APPENDIX A

DRAFT ORDER

HULLCAR VALLEY AREA BASED MANAGEMENT PLAN

PROVINCE OF BRITISH COLUMBIA
ORDER OF THE MINISTER OF ENVIRONMENT
SECTION 89, *ENVIRONMENTAL MANAGEMENT ACT*

Ministerial Order No. ____

Whereas there is evidence that water quality within Hullcar Aquifer 103 is a matter of concern in the community, with sampling of the Steele Springs drinking water source showing increasing nitrate levels near and exceeding the Canadian Drinking Water standard for nitrates of 10 mg/L;

And whereas the Minister of Environment wishes to reduce nitrate concentrations in the aquifer and manage water quality to reverse increasing trends in water contaminant (nitrate) concentrations in Hullcar Aquifer 103 for the short term and long term;

And whereas the Ministry of Environment has acted to identify and quantify potential sources of nitrate by collecting and reviewing water quality sample data within the Hullcar Valley since 2014;

And whereas unconfined and relatively shallow aquifers like Hullcar Aquifer 103 are vulnerable to impacts from human activities;

And whereas area residents depend on safe drinking water sourced from the Hullcar Aquifer;

And whereas the local economy relies on agricultural and related activities;

And whereas agricultural, range and other activities involve the application or deposition of manure or other nitrate-containing substances to the land as a conventional part of conducting those activities;

And whereas the Minister of Environment considers that in order to protect the environment, an area based management plan for Hullcar Valley area that is adaptive and reflects the needs of the community is advisable for the purposes of environmental management to address current water quality trends for nitrates;

Now therefore:

I, Mary Polak, Minister of Environment, order that:

1. In accordance with the provisions of section 89 of the *Environmental Management Act*, the area described in and shown on the map appended as Schedule A to, and forming part of, this Order is designated for the purpose of developing the Hullcar Valley Area Based Management Plan.

2. In accordance with the provisions of section 89 of the *Environmental Management Act,* the process for the development of the Hullcar Valley Area Based Management Plan designated in section 1 above, is set out in Schedules B and C attached to, and forming part of, this Order.

_____ _____

Minister of Environment Date

(This part is for administrative purposes only and is not part of the Order)

Authority under which Order is made:

Act and section: *Environmental Management Act*, Sections 89, 90
Other (specify):

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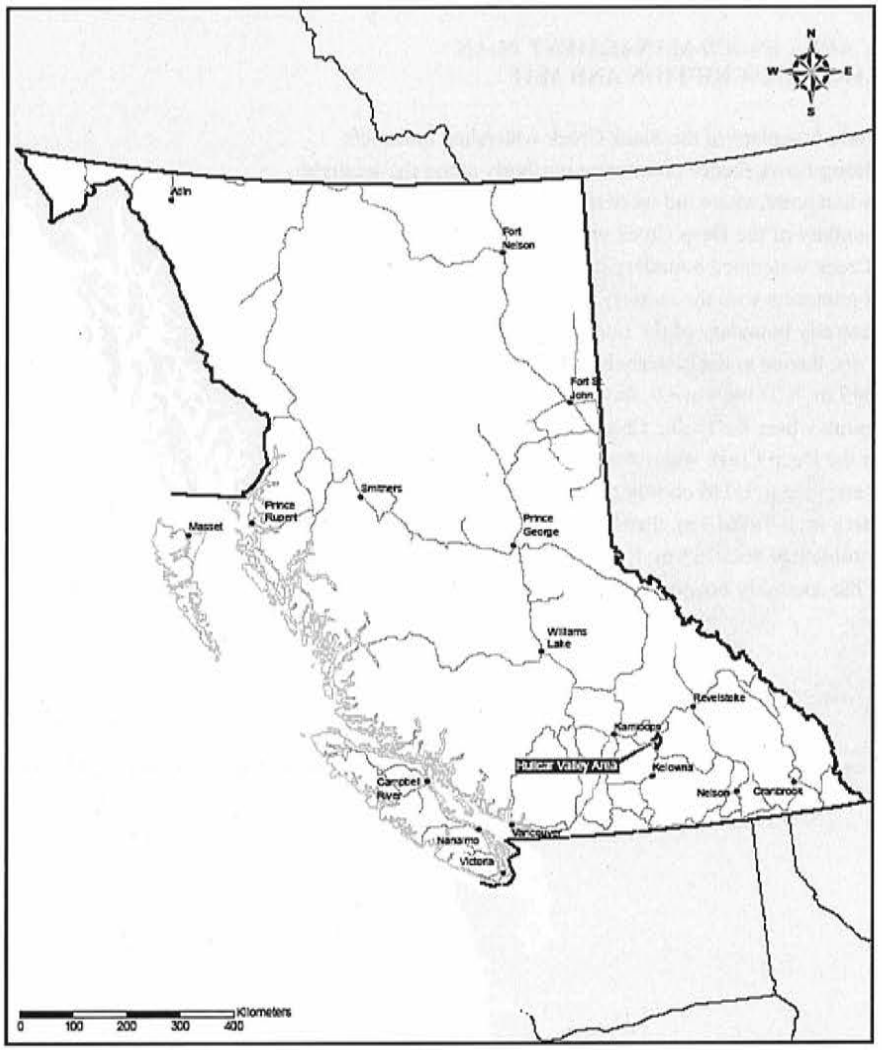
SCHEDULE A

HULLCAR VALLEY AREA BASED MANAGMENT PLAN
DESIGNATED AREA DESCRIPTION AND MAP

Commencing at a point where the westerly boundary of the Slack Creek watershed intersects with the centre line of Heywood Armstrong Road, thence continuing northerly along the westerly boundary of the Slack Creek watershed to a point where the westerly boundary of the Slack Creek watershed meets the westerly boundary of the Deep Creek watershed, thence northerly, easterly and southerly along the Deep Creek watershed boundary to a point where the easterly boundary of the Deep Creek watershed intersects with the easterly boundary of the Leduc Creek watershed, thence southerly along the easterly boundary of the Leduc Creek watershed to UTM coordinate N 5604854 m, E 771758 m +/-, thence to the easterly boundary of the Leduc Creek watershed at UTM coordinate N 5604349 m, E 771968 m +/-, thence southerly and westerly along the Leduc Creek watershed to a point where the Leduc Creek watershed boundary intersects with the easterly boundary of the Deep Creek watershed, thence southerly along the easterly boundary of the Deep Creek watershed to UTM coordinate N 5599239 m, E 769346 m +/-, thence to UTM coordinate N 5599018 m, E 768610 m, thence to the southerly boundary of the Slack Creek watershed at UTM coordinate N 5600705 m, E 767703 m +/-, thence southwesterly and northwesterly along the southerly boundary of the Slack Creek watershed to the point of commencement.

DRAFT

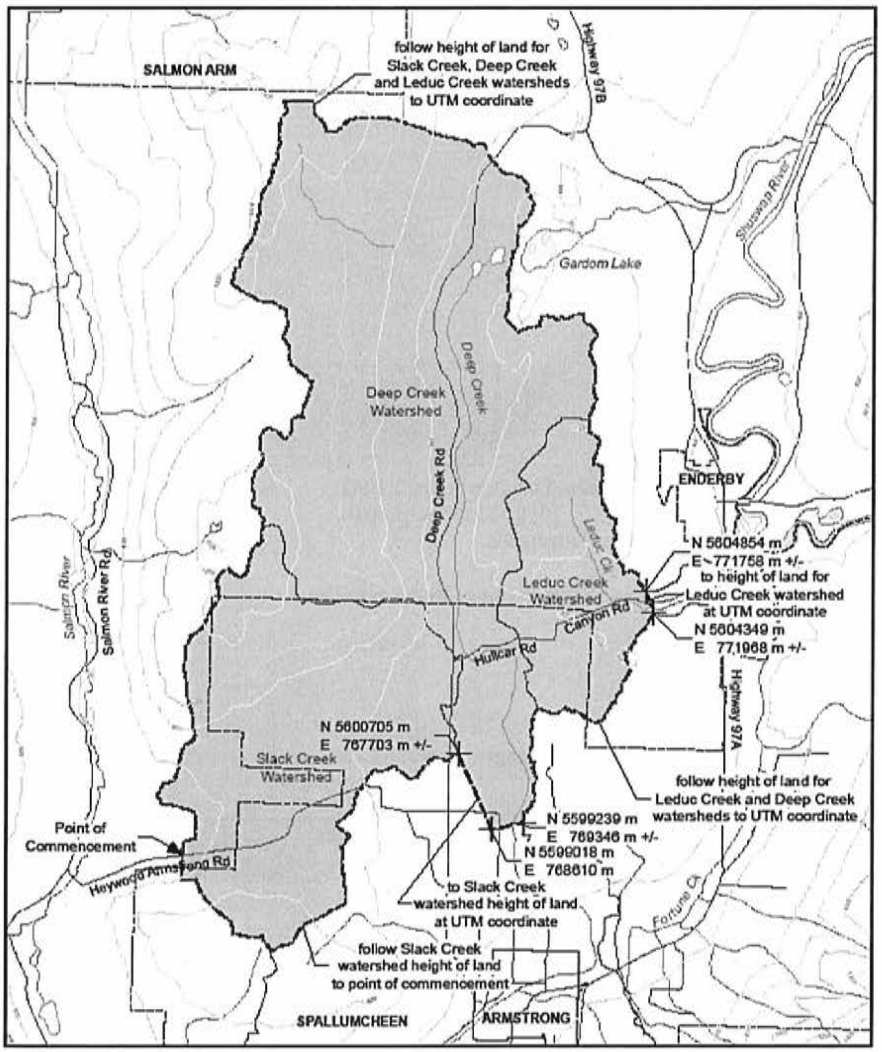


Legend

Hullcar Valley Area Based Management Plan Boundary

HULLCAR VALLEY AREA BASED MANAGEMENT PLAN BOUNDARY

BRITISH COLUMBIA



HULLCAR VALLEY AREA BASED MANAGEMENT PLAN BOUNDARY

Legend

Hullcar Valley Area Base Management Plan Boundary

BRITISH COLUMBIA

SCHEDULE B
PROCESS AND TIMELINE FOR THE DEVELOPMENT OF THE HULLCAR VALLEY AREA BASED MANAGEMENT PLAN

In accordance with section 89 of the *Environmental Management Act:*

1. The following (hereunder referred to as 'the Parties')
   a) Township of Spallumcheen
   b) Splatsin
   c) Steele Springs Water District
   d) H.S. Jansen and Sons Farm Ltd.
   e) Kenneth Regehr Holdings Ltd.
   f) George E Curtis and Kevin F Curtis
   g) Grace-Mar Farms Ltd.
   h) Save Hullcar Aquifer Team

are responsible for preparing the Hullcar Valley Area Based Management Plan (the "Plan"). Each Party listed in this Section will provide to the Minister, by MONTH XX, 2016, the name of their representative and the name of one alternate representative for acknowledgement.

2. The Parties are authorized to and must prepare a detailed Plan as per the Terms of Reference. The Terms of Reference includes the following:
   a. the purpose of the Plan;
   b. the issues to be addressed in the Plan;
   c. the process for public and stakeholder consultation;
   d. the direction for coordination with persons responsible for the Okanagan Shuswap Land and Resource Management Plan; and
   e. the time limit for completion of the Plan.

3. The Terms of Reference for establishment of the Plan are included in Schedule C.

Zacharias-Homer, Chri..., 4/7/16 2:25 PM
Comment: Participation in the process is either by being named as a 'Party' responsible for actively participating in development of the Plan; or by being consulted on aspects of the Plan (see Sched C 5.0 below)

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SCHEDULE C
Terms of Reference

1.0 INTRODUCTION

The Hullcar Valley Water Quality Plan (the "**Plan**") is an area based plan management plan focussing on water quality and developed under Section 89 of the *Environmental Management Act.*

The Hullcar Valley is located in the Township of Spallumcheen of British Columbia. The Valley contains Hullcar aquifer 102 (confined) and Hullcar aquifer 103 (unconfined), Deep Creek and several tributaries.

The regional economy of the Hullcar Valley and surrounding areas is heavily dependent on agriculture and related activities, and has a long history of agricultural activity.

There is evidence of increasing concentrations of nitrate in surface and groundwater sources in the Hullcar Valley. This issue is largely associated with historical and current agricultural activity, and in particular, leaching from agricultural waste storage, nutrient application to fields, septic system waste and commercial fertilizer.

It is within this context that the British Columbia Minister of Environment (the "**Minister**") determined that an area based management plan should be developed under Section 89 of the *Environmental Management Act.* This Terms of Reference outlines the purpose, scope and process for development of the Plan. As required by the Order, the Plan will be completed by the parties named in the Ministerial Order in accordance with these Terms of Reference. The Plan will be submitted to the Minister for approval by Month DD, 2017.

2.0 PURPOSE OF THE PLAN

The goal of the Plan is to identify and implement solutions to reverse the increasing trend of nitrate to ensure the ongoing health of the Hullcar Aquifers 102 and 103, Deep Creek and Steele Springs, while at the same time allowing for continued sustainable agricultural operations in the Designated Area. In order to remediate water quality effects of past activities and to guide future development in the Designated Area, the purpose of the Plan is to describe the actions which will be taken by the Parties named in the Ministerial Order in the Designated Area to immediately begin to decrease water quality concentrations of nitrate to acceptable levels to 9.0 mg/L or lower (nitrate-nitrogen) as per the Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Nitrate and Nitrite.

3.0 ISSUES TO BE ADDRESSED IN THE PLAN

The Plan will address the issues described in this Section 3.0.

3.1 Outcomes to be Achieved

A) The Plan will establish environmental management objectives, outcomes and outputs for the Designated Area, including the following:

i. identification of measures to be undertaken to ensure protection of surface water and groundwater for drinking water uses (an example may be implementing consistent buffer areas around wellheads and water sources when applying agricultural waste to fields).

ii. identification of measures to be undertaken to manage nitrate sources in the receiving environment that are not found in the nutrient management plan or legislation (an example may be adjustments to agricultural waste management practices such as installing an impermeable liner under field storage), and

iii. identification of nitrate treatment technologies.

B) The water quality compliance points will be set for the following locations in the Plan:

(i) Surface water TBD)

(ii) Surface water TBD)

(iii) Steele Springs Drinking Water Overflow (E301110)

(iv) Groundwater locations...

(v) Groundwater location

Zacharias-Homer, Chr..., 27/6/16 2:12 PM
Comment: To be confirmed once integrated monitoring study is completed

C) The Plan must include a group nutrient management plan that includes, at a minimum, the total volume of agricultural waste generated, total volume land applied (solid and liquid), volume treated or removed (sold, hauled away, etc.) from land application in the Designated Area, crop types for uptake of the nutrients, and soil sampling requirements.

D) The Plan must provide a description of the social and economic costs and benefits of the agriculture industry in the Designated Area by summarizing, at a minimum, existing information found in Regional District North Okanagan Regional Agricultural Plan Market Opportunities Analysis, and Central Okanagan Economic Profile for Agriculture.

3.3 Implementation

The Plan must provide a detailed sequence of actions to demonstrate how the targets established under Section 3.2 will be achieved.

3.4 Monitoring

The Plan must define on-going monitoring and assessment programs that will be implemented on approval of the Plan to validate and adaptively manage water quality concentration targets and group nutrient management planning. The monitoring program will also include water quality monitoring at the locations described in Section 3.2 and soil sampling of locations identified in the group Nutrient Management Plan. All information produced per 3.4 Monitoring will be publicly reported.

3.5 Coordination with Other Management Plans

The Parties will determine what coordination is required with person(s) responsible for the Okanagan Shuswap Land and Resource Management Plan[1] (OSLRMP). The Area Based Management Plan will outline how the OSLRMP will be integrated or coordinated with the Plan.

3.6 Amendments to the Plan

The Plan is expected to be adaptive to reflect changing circumstances, technologies and science and to reflect the results of the on-going monitoring and assessment programs described in Section 3.4. The Plan will propose a process for periodic Ministry of Environment review and approval of amendments to the Plan.

4.0 FACILITATOR AND ADMINISTRATIVE SUPPORT

An independent third-party facilitator (the "**Facilitator**") will be appointed to facilitate the plan development process established by the Terms of Reference. The Facilitator will provide secretariat support including organizing meetings of the Parties, providing notice of meetings to Parties, receiving and distributing meeting information to Parties, and preparing agendas for, and taking and preparing notes of meetings. The Secretariat will also provide support to consultation process by facilitating open houses, and summarizing input received in the consultation process.

Each party will bear the costs of participation in ABMP development.

5.0 PROCESS FOR CONSULTATION

With respect to both the preparation and implementation of the Plan, the Parties will consult with, or notify as appropriate, the following groups:

a) the public;

b) the Province of BC;

c) Okanagan Basin Water Board; and

d) other agricultural operators in the Designated Area.

Consultation will be facilitated by the Facilitator through the following methods:

a) small group meeting and/or an open house in key communities such as Spallumcheen and Armstrong;

b) physically posting consultation materials at Hullcar Hall; and

c) written submissions through mail, email or fax.

The input received through consultation will be considered, along with technical, social and economic information, in developing and refining the Plan for submission to the Minister. The Facilitator will produce a Consultation Summary Report to describe what was heard during consultation. A Consideration Report prepared by the Parties will describe how input was considered in developing, refining and implementing the Plan.

[1] https://www.for.gov.bc.ca/tasb/SLRP/plan70.html

6.0 DISPUTE RESOLUTION PROCESS

Disputes regarding procedural matters relating to the work of Parties will be referred to the Facilitator for decision. Procedural matters include issues such as meeting dates and locations, information to be included for public posting, and other similar matters. Disputes among Parties regarding the technical advice will be documented and noted in the Plan submitted for approval by the Minister.

7.0 TIME LIMIT FOR COMPLETION OF THE PLAN

The Parties must complete the Plan and submit it for approval to the Minister of Environment by MONTH DD, 2017.

DRAFT

APPENDIX B

THE CORPORATION OF THE

TOWNSHIP OF SPALLUMCHEEN

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OFFICE OF THE MAYOR

July 26, 2016

Christa Zacharias-Homer
Deputy Director, Regional Operations Branch
Environmental Protection Division, Ministry of Environment
PO Box 9334 Stn. Prov. Gov't., Victoria, BC V8W 9N3

Dear Christa:

Re: Draft Province of BC Order of the Minister of Environment Section 89, Environmental Management Act
Proposed Hullcar Valley Area Based Management Plan

The purpose of this letter is to provide the Township of Spallumcheen's written comments about the draft Order that was provided July 4, 2016 and introduced at the July 5, 2016 conference call organized by the Ministry of Environment. The conference call participants were invited to provide written comments by July 22, 2016. Thank you for being agreeable to the Township providing its written comments prior to July 29, 2016 due to the Township's Council meeting schedule.

The Township appreciates the Ministry's efforts in 2016 to coordinate the Hullcar Aquifer Inter-Ministry Team to identify sources and implement actions to minimize nitrates in the Hullcar Aquifer.

The Township understands that an Area Based Management Plan is one option available to the Minister and it has been identified as a tool that may be appropriate in the Hullcar Valley to assist in the reduction of the high nitrate levels in the Hullcar Aquifer.

The Township is interested in the possibility of participating in the Plan, subject to the Township reviewing and accepting the final details, including Schedule A – Designated Area and Map, Schedule B – Process and Timeline and Schedule C – Terms of Reference.

However, the Township is cautious that the implementation of the Plan process may be a method for the Province to download the high nitrate issue and its responsibility for water quality protection and agricultural practices to the Plan participants and mores specifically the Township. On the other hand, the Township appreciates that the Plan process provides an opportunity for local stakeholders in the Hullcar Valley to provide input into decision-making about water quality protection and agricultural practices. There is a delicate balance between providing input to the Plan and the possibility of accepting responsibility for implementing the Plan's recommendations. Refinement of the proposed Order may alleviate the Township's

concerns about downloading and responsibilities, as well as provide clarity about how the Plan process is expected to unfold.
The following are some key points identified by the Township about the draft Order:

- Regardless of the details of the proposed Order and Plan process, the Township believes that it is premature for the process to be initiated without the results of the Provincial scientific/technical studies that are underway to identify the source(s) of the high nitrates. This information is critical to identify the necessary actions to mitigate and remediate the high nitrate level in the Hullcar Aquifer. This information may also inform which stakeholders need to be involved in the Plan process. Without this information there is no foundation from which to begin preparing the proposed Plan. The necessity for this information has also been identified by representatives of the Provincial Ministries and the Interior Health Authority who have also indicated that the source(s) of the high nitrates are not known and the scientific/technical studies are necessary to provide this information. It is therefore unreasonable for the proposed Plan participants to proceed without this information.

- The purpose of the Plan to reduce the nitrate levels in the Hullcar Aquifer needs to be more aggressive. The draft Plan identifies that nitrate levels need to be reduced to 9.0 mg/L or lower. The Township believes that the goal needs to be to reduce the nitrate levels to at least 6.0 mg/L which the Township understands is the level at which the Interior Health Authority will consider removing the Water Quality Advisory.

- Another purpose of the Plan is to guide future development in the designated area. How is development defined? Discussions to date have focused on agricultural land use and activities. Is the intention for the Plan to apply to other types of land use in the Hullcar Valley?

- Representatives of the Ministries of Environment, Agriculture, and Forests Lands and Natural Resource Operations need to participate in the Plan process. They are coordinating the scientific/technical studies and have the expertise to understand and explain the methodologies and findings. These Ministries also have the jurisdiction necessary to implement the Plan's recommendations and have the knowledge to inform Plan participants if a potential Plan recommendation is not achievable.

- Provincial funding to administer the Plan process, prepare the Plan, implement its recommendations and monitor its outcomes needs to be confirmed. Any costs that are expected to be borne by other Plan participants need to be identified.

- The decision-making process for the Plan participants in preparing the Plan (eg. consensus, majority vote, etc.) needs be confirmed. How the Minister will decide if the Plan is acceptable and how it may be implemented also needs to be confirmed.

- The designated area of the Plan includes portions of the Columbia Shuswap Regional District and the Regional District of the North Okanagan. Clarification as to how these jurisdictions will be included in the Plan process is also required.

Thank you for the opportunity to provide comments about the draft Order.

The Township is available to provide additional comments about subsequent drafts of the Order.

Please contact the undersigned or Corey Paiement, Chief Administrative Officer, if you have any questions about the foregoing.

Yours truly,

Janice Brown

Janice Brown
Mayor

cc:

Honourable Mary Polak, Minister of Environment
Honourable Norm Letnick, Minister of Agriculture
Honourable Terry Lake, Minister of Health
Honourable Steve Thomson, Minister of Forests, Lands and Natural Resources Operations
Greg Kylo, MLA Shuswap
Brian Upper, Chairman, Steele Springs Waterworks District
Al Price, Save Hullcar Aquifer Team
Brian Gregory, Environmental Health Officer, Interior Health Authority

APPENDIX C

BEST MANAGEMENT PRACTICE: FIELD MANAGEMENT (Manure Application and Irrigation)

Dr. Byron H. Shaw, Ph. D

I. Purpose

The purpose of this BMP is to control and limit the impacts of manure runoff and leaching to Washington's surface and ground waters. The purpose of this BMP is also to achieve compliance with applicable Washington State and federal water quality laws and recommended water quality criteria.

II. Manure Applications

This management standard applies to all applications of manure to agricultural fields. The core purpose of manure applications is to fertilize crops with required nutrients at a rate that is as close as possible to a crop's ability to use those nutrients. This will reduce or prevent excess nutrients from running off fields and into surface waters or leaching through soils and into groundwater.

A. Environmental Considerations

- Manure applications should only occur at times when the currently growing crop can make use of the nutrients contained within the manure, or shortly before new crops are to be planted. Many crops go dormant during winter months, while other crops, like alfalfa, uptake nutrients best when applied through multiple, smaller applications during the growing season. As a result, winter applications are **strongly** discouraged. Only apply manure in winter if storage lagoons are near capacity and in consultation with a certified agronomist and approved by the state regulatory agency. Ensure that lagoons are properly drawn down the subsequent year for adequate storage.

- It is the responsibility of the farmer to ensure that manure is applied in a manner that prevents runoff to surface waters or leaching to groundwater. Applications should not take place when the following field or weather conditions are present:

    - The field is frozen or snow-covered. Winter applications should be avoided at all costs due to the strong likelihood that 1) the field will be incapable of absorbing the liquid nutrients, and 2) the crop is unlikely to make use of nutrients applied during winter. Snow melt and early spring rains are likely to cause runoff of much of the applied nutrients. **Plan accordingly to ensure adequate storage during winter months!**

    - The field is saturated, either due to a prior manure application, precipitation, or irrigation. Over-saturated fields may show "ponding," or soils may be very wet. Moisture sensors should be used to determine field moisture conditions (see discussion in Section III A, below).

    - Before rainfall is predicted, during, or shortly after precipitation events.

- There are areas that can easily convey runoff and manure pollutants to nearby surface waters. This includes tile drains, waterways, intermittent streams, irrigation ditches, and culverts. There should be and vegetative buffers within at least 50 feet of these conveyance features. Manure should not be applied in these buffer areas.

- Pay close attention to all applicable riparian and stream setbacks when identifying fields for manure application. Manure must not be allowed to enter or flow into riparian areas. For additional information on minimum buffer widths, see BMP: Riparian Areas & Buffers in this appendix.

- Manure applications are most effective when the soil has capacity to absorb the liquid and nutrients contained within the manure. Applications should occur when the soil has a moisture content between 25 and 75 percent of its field capacity, or close thereto. Soil moisture content can be measured by using a number of commercially available sensors and other devices.

B. Agronomic Rate

All manure and fertilizer applications must be made in accordance with the "agronomic rate." The agronomic rate is a rate of manure application that provides an amount of nutrients to a given crop that is as close as possible to the crop's ability to uptake the nutrients applied when nutrient sources are already present or will become present during the growing season. Manure applications that supply excess nutrients to crops can result in nutrient runoff and leaching into the waters of the state.

To calculate an agronomic rate, a farmer should obtain the following information **before** applying manure:

- The present nutrient levels in the soil. An agronomist or certified laboratory personnel should take composite soil samples at one-, two-, and three-foot depths. Composite samples should include at least 8 samples at each depth per each five-acre field area. For example, a 20-acre field should have 32 individual sites sampled into four composite samples for each depth. Sampling parameters must include nitrate, ammonium, phosphorus, potassium, organic matter, and pH. Sampling must occur prior to any manure application and the results used in making new applications; if double-cropping, take soil samples after each harvest and before applying any additional manure. There will be instances where present soil nutrient levels and anticipated credits from organic matter, past manure applications, or crop residues are adequate to fertilize a crop or at least meet part of the crop needs. In these situations, reduced application rate or no manure or fertilizer application should be made. Additionally, nutrients contained within manure release over time, making it even more important to accurately gauge the soil's present nutrient content before applying more. The nutrient budget attached hereto takes this into account by requiring farmers to use first, second, and third-

year manure credits for consecutive applications. Ammonia that has volatilized from manure applications may also be atmospherically re-deposited onto fields. This is another reason why current soil sampling analyses are vital for proper nutrient planning.

- Take all appropriate nutrients additions into account. For instance, legume crops can add nutrients back into the soil through decomposition. Organic matter mineralization will add approximately 20 to 40 pounds per acre per year of plant available nitrogen per percentage of organic matter in the soil.

- The present nutrient levels in the manure to be applied. Nutrient levels can vary widely between storage impoundments and sources of manure (e.g., solid, compost, liquid) and at different times of the year. It is imperative to know the actual nutrient content of the manure that is to be applied in order to calculate an agronomic rate. A certified technician and laboratory should take composite samples of the source of the manure that is to be applied shortly prior to application. Sampling parameters must include total nitrogen, nitrate and ammonium nitrogen, total phosphorus, potassium moisture content and organic matter.

- The amount of nutrients the crop is expected to use as fertilizer and remove with crop harvest. Farmers should review their harvest records to determine the average yield for the past five years for the crop in question. The NRCS 590 standard states that reasonable yield goals should be used in making fertilizer recommendations. These are difficult to state but either a 3-5 year average or a county yield average should be used. The yield of the crop will determine how many nutrients the crop requires for fertilization. Application rates should be as close as possible to the amount of nutrients a reasonable yield for the crop is expected to uptake based on that average. Alternatively, farmers may make use of tissue analyses during the middle of the season to determine whether a crop needs additional fertilization.

- Fertilizing to maximum yields possible should be avoided as this results in large amounts of excess nutrients in most years that leach or runoff to water resources and are costly to farmers.

- Once the information identified above has been obtained, farmers should make use of the nutrient budget attached hereto. See Sample Nutrient Budget in Section IV. The budget takes into account the present soil nutrient levels, the amount of nutrients contained within the source manure, and the amount of nutrients needed by the crop being grown. It also takes into account the amount of nutrients likely to become available from organic mater mineralization or previous crop residues. For instance, if a field's soil already has or will have 120 lbs./ac nitrate throughout the top three feet of the soil column, and the crop planted requires 200 lbs./ac nitrate for sufficient fertilization, then the budget will recommend that the farmer apply no more than 80 lbs./ac nitrate onto the field.

- Use of the nutrient budget should be field-specific, and farmers should keep a budget for each field to which manure is applied.

- Maintain nutrient budget information for at least five years for each field. This will allow the farmer to make adaptive changes that maximize the use of manure nutrients while minimizing and eliminating environmental impacts.

- Crop harvest records and nutrient analyses should supplement soil data in determining nutrient removal from each field.

- If the soil test results for a field vary significantly there may be a need to subdivide the field for management purposes or at least modify the manure application on certain parts of fields. These concepts of precision agriculture should be used when possible.

- Volatilization leaching and runoff losses need to be minimized to use manure nutrients in an agronomic and environmentally sound manner. Incorporation of applied manure during or soon after application is the best means of insuring efficient use of these nutrients.

C. Equipment and Maintenance

- Use the most efficient type of manure spreading equipment for the job. Manure spreader calibration data should be kept and done each season to make sure application rates are accurately known. University Extension Publications should be used to calibrate spreaders.

- Always ensure that manure-spreading equipment is properly calibrated and maintained. Follow the manufacturer's recommendation concerning scheduled maintenance and upkeep.

- Flow meters should be installed on all liquid application equipment.

D. Record-Keeping

- Maintain contemporaneous records about manure applications. Records should include:

  - The volume in gallons or tons per acre of manure applied on a specific day or days.

  - Records of any nutrient additions separate from manure.

  - The weather conditions 24 hours prior to and during application.

  - Soil tests showing a need for manure application that are field-specific.

- Manure tests showing the nutrient content of the manure applied.
- Crop records showing that the planted crop is expected to removce the nutrients applied.
- Copies of the completed nutrient budget attached hereto.
- Tissue analyses, if this method is used to gauge a crop's need for additional fertilization.
- Yield data and nutrient analysis to determine the actual amount of nutrients removed by each crop from each field.

- Also maintain records of all exports of manure to third-party recipients. This includes all exports of solid and liquid manure. Ensure that the recipient of the manure has an agronomic need for the manure to be applied by requesting and retaining copies of recent soil sampling records from the recipient. Also provide a manure nutrient analysis of the manure being exported for the recipient to use in making nutrient application decisions.

E. Prohibitions

- Stop manure applications immediately if any of the following are observed:
  - Ponding of manure water in fields. This condition indicates that the soil in the field has reached its holding capacity and can no longer absorb more manure or manure nutrients.
  - Run-off of manure water. Surface waters will be impacted by manure that is allowed to run-off the field.
  - Any discharges to surface waters, ditches, canals, culverts, or other conduits.
- Carefully observe manure applications on fields that have slopes exceeding 6%.
- Do not apply if soil sampling does not show a present need for additional manure applications. Applications beyond what a crop can use are not agronomic and may result in environmental degradation.
- Do not apply manure to areas that are within a riparian area or other type of setback or buffer as listed is section A above.

III. Irrigation Water

This management standard applies to the application of irrigation water to agricultural fields. Where irrigated fields are present, it is vital that farmers apply sufficient water to the crop while minimizing the loss of excess water. Excess irrigation water can cause manure nutrients such as nitrate to move deeper

into the soil profile, where it will eventually discharge to groundwater. Over-irrigation can also result in surface runoff and contamination of surface water. Consequently, proper irrigation management is a necessary tool for environmental protection.

A. Amount and Timing of Water Delivery

- Irrigation water should only be applied to irrigated fields when the crop needs it. Moisture sensors should be used to determine if the soil needs water, and when there is too much water in the soil creating a risk of leaching. It is recommended that irrigation occur when the soil is halfway between wilting point and field capacity. Irrigating to field capacity in the upper two feet of the soil will help prevent leaching losses. This will vary widely depending on soil type. Soils should not be irrigated when rainfall is predicted, before harvest when plants will not use water, or during dormant seasons when no plants are present.

B. Equipment and Maintenance

- Use the right type of irrigation equipment. Replace rill irrigated fields with pivot systems, which are far more efficient at delivering water to crops. Low flow drop nozzle irrigation or drip irrigation is preferred to normal high-pressure sprinkler systems.

- Always ensure that irrigation equipment is properly calibrated and maintained. Follow the manufacturer's recommendation concerning scheduled maintenance and upkeep.

IV. Sample Nutrient Budget

The nutrient budget must include realistic annual yield goals and associated estimates of nutrient requirements for nitrogen, phosphorous, and potassium. Nutrient removal for specified crops and yields will be based on estimated values contained in Chapter 6, Agricultural Waste Management Field Handbook ("Role of Plants in Waste Management"), or specific data for the 3-5 year average on the farm.

The following table may serve as a basic nutrient budget for use in planning for manure application. Remember, you should use a separate budget for each field or part of field, and maintain the records for at least five years.

Field Name or Identification: _____

Crop year: _____

Soil sample results (pounds per acre):

	Ammonium	Nitrate	Phosphorus	Potassium
1st ft. (0"-12")				
2nd ft. (12"-24")				
3rd ft. (24"-36")				
Field Total				

Total pounds of available nitrogen, nitrate plus ammonium: _____
Estimated nitrogen release from organic matter mineralization (percent organic matter times 30 pounds): _____
Credit from past manure applications (second year manure credits increase by 10 percent over first year; third year credits increase an additional 5 percent): _____
Credit from past crop residues (use Extension guides for credits for alfalfa or other legume residues): _____
Atmospheric deposition (estimates of about 10 pounds per acre per year but may vary geographically): _____
TOTAL NUTRIENTS LIKELY TO BE AVAILABLE DURING GROWING SEASON:

Ammonium	Nitrate	Phosphorus	Potassium

Nutrient needs based on crop to be grown and reasonable yield goal times. Include nutrient content from past analysis or USDA crop nutrient removal tool. Pounds per acre need – nutrient already available = nutrient application need for the crop.

Pounds per acre need	Nutrient already available	Application need

REFERENCES

(1) **Bary, A., C. Cogger and D.M. Sullivan.** *Fertilizing with Manure*, Washington State University, PNW0533.

(2) **Matthews, W. and B. Peterson.** *Manure Management Guidelines for Western Washington*, Washington State University Cooperative Extension, *funded in part by* Washington State Dept. of Ecology and Centennial Clean Water Funds. WSU Cooperative Extension – Whatcom County (1995).

(3) **Sullivan, D.M. and C.G. Cogger.** *Post-harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades*, Oregon State University Extension Service, EM8832-E (2003).

(4) **Natural Resources Conservation Service (NRCS).** Conservation Practice Standard: Nutrient Management (Code 590). NRCS, WA (2014).

(5) **Natural Resources Conservation Service (NRCS).** Technical Notes: Winter Period Application of Manure in Washington State. USDA/NRCS, WA (2014).

(6) **Natural Resources Conservation Service (NRCS).** Technical Note 17: A Planner's Guide to Nutrient Management. NRCS (2015).

(7) United States Department of Agriculture (USDA). Natural Resources Conservation Service: Practice Standard 590 (Nutrient Management) Fact Sheet. USDA (2014).

(8) **United States Department of Agriculture (USDA)**. Soil Conservation Service (SCS). Part 651: Agricultural Waste Management Field Handbook, Ch. 6, Role of Plants in Waste Management. USDA/SCS (1992).

BEST MANAGEMENT PRACTICE: WASTE STORAGE IMPOUNDMENTS
Water and Environmental Technologies

I. Purpose

The purpose of this BMP is to control and limit the impacts from waste storage impoundments to Washington's surface and ground waters and to comply with applicable state and federal water quality laws.

II. Definitions

Waste storage impoundment: a facility to temporarily store manure, urine, and other excreta from livestock before being used as fertilizer.

Surface waters: ponds, reservoirs, streams, and wetlands.

Open channel storm water conveyance and storage structures: drainage ditches, detention/retention ponds, and swales.

Closed conduit storm water conveyance structures: culverts, pipes, and drain tiles.

Geomembrane liner: a flexible membrane liner used to contain or prevent waste constituents and leachate from escaping a waste management unit. Geomembranes are made by combining one or more plastic polymers with ingredients such as carbon black, pigments, fillers, plasticizers, processing aids, crosslinking chemicals, anti-degradants, and biocides. (Environmental Protection Agency (EPA), 2012)

Leak detection, collection, and removal system: a system located between the primary and secondary liner to provide leak warning, as well as collect and remove any liquid or leachate that has escaped the primary liner. (Environmental Protection Agency (EPA), 2012)

Process wastewater: water directly or indirectly used in the operation of the confined animal feeding operation (CAFO) for any or all of the following: spillage or overflow from animal or poultry watering systems; washing, cleaning, or flushing pens, barns, manure pits, or other CAFO facilities; direct contact swimming, washing, or spray cooling of animals; litter or bedding; dust control; and stormwater which comes into contact with any raw material, products or by-products of the operation. (U.S. Government, 2012)

Freeboard: the distance from the top of the maximum design storage volume to the top of the storage structure.

III. Siting of Waste Storage Impoundments

CAFO's should evaluate the climate, topography, and geology of the site, as well as the location and layout of the facility to determine the best waste storage area for operation (U.S. Environmental Protection Agency, 2004). Waste storage impoundments should be located away from water bodies, floodplains, drinking water wells, shallow groundwater, sinkholes, and other environmentally sensitive areas. (U.S. Environmental

Protection Agency, 2004) Waste storage impoundments must be properly located to eliminate impacts to the environment to the maximum extent practicable. The following guidelines are recommended:

A. Environmental Considerations

- ∞ Waste storage impoundments must be located outside the 100-year floodplain.
- ∞ Waste storage impoundments must be located a minimum of 100 feet from surface water (Kansas Department of Health & Environment, 2006) and open channel structures and closed conduits storm water conveyance/storage structures.
- ∞ Waste storage impoundments must be located a minimum of 100 feet from water supply wells. (Kansas Department of Health & Environment, 2006)
- ∞ Waste storage impoundments must be located a minimum of 200 feet from public water supply reservoirs. (Kansas Department of Health & Environment, 2006)
- ∞ The locations of new or expanding waste storage impoundments must include a comprehensive geologic investigation by a licensed environmental specialist. This investigation must include, but is not limited to, a sub-surface exploration to at least 10 feet below the lowest elevation of the impoundment structure. For swine waste storage impoundment, a sub-surface exploration to at least 25 feet below is required. (Kansas Department of Health & Environment, 2006) The depth of seasonally high ground water must be monitored and documented.
- ∞ The locations of new or expanding waste storage impoundments must utilize terrain, vegetation, and meteorology (i.e., climate, weather, prevailing wind direction) to direct emissions away from the vicinity of habitable structures and comply with applicable county and state setback distances.

  Note: Proper sanitation, housekeeping, feed additives, and moisture control, as well as frequent removal and land application of manure from buildings and storage facilities, can reduce emission of dust, odors, and other gases, in addition to minimizing fly production. (Natural Resources Conservation Service (NRCS), 2009)

III. Design of Waste Storage Impoundments

The design storage volume for a waste storage facility (impoundment) shall consist of the total of the following as appropriate:

1. Manure, wastewater, and other wastes accumulated during the storage period;
2. Normal precipitation less evaporation on the surface area of the facility during the storage period;
3. Normal runoff from the facility's drainage area during the storage period;
4. 25-hear, 24-hour precipitation on the surface of the facility;
5. 25-hear, 24-hour runoff from the facility's drainage area;
6. Residual solids after liquids have been removed; and
7. Addition storage as may be required to meet management goals or regulatory requirements. (U.S. Environmental Protection Agency, 2004)

It is recommended that impoundments be oversized using a safety factor of at least 10% to prevent discharges during years of higher-than-anticipated wastewater production.

Liner Specifications
Waste storage impoundments require an impervious double-geomembrane liner with a true leak detection system. The liner and leak detection systems shall be designed, installed, and maintained in conformance with manufacturer specifications.

Roof runoff should be diverted from waste storage impoundments unless needed for dilution. Diversions options include roof gutters and downspouts with underground or open channel outlets. The design of runoff structures should adhere to *NRCS Conservation Practice Standard 588, Roof Runoff Structure.* (Natural Resources Conservation Service (NRCS), 2009)

Diversions must have a minimum capacity for the peak discharge from the 2-year, 24-hour storm event. Diversion channels must be maintained to remain effective. The design of diversion channels should adhere to *NRCS Conservation Practice Standard 362, Diversion.* (NRCS, 2010)

IV. Operation and Maintenance

An Operations and Maintenance Plan is required. Waste storage impoundments must be operated and maintained to prevent the discharge of pollutants into waters of the U.S. This includes, but is not limited to:

- Removing solids from storage structures as needed to maintain the design storage capacity. (U.S. Environmental Protection Agency, 2004)

- Maintaining storage capacity for the design storm event (25-year, 24-hour storm event for existing CAFOs and 100-year, 24-hour storm event for new CAFOs). (Environmental Protection Agency (EPA), 2004)

- Waste storage impoundments must be inspected on a routine basis (recommend bi-weekly) and after a significant storm event (i.e., ½-inch of rainfall) by trained personnel using a checklist. Tasks include checking the exposed liner material, measuring and recording the level of the solids and freeboard (recommended that freeboard be 0.3 meters (1 ft.) for lagoons without a drainage area and 0.6 meters (2 ft.) for lagoons with a drainage area), (Environmental Protection Agency (EPA), 2004) and documenting maintenance needed and/or performed.

- Waste storage impoundments must be inspected annually after drawdown by trained personnel using a checklist. Tasks include checking the integrity of the impoundment and liner, cleaning accumulated solids and debris, repairing impoundment and liner, and documenting (amount of the solids and debris removed) maintenance performed.

  NOTE: Liner repair must be conducted by a certified technician.

REFERENCES

1) **Environmental Protection Agency (EPA).** Chapter 7: Section B Designing and Installing Liners--Technical Considerations for New Surface Impoundments, Landfills, and Waste Piles. *Part IV Protecting Ground Water.* s.l. : EPA, 2012.

(2) **U.S. Government.** Part 412 - Concentrated Animal Feeding Operations (CAFO) Point Source Category Section 412.2 - General Definitions. [book auth.] U.S. Government. *Code of Federal Regulations (CFR).* Washington, DC : U.S. Government Publishing Office, 2012.

(3) **U.S. Environmental Protection Agency.** *Managing Manure Nutrients at Concentrated Animal Feeding Operations.* Washington, DC : EPA Office of Water, 2004.

(4) **Kansas Department of Health & Environment.** *Design Standards for Confined Feeding Facilities.* Topeka, Kansas : Kansas Department of Health & Environment, 2006.

(5) **Natural Resources Conservation Service (NRCS).** Part 651 Agricultural Waste Management Field Handbook. *Agricultural Waste Management System Component Design.* s.l. : United States Department of Agriculture, 2009.

(6) **NRCS.** *Conservation Practice Standard: Diversion (Code 362).* s.l. : NRCS, 2010.

(7) **Environmental Protection Agency (EPA).** *Managing Manure Nutrients at Concentrated Animal Feeding Operations.* Washington, D.C. : U.S. EPA, 2004

APPENDIX D

BEST MANAGEMENT PRACTICES STATEMENT

BRIAN UPPER, D.V.M, CHAIRMAN OF STEELE SPRINGS WATERWORKS DISTRICT

Notes to Calvin Sandborn and Jessica Wilson October 18, 2016

The Shaw Best Management Practices (BMP) covers the important factors quite well regarding nitrogen which is, by far, the most difficult nutrient to track. The problem with even a quality BMP is that the soil and manure tests, as well as the estimates of crop requirements are approximate even with ideal sampling procedures and adherence to the recommended 'book values'. On top of that, there is a degree of subjective (ie ball park) estimating of field losses and gains of nitrogen (ammonium and nitrate) that happens within the topsoil. Below the root zone, if a field has minimal nitrate contamination, as may be the case in other parts of the Hullcar Valley, there is a small degree of buffering (aka natural forgiveness) so that if estimates of nitrogen are slightly high, the nitrate in groundwater may hardly change. But there is little of this potential buffering if nitrates are plentiful in the deeper layers as is the case in the 'field of concern'. Then, there is the nutrient application, often divided into rate and timing, which is arguably the biggest fudge factor of them all.

Here are my draft recommendations for nutrient management of farm operations in the Hullcar Valley. These recommendations coupled with those of manure management experts, soil scientists, hydrologists and environmental ecologists could be compiled after the Environmental Impact Assessments, the Integrated Monitoring Study, the Post-Harvest Nitrate Study and the Ambient Hydrogeological Network Sampling have been completed and have been impartially and transparently assessed.

(1) A farm operation that is found not to be contributing to aquifer pollution with nitrate would be required to strictly follow the Shaw or similar BMP as written, with Ministry of Agricultural and Environment supervision. The farm operators would still be required to adhere to the AWCR. All lands on which the farm operation applies its manure (waste) would be on the BMP.

(2) A Farm operation that is found to be contributing little or moderately to the nitrate pollution of the Hullcar Aquifers would be required to follow the BMP (as above) with supervision from a highly qualified professional who is a Professional Agrologist, is very experienced in manure management and who is also experienced in controlling agricultural based pollution of groundwater and surface water. *Particular attention would be paid to correct soil sampling and manure sampling methods. Manure/effluent application procedures would also be monitored, ensuring that nutrients are not inadvertently over applied on any of the lands farmed by the operation.

(3) A farm operation that is found to be a major contributor of nitrate groundwater pollution would be required to follow the BMP as in point 2 above. However, if nitrate contamination below the root zone is detected, via soil or ground water tests, below any lands (fields) farmed by the farm operation, no nitrogen would be allowed to be applied to those lands (fields), until the nitrate in the aquifer water flowing under such fields is found to contain less than 3 ppm of nitrate nitrogen.

These recommendations are in summary form and are subject to interpretation, modification, clarification and expansion by the undersigned. The object of strictly following the described BMP is to remediate the Hullcar Aquifers. An additional goal is to reduce wastage of the valuable nutrients, ammonium and nitrate, thus substantially reducing costs to the farm operation.

Respectfully submitted,

Brian Upper D.V.M, Chairman of Steele Springs Waterworks District

APPENDIX E

REVIEW OF BEST MANAGEMENT PRACTICES

GRAND RIVER WATER MANAGEMENT PLAN

Grand River Water Management Plan
TECHNICAL BRIEF

Report No.:	WMPSC-2013-01-03	**Date:**	January 16, 2013
To:	Water Management Plan Project Team		
From:	Anne Loeffler, member, Water Quality Working Group		
Subject:	A Review of Best Management Practices to address Agricultural Sources and Pathways of Nitrogen, Phosphorus and sediment		

RECOMMENDATION

For information only

REPORT:

Introduction

The following objectives were identified in the Terms of Reference for the Water Quality Working group:

- to identify the Best Management Practices (BMPs) most effective to deal with the key mechanism/processes involved in the transport of nutrients in the watershed; and
- to compare this list of BMPs with the BMPs currently implemented by the Rural Water Quality Program (RWQP) and identify information and knowledge gaps.

There is consensus among the water quality working group members that nonpoint/diffuse sources of nutrients from lands that have a surplus of nitrogen/phosphorus from the over-application of manure and/or fertilizers are a major source of nutrients and sediment to the river system. While nutrient inputs from large point sources are an important issue, this brief deals with addressing the agricultural and rural sources.

The GRCA currently delivers the Rural Water Quality Program on farms throughout the watershed. The RWQP started in the Region of Waterloo in 1998 and has slowly expanded to include the entire watershed. Through this program, staff deliver technical and financial assistance to farmers who wish to address potential water quality impairment issues on their farms. Participation in the program is voluntary. The program is funded mostly by the upper tier municipalities. Local steering committees prioritize BMP applications and decide appropriate funding levels to direct the available funding. Through the RWQP program structure, the GRCA is also able to direct some provincial, federal and corporate funding sources to those areas where no municipal funding is available. The list of eligible BMPs is shown in Table 1.

Federal and provincial cost share programs such as the Canada-Ontario Farm Stewardship Program (COFSP) also offer cost share incentives for a number of BMPs. Province-wide programs such as COFSP

are currently available on a first come, first served basis and do not directly prioritize water quality issues.

BMP identification and characterization

Several North American literature reviews have been conducted recently to assess the effectiveness of agricultural BMPs (see References section). This research must be carefully evaluated within the context of local geomorphic and hydrologic conditions. BMP effectiveness has been shown to be extremely site-specific and may vary considerably between sites from the watershed level down to the individual field level. Specific site conditions must always be considered before making decisions regarding which BMPs to implement. It is important to have a wide suite of practices to choose from to address a specific issue. It is also important to recognise that the implementation of a suite of BMPs may be necessary for maximum benefit since multiple transport pathways for multiple forms and types of nutrients are often in operation on agricultural lands during any given season. As a result, a multi-barrier approach, rather than reliance on a single or a few BMPs, is recommended.

To qualify as a Best Management Practice, a practice must be a proven, practical and affordable approach to conserving soil, water, and other natural resources. New technologies and practices are being developed (or likely will be) to address nutrient issues, however they are not considered BMPs until proven. BMPs promoted in Ontario and which could influence nutrient management are listed and described in Appendix 1.

The ACT (Avoid, Control, and Trap) approach (NRCS, 2012) characterizes BMPs to fit into a multi-barrier approach to address different sources and pathways of nutrients from agricultural sources as follows:

- Does the BMP **avoid** the creation of the problem?
- Does it **control** its movement of the potential contaminant from the source?
- Does it **trap** (or treat) the potential contaminant before it enters a watercourse?

Table 1 aligns BMPs by the potential contaminants (e.g. phosphorus, nitrogen, sediment) and predominant pathways for their movement. While greatest priority should probably be given to BMPs that avoid the creation of a problem, BMPs that control and trap nutrients must also be part of the toolkit.

Experts at the OMAFRA workshop on the Assessment of Agricultural Best Management Practices (April 2012) agreed that there is no one single BMP that will solve the problem everywhere. Many BMPs may also have undesirable side effects, such as increased release of greenhouse gases. Some potential negative side effects of specific BMPs are of particular interest:

- Conservation tillage, which is practiced to decrease particulate phosphorus and sediment losses, may result in increased dissolved phosphorus levels in surface runoff if fertilizer is left on the surface rather than being banded below the surface.

- Techniques to enhance water infiltration, and reduce transport of dissolved phosphorus across the soil surface, may lead to increased leaching of nitrate.

Gap identification

- For the current Grand River Rural Water Quality Program (RWQP), watershed municipalities supply the funding to assist farmers with implementing BMPs. The level of funding assistance available to farmers across the watershed varies widely by upper tier municipality. Local steering committees prioritize BMP applications and decide appropriate funding levels to direct the available funding
- Due to the lack of resources, no financial assistance can be offered at present to address agricultural nutrient issues in some areas that have been identified as priority areas, including the headwaters of the Nith River. In addition, funding assistance is extremely limited at present in the municipalities of Perth, Halton, and Hamilton.
- The funding of manure storages, one of the most expensive BMPs, is currently restricted to Waterloo, Wellington and Brant Counties. Livestock operations in other counties in the watershed therefore currently have no assistance available to them through the RWQP.
- Annual incentive payments to keep fragile agricultural land out of production are limited to Waterloo Region and Wellington County. For example, planting trees and native cover on fragile lands such as steep slopes helps to reduce erosion and limit the mobilization of sediment and phosphorus into streams.
- While nutrient management planning services are currently funded in most parts of the watershed, consideration should be given to effective means of promoting all aspects of nutrient management, include the 4-R Nutrient Stewardship program which includes the **R**ight rate, **R**ight time, **R**ight source, and **R**ight placement of all nutrients (www.ipni.net/4R).
- Current programming provides incentives primarily for capital projects. There is a need to develop tools and mechanisms to provide incentives for practices such as cover cropping, crop rotation, and strip cropping. Many of the nutrient stewardship BMPs fall into the category of practices rather than being capital projects or structures that can be incented in a traditional cost share program. These capital projects are often in the "trap" category, recovering nutrients as they leave the field, but they are either less effective than avoiding or controlling the nutrient losses in the field, or they need to work in concert with in-field practices to be most effective.
- Some issues are best addressed at a broader level than at the farm scale. For example, thought could be given to rural stormwater planning at a subwatershed scale. The RWQP currently does not have a mechanism for providing funding for collaborating multiple landowners at the community or subwatershed level.
- Generally, funds are available for farmers only. With the exception of tree planting projects and well projects in some municipalities, rural non-farm property owners are not eligible for support through existing programs.
- Federal and provincial cost share programs play an important role in supporting BMP adoption locally. The number of BMPs implemented through the RWQP is related to the availability of

funding from other programs such as the Canada-Ontario Farm Stewardship Plan. When financial support available through other cost share programs is fully allocated, implementation through the RWQP becomes limited and farmers hold off on implementing projects to await a new influx of funds.

- Currently there is no funding for monitoring implementation and individual or collective performance of BMPs.

Key recommendations for moving forward

- There is a need to develop a watershed-wide Rural Water Quality Program that provides technical and funding assistance to priority farms in all municipalities in the watershed.
- Enhanced assistance may be appropriate in priority areas or subwatersheds
- Currently municipal tax structures provide a disincentive for naturalization projects on agricultural land. A modified system that provides property tax breaks to people who conduct naturalization or tree planting projects should be investigated.
- A wide range of BMPs is needed in the toolkit rather than focussing on a limited number of practices.
- There is a need to recognize that rural non-farm property owners control a significant proportion of the rural landscape, and programs need to be adapted and available to them as well as the farming sector.
- Adapt the RWQP program as innovative technologies become proven as Best Management Practices. A mechanism should be developed to review and incorporate new BMP's into the RWQP toolkit.
- Demonstration projects should be considered for incorporation into the current RWQP funding structure.
- Flexibility in incentive programming structure is important. One option to be considered is the bundling of incentives or practices i.e. making regular soil testing mandatory to receive performance incentive payments for establishing cover crops.
- Monitoring programs should be in place to measure the effectiveness of the implementation of BMPs at the subwatershed scale. Also, the implementation of BMPs on all farms (not just those farms participating in the RWQP) should be tracked to help understand the relationship between BMP implementation and water quality.
- As in the past, the collective knowledge of technical experts at Agriculture and Agri-Food Canada as well as the Ontario Ministry of Agriculture, Food and Rural Affairs should continue to inform the selection of BMPs in the RWQP.

Table 1. Using the ACT (Avoid, Control, Trap) approach to characterize agricultural BMPs on private land
Black = currently part of the RWQP BMP toolkit in most municipalities- Red = currently NOT part of the RWQP toolkit
Purple = funding limited to Wellington County RWQP

Source	Sediment	Particulate Phosphorus	Soluble Reactive Phosphorus	Nitrogen
Pathway	**Erosion**	**Erosion**	**Runoff**	**Infiltration**
Avoid	• Livestock fencing • Buffer strips • Streambank stabilization structures • Machinery crossings • Windbreaks • Fragile land retirement • **Cover crops** • Crop rotation • Setbacks	• Nutrient management planning • Phosphorus rate • Phosphorus source • Phosphorus placement • Phosphorus timing • Livestock fencing • Buffer strips • Streambank stabilization structures • Machinery crossings • Windbreaks • Fragile land retirement • **Cover crops** • Crop rotation • Feed regimes to reduce nutrients in manure • Setbacks	• Nutrient management planning • Phosphorus rate • Phosphorus source • Phosphorus placement • Phosphorus timing • Livestock fencing • Clean water diversion • Manure storage • Milkhouse or other wastewater treatment or storage • Decommission unused manure storage • Fragile land retirement • Crop rotation • Feed regimes to reduce nutrients in manure • Setbacks	• Nutrient management planning • Nitrogen rate • Nitrogen source • Nitrogen placement • Nitrogen timing • Livestock fencing • Manure storage • Clean water diversion • Decommission unused manure storage • Dead stock composting facilities • Fragile land retirement • **Cover crops** • Crop rotation • Irrigation management • Feed regimes to reduce nutrients in manure
Control	• Soil conservation planning • Water and sediment control basins • Grassed waterways • Drop structures • Terraces • Livestock fencing • Tile outlet stabilization • **Cover crops** • Strip cropping • Residue management	• Soil conservation planning • Water and sediment control basins • Grassed waterways • Drop structures • Terraces • Tile outlet stabilization • Strip cropping • Livestock fencing • **Cover crops** • Residue management	• Manure storage • Milkhouse waste treatment • Soil conservation planning • Fertilizer storage and handling facilities • Grassed waterways • terraces • **Cover crops** • **Tile drain control structures** • Strip cropping	• Manure storage • Fertilizer storage and handling facilities • **Cover crops** • **Tile drain control structures**
• Table 1 (continued)				

Source	Sediment	Particulate Phosphorus	Soluble Reactive Phosphorus	Nitrate Nitrogen
Pathway	**Erosion**	**Erosion**	**Runoff**	**Infiltration**
Trap	• Buffer strips • **Wetland creation** • Rural stormwater planning	• Buffer strips • **Wetland creation** • Tile water treatment • Rural stormwater planning	• Buffer strips • **Wetland creation** • Tile water treatment	• Buffer strips • **Wetland creation** • Tile water treatment • Tile drain control structures

Appendix 1: Definitions and short descriptions of BMPs listed in Table 1

Source: For the purposes of Table 1, the source of nutrients or sediment is the consideration of both land cover/use and land management practices. For instance, a source category as defined for the water management plan would include a nonpoint (or diffuse) source that may include animal manure applied onto agricultural lands. See Table A1 below for an illustration of a variety of nutrient and sediment source categories identified for the watershed.

Pathway: Predominant mechanism by which contaminants move towards water resources. For example, erosion, runoff, infiltration/discharge of groundwater.

ACT Approach: The ACT approach focuses on the function/mechanism by which a management practice mitigates the occurrence, form or movement of a potential contaminant, in this case sediment or various nutrient forms.

> **Avoid:** Reduce the amount of potential contaminant at source by reducing its use/occurrence in the field in the first place
>
> **Control:** Alter the amount or movement of the potential contaminant in field by transforming the contaminant or partitioning to different pathways or altering (slowing) the pathway

Trap/Treat: Removal of the potential contaminant from pathway, typically at edge of field. May include removal by transformation (e.g. denitrification) or trapping and removing. This should be a permanent solution e.g. P trapped in vegetation that is removed is not available to dissolve when plant material freezes, and so does not move with snowmelt**Buffer strip** – a strip of permanent vegetation, usually a mix of trees, shrubs and grasses at least 3 meters wide along the side of a watercourse. It provides habitat and protection for water quality from erosion, excess nutrient runoff, and contaminants.

Clean water diversion– Eavestrough, berms, and/or roofs to divert clean rain water and surface water from livestock yards and manure storages, thereby decreasing the volume of contaminated runoff. Can also be diversions around structures such as greenhouses, farmsteads, or parking lots.

Cover crop – A crop grown in rotation with regular crops for ground cover rather than for harvest. These crops (e.g. red clover or oil seed radish) can absorb leftover nutrients from the soil, and may release them to the next crop. They may help reduce leaching of nutrients into ground water.

Crop rotation – Using a different crop in the same field for each new planting. Crop rotation improves crop yields, and makes it easier to control insects and weeds. If legumes are included in the rotation, nitrogen will be carried over to the next crop.

Dead stock composting– A process of managed decomposition of deadstock achieved by mixing deadstock with substrate at the proper ratio. Micro-organisms, in the presence of oxygen, break down the organic matter to produce a stable, dark, soil-like material that has very little odour. Composting can be done in a bin system, windrows, inside a container (in-vessel) or a building.

Decommissioning unused manure storage – unused manure storages may accumulate rain water and eventually overrun or leak residual nutrients into ground and surface water.

Drop structure – a structure to control erosion in an area of concentrated flow by directing water from a higher level to a lower level. May include rock chute spillways or drop pipe inlets.

Nutrient rate – BMPs for selecting the appropriate rate of fertilizer, manure or other sources of nutrients to avoid losses of unused nutrients. Includes assessing nutrient supply from all sources and assessing plant demand. Includes soil testing for existing nutrient levels. May include variable rate application to address spatial variability within fields.

Nutrient source – BMPs for selecting the appropriate nutrient source and form to ensure a balanced supply of nutrients that suit the soil properties. May include commercial fertilizers, livestock manures, bio-solids, and credits from previous crops. May include controlled nutrient release products such as slow nitrogen release products.

Nutrient placement – BMPs for appropriate nutrient application may include banding, injection, incorporation, and side dressing. Need to recognize crop rooting patterns and manage spatial variability within fields.

Nutrient timing – BMPs for applying nutrient sources at appropriate times to minimize nutrient losses to the environment. Involves assessing the dynamics of crop uptake and soil supply, and determining timing when risk of loss is least.

Fertilizer storage and handling facilities – facilities to allow for the safe handling and loading of fertilizers into application equipment.

Fragile land retirement – removing fragile agricultural land subject to severe wind and water erosion from agricultural production and establishing trees or other permanent vegetation. Examples may include steep slopes and other erosion-prone lands, floodplains, and poorly drained lands.

Grassed waterway – a broad, shallow, permanently vegetated channel designed to safely convey concentrated runoff from farm fields to a stable outlet.

Livestock fencing – fencing erected to restrict livestock access from watercourses to protect streambanks and eliminate manure inputs. Livestock fencing projects often require the installation of livestock stream crossings and alternate water sources.

Machinery crossing – structure built to allow machinery to safely cross a watercourse without causing damage to the stream bed or bank.

Manure storage – concrete or steel structures, tanks or buildings to contain livestock manure and manure runoff.

Nutrient management planning – creating plans that evaluate appropriate nutrient application rates and other regulatory standards of application. Nutrient management plans should incorporate or consider all of the 4Rs (right rate, right source, right time, and right place) of nutrient stewardship.

Residue management (conservation tillage) – tillage methods and planting systems that keep soil covered with crop or crop residue after harvest, over winter, before planting and after planting to reduce the risk of erosion and the delivery of sediment and nutrients to watercourses. Conservation tillage leaves 30% or more of the soil surface covered with crop residue after planting.

Rural stormwater planning – developing a plan to contain and/or treat surface runoff from a subwatershed. The intent is to deal with rural stormwater at a broader scale than the farm scale.

Setback (or separation distance) – distance maintained between application (of nutrient, pesticide) and water resource of concern

Soil conservation planning – developing a plan to evaluate the potential of various BMPs to reduce soil erosion. Should be done by qualified consultants.

Streambank stabilization – may include bioengineering techniques, ditchbank seeding, spillway drop structures, and culvert or tile outlet protection.

Strip cropping –systems of crop strips across a slope to control soil erosion. Usually consist of alternate strips of forage crops and cereal/row crops, between 23 to 46 m in width.

Terraces – earthen berms that intercept runoff and divert it into a subsurface drainage system, reducing erosivity and volume of overland flow

Tile outlet control structures – structures that control subsurface drainage volume and nutrient losses through tiles.

Tile outlet stabilization – the use of erosion resistant material, such as rock riprap on top of a filter cloth, to protect the stream or ditchbank area from erosion where water exits a tile drain.

Tile water treatment – bioreactors, detention ponds or treatment ponds that treat tile water at the end of the tile.

Wastewater treatment or storage – the proper treatment or containment of washwater from milk pipelines, milking parlours, and other components of dairy production facilities, as well as on-farm processing, greenhouse, bunker silo, solid manure pile wastewater or runoff containment, treatment and/or reuse.

Water and sediment control basins – an earthen berm that intercepts and ponds runoff, then releases it slowly into a subsurface drainpipe in less than 24 hours.

Wetland creation – creation of wetlands to hold back and slowly release surface runoff from farm fields.

Windbreaks - rows of trees planted on field borders to reduce wind speeds, protect crops and reduce the risk of soil erosion by wind.

Table A1. Watershed source categories of nutrients and sediment and the key transport mechanism associated with moving nutrients / sediment from land to surface water.

Nutrient & Sediment Source Category			Issue	Key transport mechanisms
I	II	III		
Non Point Sources	Forested, wetland areas	Stormwater	Sediment, Phosphorus	Runoff
	Rural (Non Agriculture)	Stormwater	Sediment, Phosphorus	Runoff
	Agriculture	Manure	Phosphorus, Nitrogen	Runoff, infiltration
		Inorganic fertilizer	Phosphorus, Nitrogen	
		Non Agricultural Source Materials (NASM)	Phosphorus, Nitrogen	
		Soil Erosion	Sediment	Runoff
	Urban	Stormwater	Sediment, Phosphorus	Runoff
	In-River	Sediment	Sediment, Phosphorus	In-river flows; bank scouring; weirs/dams; internal cycling of nutrients
	Large Water Mgmt Reservoirs	Sediment	Phosphorus	Internal cycling of nutrients
	Septic Systems	Effluent	Nitrogen	Infiltration
Point Source	Wastewater Treatment Plants	Effluent	Phosphorus Nitrogen	Direct discharge
	Agriculture Washwaters		Phosphorus Nitrogen	Direct discharge

Appendix 2: Recent literature reviews and suggested reading

- Boston, Trevor, Barry Evans, and Conrad Stang. 2010. **Review of Agri-Environmental BMP effectiveness. Identifying performance expectations for applications in the Lake Simcoe watershed.** Prepared for the Ontario Ministry of Agriculture, Food and Rural Affairs by Greenland International Consulting Ltd.
- Cumrine, John P. 2011. **A working document for the development of a BMP toolbox for reducing dissolved phosphorus runoff from cropland to Lake Erie**. Heidelberg University, National Center for Water Quality Research.

- Hart, Murray R., Bert F. Quin, and M Long Nguyen. 2004. **Phosphorus runoff from agricultural land and direct fertilizer effects: a review.** Journal of Environmental Quality, Vol. 33: 1954-1972.

Other suggested reading

- University of Minnesota Extension. 2008. **BMPs for Nitrogen on coarse textured soils.**
- Osmond, Deanna, Don Meals, Dana Hoag, Mazdak Arabi, Al Luloff, Greg Jenings, Mark McFarland, Jean Spooner, Andrew Sharpley, and Dan Line. 2012. **Improving conservation practices programming to protect water quality in agricultural watersheds: Lessons learned from the National Institute of Food and Agriculture – Conservation Effects Assessment Project.** Journal of Soil and Water Conservation 67(5): 122A-127A. www.swcs.org
- Schnepf and Cox (editors), 2006. Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Soil and Water Conservation Society, Ankeny, Iowa. 326 pp.
- WESA. 2012. Hydrogeological Assessment Wilmot Centre Well Field. Executive Summary Report. Project No. W-B8791-08. Prepared for the Regional Municipality of Waterloo.

References

- Ontario Environmental Farm Plan
  www.ontariosoilcrop.org/en/programs/canada_ontario_environmental_farm_plan_efp.htm
- Best Management Practices series
  www.omafra.gov.on.ca/english/environment/bmp/series.htm
- 4R Plant Nutrition: A Manual for Improving the Management of Plant Nutrition
  www.ipni.net

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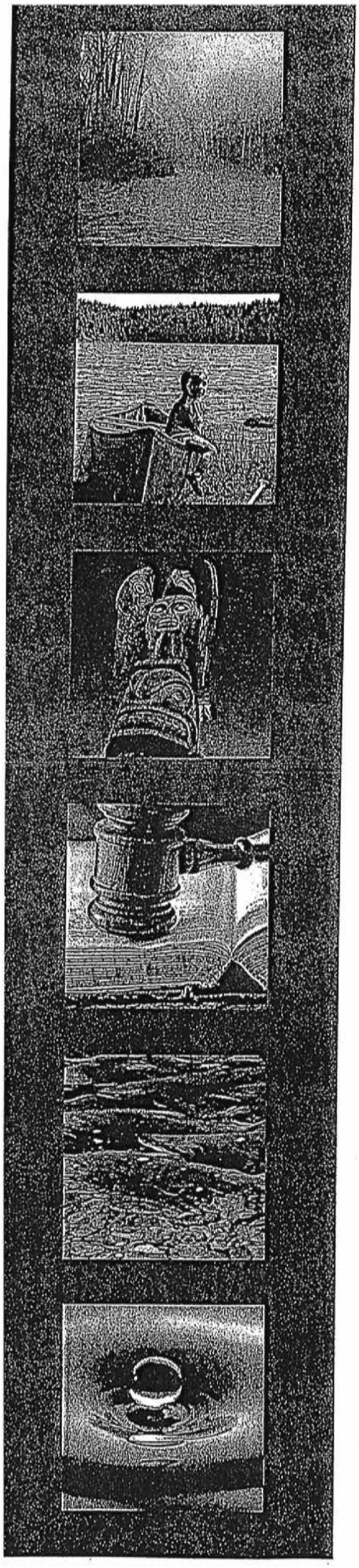
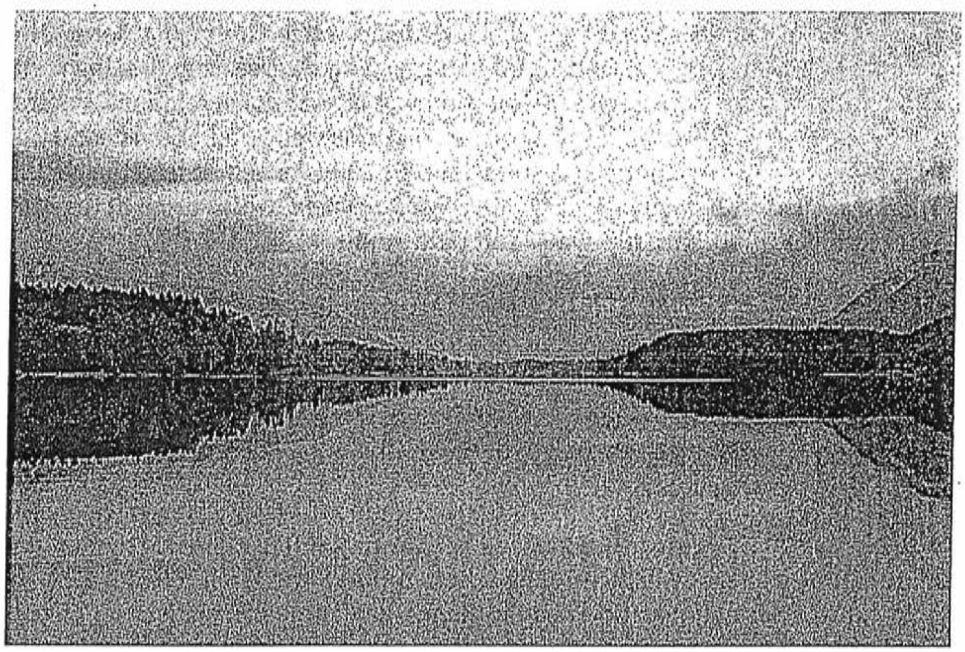


APPENDIX F

A Watershed Governance Case Study

The Cowichan Watershed Board:
An Evolution of Collaborative Watershed Governance



by Rodger Hunter
with Oliver M. Brandes, Michele-Lee Moore, and Laura Brandes

August 2014

See http://poliswaterproject.org/publication/761

POLIS Project on Ecological Governance
watersustainabilityproject

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APPENDIX G

April 21, 2016

Open Letter to the British Columbia Ministry of Environment, Ministry of Forests, Lands and Natural Resource Operations, Ministry of Health, Ministry of Agriculture and Interior Health Authority.

Re: Nitrate Contamination in Steele Springs and Likely Source of Contamination

After attending the 14 April Hullcar Aquifer Inter-Ministry Action Plan meeting at the Hullcar Hall, we are dismayed at both the response by the Ministries of Health, Environment and Agriculture to date, and with their proposed plans to address the nitrate contamination in the Steele Springs community water source. These plans call for a year-long study; however, this study, in and of itself will do nothing to alleviate the contamination of a drinking water source in the near-term.

The co-signers of this letter are all hydrogeologists and Professional Engineers or Geoscientists licensed to practice with the Association of Professional Engineers and Geoscientists of B.C. We have familiarized ourselves with the information currently available including review of previous reports prepared for the Hullcar aquifer systems, environmental monitoring data collected by the Ministry of Environment and water quality data collected by the Steele Springs Waterworks District and submitted routinely to Interior Health. We have also collected recent water level data and water quality samples from selected wells.

Based on our review, it is our professional opinion that effluent spreading on the field of concern by Jansen and Sons Farms Ltd. is extremely likely, if not certainly, the source of most of the nitrate contamination in Steele Springs.

We agree that some of the ambient background concentration of nitrate-nitrogen in MoE mapped Aquifer 103 (which discharges into Steele Springs), likely results from septic disposal to ground, lower intensity agricultural practices and other sources of nitrogen in the area. Based on the information currently available, this background concentration is likely on the order of 2 mg/L or less. Recent nitrate concentrations in Steele Springs have been measured in excess of 13 mg/L. There is little doubt in our minds that the reason for elevated nitrate concentrations in Steele Springs is due to liquid effluent spreading on the so-called "field of concern", which is currently under a Ministry of Environment Compliance Order. This compliance order unfortunately allowed continued application of effluent and now, two years later, the drinking water is still contaminated.

We do not believe public health and protection of the environment is being held paramount in government's handling of this issue. Moving forward, a precautionary approach is warranted for this situation. It is clear contamination of a drinking water source has occurred and is occurring. This contamination poses a clear risk to public health based on guidelines put in place by Health Canada and routinely enforced by Interior Health. The prudent action to be taken is to impose a moratorium on further liquid effluent spreading on the field of concern until the situation is fully understood and it can be scientifically demonstrated that resuming liquid effluent spreading will not impact water quality at Steele Springs.

Powers exist under the Drinking Water Protection Act that allow Interior Health drinking water officers to take action to prevent contamination of drinking water sources. These powers do not require conclusive proof of the source of the contamination, only identification of a likely or probable source. There is a clear probable source in this instance, and as professionals and as representatives of the Steele Springs Waterworks District, we strongly urge government to take action now and impose the requested moratorium.

Respectfully submitted,

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Hydrogeologist

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APPENDIX H

The Conservation Technology Information Centre Defines a Nutrient Management Plan in the following way:

What is a Crop Nutrient Management Plan?

A Crop Nutrient Management plan is a tool to increase the efficiency of all the nutrient sources your crop uses while reducing production and environmental risk, ultimately, increasing profit.

10 KEY COMPONENTS

Ag experts agree that there are ten fundamental components of a Crop Nutrient Management Plan. Each component is critical to helping you analyze each field and improve nutrient efficiency for the crops you grow.

1. Field map. The map, including general reference points (such as streams, residences, wellheads, etc.), number of acres, and soil types is the base for the rest of the plan.

2. Soil test. How much of each nutrient (N-P-K and other critical elements such as pH and organic matter) is in the soil profile? The soil test is a key component needed for developing the nutrient rate recommendation.

3. Crop sequence. Did the crop that grew in the field last year (and in many cases two or more years ago) fix nitrogen for use in the following years? Has long-term no-till increased organic matter? Did the end-of-season stalk test show a nutrient deficiency? These factors also need to be factored into your plan.

4. Estimated yield. Factors that affect yield are numerous and complex. Your field's soils, drainage, insect, weed and disease pressure, rotation and many other factors differentiate one field from another. This is why using historic yields is important in developing your yield estimates for next year. Accurate yield estimates can dramatically improve nutrient use efficiency.

5. Sources and forms. The sources and forms of available nutrients can vary from farm-to-farm and even field-to-field. For instance, manure fertility analysis, storage practices and other factors will need to be included in your plan. Manure nutrient tests/analysis are one way to determine the fertility of it. Nitrogen fixed from a previous year's legume crop and residual affects of manure also effects rate recommendations. Many other nutrient sources should also be factored into your plan.

6. Sensitive areas. What's out of the ordinary about your field plan? Is it irrigated? Next to a stream or lake? Especially sandy in one area? Steep slope or low area? Manure applied in one

area for generations due to proximity of dairy barn? Extremely productive—or unproductive—in a portion of the field? Are there buffers that protect streams, drainage ditches, wellheads, and other water collection points? How far away are the neighbors? What's the general wind direction? This is the place to note these and other special conditions.

7. Recommended rates. Here's the place where science, technology, and art meet. Given everything you've noted, what is the optimum rate of N-P-K, lime, and any other nutrients. While science tells us your crop has changing nutrient requirements during the growing season, a combination of technology and your management skills assure optimum nutrient availability at all stages of growth. No-till corn generally requires starter fertilizer to give the seedling a healthy start.

8. Recommended timing. When does the soil temperature drop below 50 degrees? Will a nitrogen stabilizer be used? What's the tillage practice? Strip-till corn and no-till corn require different timing approaches than corn planted into a field that's been tilled once with a field cultivator. Will a starter fertilizer be used to give the seedling a healthy start? How many acres can be covered with available labor (custom or hired) and equipment? Does your manure application depend on a custom applicator's schedule? What agreements have been worked out with neighbors for manure use on their fields? Is a neighbor hosting a special event over the weekend? All these factors and more will likely figure into the recommended timing.

9. Recommended methods. Surface or injected? While injection is clearly preferred, there may be situations where injection is not feasible (i.e. pasture, grassland). Slope, rainfall patterns, soil type, crop rotation and many other factors affect which method is best for optimizing nutrient efficiency (availability and loss) in your fields. The combination that's right for you in one field may differ in another field…even with the same crop.

10. Annual review and update. Did you actually do what you planned to do? Even the best managers are forced to deviate from their plans. Did an unusually mild winter or wet spring reduce soil nitrate? Did a dry summer, disease, or some other unusual factor increase nutrient carryover? What was applied where? At what rate? Using which method? These and other factors should be noted as they occur. If you're like most people, it's easier to make notes as it's being done than to remember back six to 10 months.

Source: online: http://www.ctic.purdue.edu/resourcedisplay/325/