed group, and Provincial Government | During or immediately after an anoxic event, as required | no effect, but relief from extreme odour has value |

| Task | Responsibility | Timeline | Potential Load Reduction |
|---|---|---|---|
| F) Education & Awareness of Nitrate Issues | | | |
| Open meetings for farmers, landowners processors, citizens on current Developments on Nitrate issues | KNWSA, Dept. of E,L & J, Dept. of Ag., Fed. Of Ag | At least once every 2 years | unknown, likely positive |
| Occasional articles in newsletters, County Line Courier on nitrate issues | KNWSA | twice a year | as above |
| Government fact sheets, as research findings become available for discussion | Dept. of Ag., AgCanada | As required | as above |
| Education for youth on nitrates | KNWSA, Dept. of Ed. | 2013 & onward | as above |
| G) Additional Research | | | |
| Support for Genomic research implementation | Farmers, Govt., Non- govt., industry | 2013 & onward | unknown, possibly very high |
| Development of a process for variable application of N | Industry, Govt., Farmers | 2013 & onward | unknown |
| Additional agronomy research, for catch crops, tillage techniques, etc. | Industry, Govt., Farmers | 2013 & onward | unknown, possibly high |

## Section 5 Monitoring, Evaluation, Adjustment

The type of monitoring that is being done for each of the three measurable results are as follows:

- Nitrate readings in well water.

  *Well water data will continue to be collected by the provincial water testing lab on a regular basis. Nitrate clinics can be held in Kensington North area every 3 years.*

- Frequency of anoxic events

  *A network of river monitors has been established in the Kensington North area including the Southwest River, with volunteers receiving information on how*

*to recognize and report anoxic events. This data will be accompanied by observations by Dept. of E, L & J.*

- Nitrate readings in surface water.

  *Data is currently collected by the Dept. of E, L & J in the SWR and analyzed by the Surface Water Biologist. This data collection and analysis shall continue.*

Valuable additional monitoring may be performed by researchers and experts.

The action portions of the plan can be reviewed annually by the Stakeholders Committee with the assistance of technical experts. A report of the annual meeting and its findings will be compiled by KNWSA staff with the assistance of the appropriate technical experts. The purpose of the Annual Meeting of the Stakeholders Committee will be to:

- Review the implementation and compliance of recommendations
- Review the effectiveness of recommendations and actions through the measurable results and observations
- Discuss the results of ongoing research, and new research and technology
- Compare the outcomes to the forecast
- Adjust the models and forecasts to reflect recent work and findings
- Propose adjustments to actions as necessary
- Re-evaluate our goals, suggest new experiments

Following the Stakeholders' meeting, the information that has been brought to the forefront can be documented and shared with other groups with similar nitrate issues, in the hope that we will receive the similar courtesy.

The cycle of activity in this plan is our hope for reducing nitrates in the groundwater and surface water of the watersheds of the pilot area, and that the knowledge gained will be useful for other watersheds throughout the province.