

From Crisis to Solutions

Towards Better Source Water Protection and
Nutrient Management in the Hullcar Valley

INDEPENDENT RECOMMENDATIONS REPORT

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Preamble

The Hullcar Valley in B.C.'s North Okanagan region is a rural area with large-scale and small-scale agricultural operations. Since 2014, residents in the area have been on a Water Quality Advisory due to elevated nitrate concentrations in the unconfined Hullcar Aquifer (#103), which is the drinking water source for approximately 250 people in the Valley. Historical agricultural practices on fields overlaying the Hullcar Aquifer have contributed to this contamination. Though agricultural practices are improving, it is uncertain if current practices are sufficient to ensure long-term source water protection. Ensuring safe and clean drinking water for Hullcar Valley residents and developing robust source water protection strategies provincially is critically important and is a clear identified priority for the Ministry of Environment and Climate Change Strategy (ENV)¹.

In August 2017, British Columbia's Minister of Environment and Climate Change Strategy ordered a review of the Hullcar aquifer situation to gather the information necessary to inform and improve future approaches to management and decision-making related to source water protection and agricultural nutrients. Between mid-August and end of October 2017, ENV specifically commissioned a review team led by the University of Victoria's POLIS Project on Ecological Governance to investigate options and develop specific recommendations to address drinking water source protection and improve nutrient management in the Hullcar Valley. This *Recommendations Report* is oriented towards finding solutions to existing problems and providing recommendations on how to avoid similar situations in the future in the Hullcar Valley and elsewhere in the province. This report is not intended to specifically investigate past actions by government or others.

The overall review consists of this independent *Recommendations Report* and also includes supporting documentation developed by Government² that collectively will:

1. Provide a synopsis of the situation pertaining to the Hullcar Aquifer that includes local context and events, status of the aquifer, and decisions and recent actions taken. This is to help outline understanding of the local situation as of September 2017.
2. Review agricultural nutrient management practices from the perspective of environmental and economic sustainability while prioritizing drinking water protection, and in consideration of short- and long-term strategies for improvement of the aquifer water quality.
3. Provide recommendations for future actions—including opportunities to improve decision-making with attention to potential supporting law and regulation reform—to ensure better drinking water source protection with a focus on management of agricultural nutrients in the context of drinking water source protection in the Hullcar Aquifer and beyond.

The third overall priority listed above is the focus of this *Recommendations Report*. The following analysis builds on and refines several recommendations that have been put forth by various experts, agencies and entities in recent years. The primary objective of the analysis is to inform immediate (1-2 months), short (within one year), and longer-term (1+ years) strategies for:

- ensuring the protection of drinking water in the Hullcar Aquifer;
- providing environmentally sound and sustainable management of agricultural nutrients; and,
- avoiding source water contamination in other high-risk areas across B.C.

¹ Although this report is focused on concern related to pollution from excess nitrates, we support the Ministry of Health's position that ensuring safe drinking water entails looking beyond just nitrates as it is important to recognize and address the potential presence of bacteria, viruses or other kinds of contaminants to take a systemic approach. Project time and scope limited our work to nitrates but the authors recognize the importance of other contaminants as part of a comprehensive approach.

² The following documents were developed by Government: Hullcar Situation Summary (Factual Record, Chronology, Roles and Responsibilities, Stakeholder Interviews), Hullcar Situation Review Nutrient Management Practices: Technical Report, Jurisdictional Scan of Nutrient Management Regulations, Jurisdictional Scan of Agricultural Cost Share and Support Programs, Review of Nutrient Management Planning in B.C., and Summary of Nutrient Management Technology Options in the Context of Hullcar.

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LIST OF ACRONYMS

ABMP	Area Based Management Plan
AGQMN	Ambient Groundwater Quality Monitoring Network
AGRI	Ministry of Agriculture
AWCR	Agriculture Waste Control Regulation
CAFO	Concentrated Animal Feeding Operation
CFO	Concentrated Feeding Operation
DWPA	<i>Drinking Water Protection Act</i>
DWPP	Drinking Water Protection Plan
EAB	Environmental Appeal Board
EFP	Environmental Farm Plan
EIA	Environmental Impact Assessment
ELUA	<i>Environment and Land Use Act</i>
EMA	<i>Environmental Management Act</i>
ENV	Ministry of Environment and Climate Change Strategy
FLNR	Ministry of Forests, Lands, Natural Resource Operations, and Rural Development
FRPA	<i>Forest and Range Practices Act</i>
HAO	Hazard Abatement Order
IAWG	Interagency Working Group
IHA	Interior Health Authority
ILO	Intensive Livestock Operation
IMP	Irrigation Management Plan
MOH	Ministry of Health
NMP	Nutrient Management Plan
SSWD	Steele Springs Waterworks District
PAO	Pollution Abatement Order
PHNT	Post Harvest Nitrogen Test
PPO	Pollution Prevention Order
QP	Qualified Professional
WQA	Water Quality Advisory
WSA	<i>Water Sustainability Act</i>
WSP	Water Sustainability Plan

1 Introduction and Overview

The well being of communities, the economy, ecosystems and indeed every British Columbian depends on access to clean and safe drinking water. Source water protection is a critical element of any robust safe drinking water provision and protection program (see Graph 1). British Columbians expect the Province to be able to protect water sources while managing the various activities on the landscape, and to ensure delivery of high quality and safe drinking water over the long term. British Columbians also expect identified ministries within the government to fulfill the commitments and principles in the provincial *Action Plan for Safe Drinking Water in British Columbia* (2002) that commits to: “ensuring safe, reliable and accessible drinking water for all British Columbians.”³

Historic and current land use development in many areas of British Columbia has largely proceeded with only secondary consideration given to source water protection and impacts on water quality and quantity. Concern exists that the current land and water management system in parts of the province is insufficient to address emerging water challenges and safeguard water sources.⁴

Concern about agricultural activities and the implications for drinking water—and groundwater in particular—have been mounting in recent years. As agriculture has intensified in many regions across the province, so too have anxieties about impacts of agricultural practices on the health and function of fresh water sources. This sensitivity is especially acute in regions located over high-risk drinking water source aquifers and where there is increasing residential settlement within or near established agricultural areas.

In recent years, the Hullcar Valley has become a focal point for issues related to agriculture

and drinking water quality. Since 2014, nitrate levels in the Hullcar Aquifer (No. 103) have not consistently met the Canadian Drinking Water Standards, leaving local residents on a persistent Water Quality Advisory.⁵ Evidence suggests that farm-based activities overlaying the aquifer are significantly contributing to the nitrate pollution that is compromising the local drinking water. These elevated nitrate levels are likely to persist for years regardless of the controls put on agricultural activities today as the current drinking water problems are manifesting historical activities (pre-2014). Although farm practices have improved more recently, it is still uncertain if existing changes to nutrient application and management practices are sufficient to ensure source water protection in the future. Historical activities have resulted in a legacy of nitrates in the soil and aquifer, and the potential for current agricultural practices to contribute to future elevated nitrate levels warrants a precautionary approach to ongoing nutrient application activities.

A number of more recent government-led activities—including various Orders, additional monitoring and tests, consultant reports, and stakeholder engagement—are attempting to understand and address the current Hullcar drinking water situation. However, further proactive steps both locally and within the overall Provincial source water protection regime will be needed to help reduce future problems and accelerate rehabilitation of the Hullcar aquifer as a safe drinking water source. It is relevant to note that any unconfined aquifer in areas of intense human activity will always be vulnerable to contamination and therefore will require additional attention, protection and safeguards.

Leading up to the Hullcar Aquifer contamination

3 British Columbia Ministry of Health Planning and Ministry of Health Services. (2002). *Action Plan for Safe Drinking Water in British Columbia*. Retrieved from: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/safe_drinking_printcopy.pdf

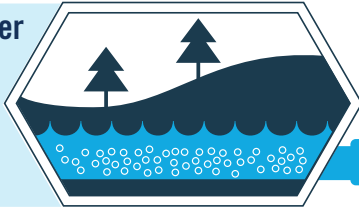
4 Brandes, O.M. and Morris, T. (2016). *Illumination: Insights and Perspectives for Building Effective Watershed Governance in B.C.* Victoria, Canada: POLIS Project on Ecological Governance, University of Victoria. Retrieved from: <https://poliswaterproject.org/files/2016/06/POLIS-Illumination-web.pdf>

5 Ministry of Health points out that potential contaminants from manure, and other land applications associated with farming (e.g. composted materials, fertilizers and pesticides) are not limited to nitrates and therefore other chemical and microbiological parameters should be routinely monitored (in accordance with Health Canada's Guidelines for Canadian Drinking Water Quality).

WHY CLEAN DRINKING WATER IS IMPORTANT

surface water

Drinking water can come from reservoirs, lakes, rivers & streams



groundwater

Drinking water can also come from aquifers

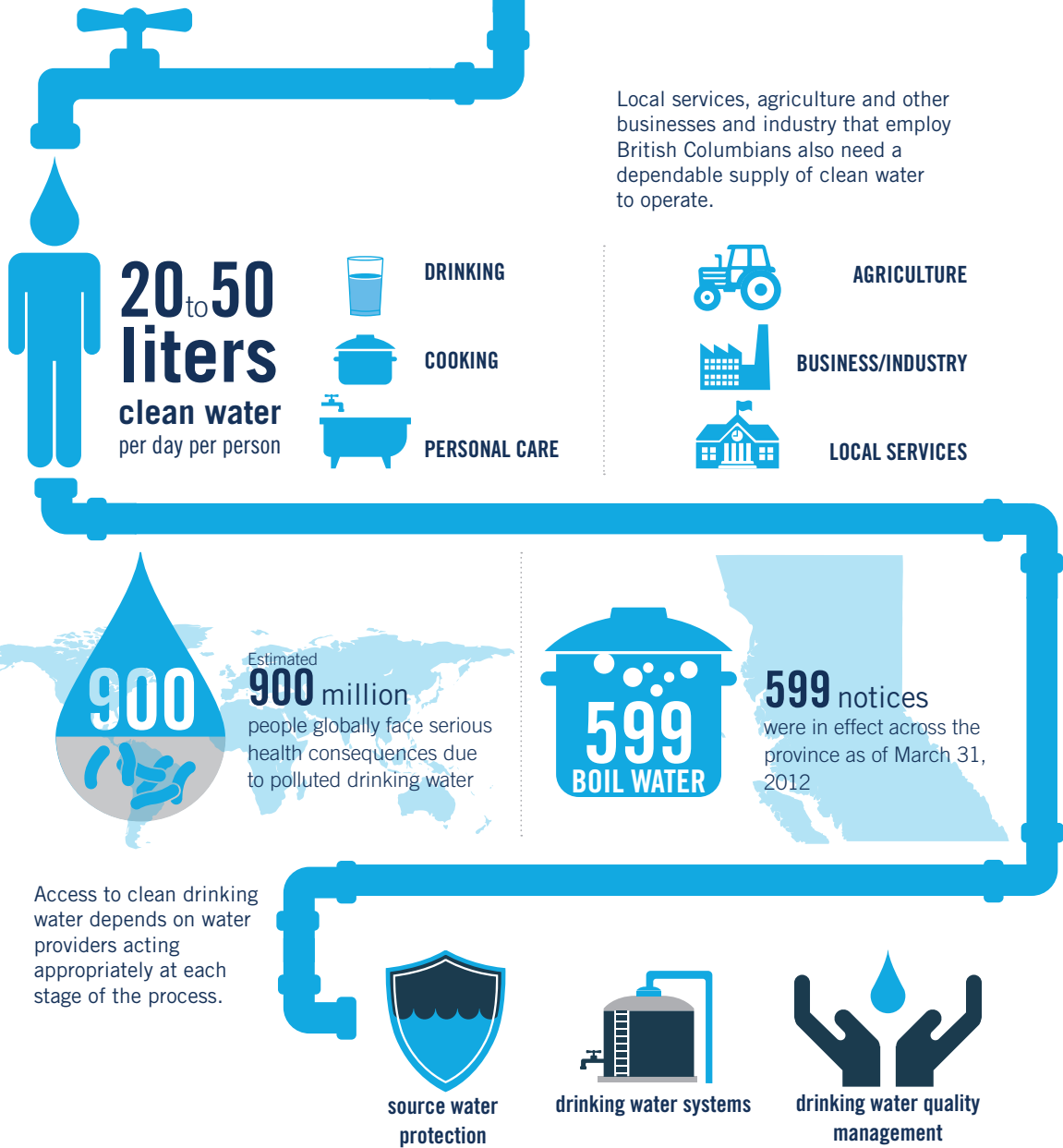
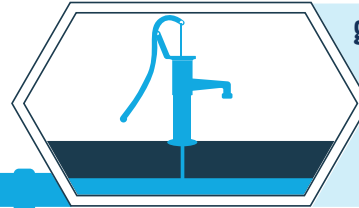


FIGURE 1: Auditor General For Local Government of British Columbia. (May 2017). *Local Government's Role in Ensuring Clean Drinking Water: Regional District of Okanagan-Similkameen*. Pg. 13.

Retrieved from: <https://www.aglg.ca/app/uploads/sites/26/2017/06/RDOS-Performance-Audit-Report.pdf>

situation, groundwater monitoring and reporting across the province, and in the Hullcar Valley specifically, have been insufficient to reliably detect concerns in water quality⁶ and trigger action before they become a crisis and a potential health hazard. Existing enforcement tools—including Pollution Abatement, Pollution Prevention, and Hazard Abatement Orders—were triggered only once the pollution to the aquifer had already occurred. Local residents identify that a slow reaction by government and an initial uncoordinated response significantly added to a problematic situation.

Considerable gaps in knowledge exist concerning local aquifer and nitrate cycling dynamics. With varying time lags between nutrient application to fields (animal waste and chemical fertilizer) and leaching through the soil and eventually into the aquifer as nitrates, uncertainty persists as to whether current measures Valley-wide will be sufficient to stop the source of nitrate pollution and allow for the full remediation of the Hullcar Aquifer back to a clean drinking water source.⁷

This report lays out nine recommendation areas in a *Solutions Framework* for the Minister of Environment and Climate Change Strategy (and the whole of the provincial government) to consider in the context of the Hullcar Valley, and—importantly—in source water protection more broadly in B.C. *The Solutions Framework* details a mix of specific immediate, short-, and longer-term solutions and recommendations to address the Hullcar drinking water contamination and associated health risks, and to avoid similar future issues arising in other areas of B.C.

These solutions encompass a mix of activities, including (but not limited to): Ministry Orders; area-based and Water Sustainability Plans; independently verified monitoring and reporting of aquifer and soil status (including groundwater and

nitrate cycling dynamics); incentives for farm based beneficial management practices and innovative technology; governance and regulatory updates; and protecting Indigenous rights to clean and adequate water supply. These collective solutions are all oriented towards the ultimate end goal of an agronomic nitrogen balance of zero with a suitable precautionary safety factor, better leveraging local expertise and engagement, and allowing the aquifer the opportunity to rehabilitate to ensure safe future drinking water.

1.1 Report Overview

This Report is organized as follows:

- Introduction to set the context and criteria that have helped guide this review.
- Problem statement and an outline of the overarching solutions needed to address the identified concerns.
- Detailed *Solutions Framework and Action Priorities* with the nine recommendation areas supported by a summary table outlining specific actions needed. The table is organized to provide immediate, short-and longer-term actions both for the Hullcar Valley and for the province more broadly.
- A series of supporting Appendices that provide:
 - overview of Orders;
 - current management and legal regime;
 - agricultural waste management in other jurisdictions;
 - *Agricultural Waste Control Regulation* (AWCR) review synopsis and suggested update priorities; and,
 - Overview of innovative technology to help address waste (nitrate pollution).

⁶ Although the focus of this review and *Recommendations Report* relates to drinking water quality, we acknowledge the Splatshin Nation's concern that includes quantities of water used for irrigation in the Valley. Section 3.6 offers a potential example of approaches currently in progress in the North Okanagan to treat domestic effluent to a standard suitable for agricultural irrigation, as an alternative to reduce groundwater demands used in agriculture in the Hullcar Valley.

⁷ Although the terms of reference for this review focused on nitrate contamination, the Ministry of Health emphasize that nitrates are a potential signal of contamination of the aquifer by manure and suggests that "aqueous pathways of contaminant migration" from the animal waste to groundwater and drinking water is active, suggesting that all contaminants associate with the animal waste could be in the groundwater.

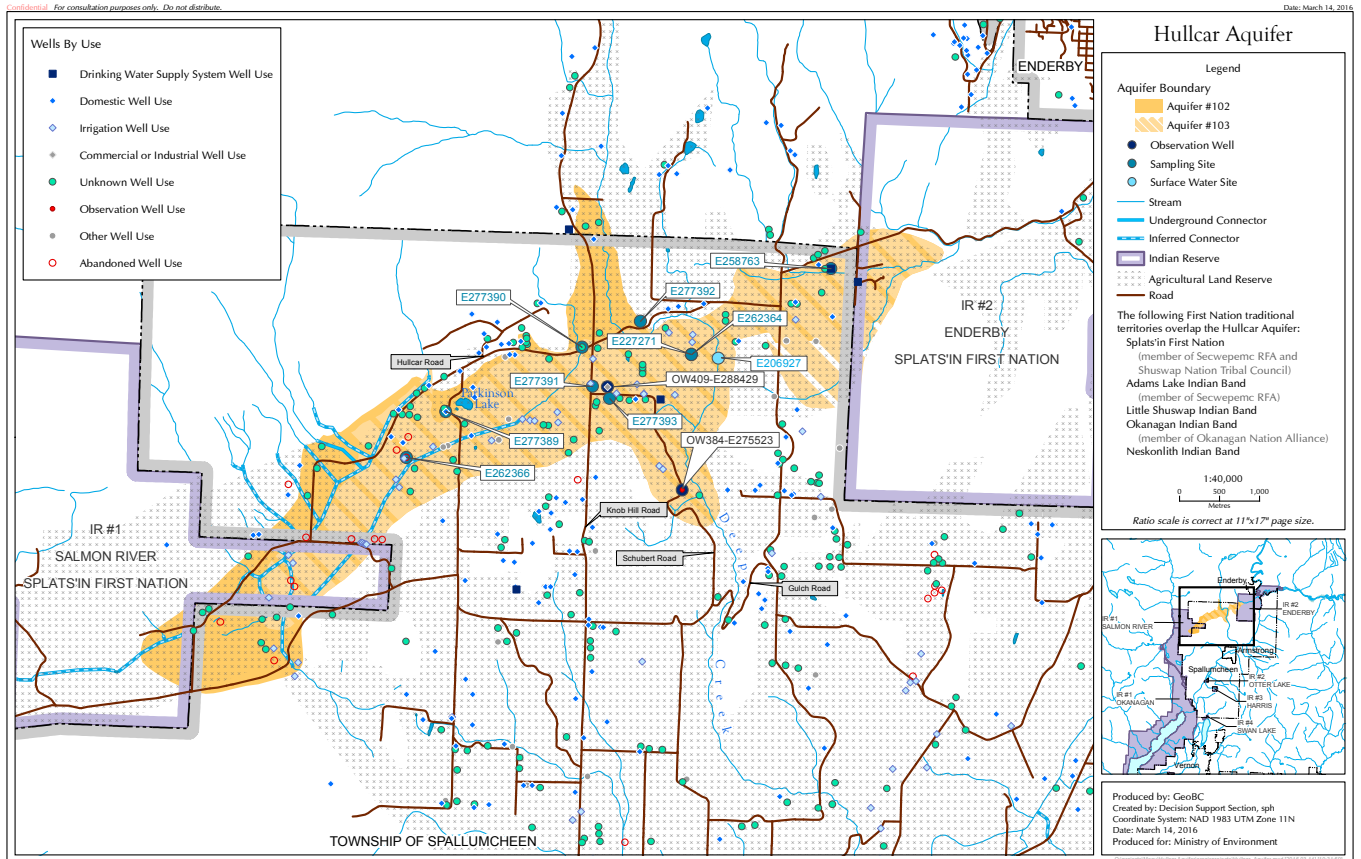


FIGURE 2: Hullcar Aquifer
SOURCE: MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE STRATEGY

1.2 Situation and Context

Elevated nitrate levels in groundwater are a significant issue in many regions in B.C., including the Fraser, Comox, and Cowichan Valleys. This problem has been particularly acute in the Hullcar Valley, which has faced persistent groundwater contamination, including elevated nitrate levels, for a number of years. The Hullcar Aquifer, located in North Okanagan northwest of Armstrong, is part of the traditional territory of the Splatsin First Nation,⁸ and is the sole source of drinking water for the Steele Springs Waterworks District (located within the Township of Spallumcheen) and the Splatsin First Nation (see Figure 2). The Hullcar Valley contains

two provincially-mapped aquifers, the Hullcar unconfined (No. 103) and Hullcar confined (No. 102). This report focuses on the range of solutions that can address the activities that are impacting Hullcar Aquifer No. 103 (the ‘Hullcar Aquifer’), as well as the lessons learned that might help advance provincial reforms to ensure a situation like this does not repeat itself in the Hullcar or elsewhere.

The Hullcar Aquifer is an unconfined aquifer. Unconfined aquifers are more vulnerable to contamination than aquifers ‘confined’ by protective layers of clay, silt, and/or till. The Hullcar Aquifer is approximately 14km², with water levels between 1.5 to 14 metres below ground, and a thickness ranging from three to 45 metres.⁹

⁸ Splatsin is the most southern tribe of the Secwepemc Nation, the largest Interior Salish speaking First Nation in Canada. Their traditional territory stretches from the BC/AB border near the Yellowhead Pass to the plateau west of the Fraser River, southeast to the Arrow Lakes and to the upper reaches of the Columbia River. Splatsin has three reserves, two of which bookend the Hullcar Aquifer: IR1 Salmon River, and IR2 Enderby. IR3 Sicamous is further north. The Okanagan Indian Band also has connections to the Hullcar Valley through hunting, fishing, and trade. The Splatsin have identified upwards of 20 residential wells on reserve that are contaminated with elevated nitrates beyond safe drinking water levels.

⁹ B.C. Ministry of the Environment and Climate Change Strategy. (2017). *Hullcar Aquifer Information*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-permitting-compliance/hullcar-aquifer>

Though nitrates are naturally produced and widespread in the environment,¹⁰ the elevated levels in the Hullcar Aquifer¹¹ have been linked to historical (pre-2014) application of solid and liquid animal wastes and chemical fertilizers from agricultural operations to lands above the aquifer. The historical legacy of nitrates in the aquifer may be compounded by more recent (post-2014) application of solid and liquid animal wastes and chemical fertilizers, which has prompted ENV and Interior Health Authority (IHA) to issue Orders (starting in 2014) to agricultural operators with lands above the aquifer.¹² ENV has classified the Hullcar Aquifer as IIA (moderate level of groundwater development and high vulnerability to contamination).¹³

The Steele Springs Waterworks District (SSWD) draws on the Hullcar Aquifer to supply approximately 150 people with drinking water from 57 different connections. Six small springs from two seep areas are the source of groundwater for SSWD. Water from the springs is collected in a cistern, and then pumped into the distribution system. There are an additional 46 known water wells drawing on the Hullcar Aquifer.¹⁴

Since early 2014, pollution in the Aquifer has reached what some local residents, the media

and the University of Victoria's Environmental Law Centre call "crisis level,"¹⁵ with nitrate levels consistently near or exceeding the Canadian Drinking Water Quality Guideline for nitrate (NO₃-N) of 10 mg/L.¹⁶ Some residents and the Splitsin First Nation believe this to be a potentially serious public health risk. IHA issued two Water Quality Advisories (WQA) for the Hullcar Aquifer in 2014: one to the SSWD in March 2014, and a second to private well owners in July 2014.¹⁷ These advisories have remained in place since 2014. Infants and those with compromised immune systems have been advised not to drink the water due to health concerns. In August 2017, IHA also issued Hazard Abatement Orders, indicating the continuing severity of the situation (see Appendix A for details on these Orders).

A combination of factors affects water quality and nitrate levels in the Hullcar Aquifer, including activities above the aquifer, aquifer materials, groundwater flow dynamics, aquifer recharge rates, and variable and extreme weather (including extreme precipitation events that result in saturated and flooded fields). Potential hydraulic connections to other aquifers and surface waters also exist.

Agricultural activity is substantial in the Hullcar Valley, and specifically on fields located overtop

10 Government of Canada. (2014). Guidelines for *Canadian Drinking Water Quality: Guideline Technical Document – Nitrate and Nitrite*. Retrieved from: <https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-nitrate-nitrite/page-2-guidelines-canadian-drinking-water-quality-guideline-technical-document-nitrate-nitrite.html#a2>

11 Ministry of Environment water samples collected from Steele Springs Water District drinking water show nitrate levels ranging from 8.8 mg/L NO₃-N in January 2014 to 13.3 mg/L NO₃-N in January 2016. Of the 14 samples taken by the Ministry of Environment (ENV) between January 2014 to January 2016, ten samples exceeded the Canadian Drinking Water Guidelines for nitrates of 10mg/L NO₃-N. Source: B.C. Ministry of Environment. (15 February 2016). *Memorandum*. Retrieved from: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/2016-02-15_moe_data_hullcar_aquifer.pdf

12 Agricultural practices are improving for some specific sites in the last year or two, as identified by Associated Environmental's *Comprehensive Monitoring Program and Environmental Impact Assessments* completed for Grace-Mar Farms Ltd. (February 2017), H.S. Jansen & Sons Farms Ltd. (February 2017), and Ken and Brenda Regehr farm (December 2016). However, it is still uncertain if these improvements will be sufficient to ensure source water protection overall for this high-risk and vulnerable unconfined aquifer.

13 B.C. Ministry of the Environment and Climate Change Strategy. (2017). *Hullcar Aquifer Information*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-permitting-compliance/hullcar-aquifer>

14 University of Victoria, Environmental Law Centre (February 1, 2016). *Drinking Water Hazard Abatement and Prevention Order*. Retrieved from: <http://www.elc.uvic.ca/wordpress/wp-content/uploads/2016/02/Drinking-Water-Protection-Order-submission-2016Feb1.pdf>

15 University of Victoria, Environmental Law Centre. (May 2017). *Recommendations for Creating an Optimal Area Based Management Plan for the Hullcar Aquifer*. P.3. Retrieved from: <http://www.elc.uvic.ca/wordpress/wp-content/uploads/2017/05/2015-03-05-FINAL-HULLCAR-REPORT-2017May17.pdf>

16 B.C. Ministry of the Environment and Climate Change Strategy. (2017). *Hullcar Aquifer Information*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-permitting-compliance/hullcar-aquifer>

17 Denham, E. (June 29, 2016). *Investigation Report F16-02 Clearly in the Public Interest: The Disclosure of Information Related to Water Quality in Spallumcheen*. Office of the Information & Privacy Commissioner for British Columbia. Retrieved from: <https://www.oipc.bc.ca/investigation-reports/1972>

of the Aquifer. Identified contributors to elevated nitrate levels in the vulnerable Aquifer include: agricultural operations, including historical application of animal waste and chemical fertilizer to fields; an overflow event from agricultural waste storage;¹⁸ and variability in crop uptake of nitrates. Domestic septic fields are also likely a smaller contributing factor. Thus, uncertainty and concern about cumulative effects are highly relevant factors to this situation.

Achieving an agronomic nutrient balance of zero is a complex process that requires ongoing monitoring, planning and testing, and, in high-risk situations, requires explicit attention to a precautionary approach.¹⁹ The need for better control of the current nitrate and waste control situation, coupled with uncertainty regarding sufficiency of current agricultural practices to address ongoing or future elevated nitrate levels in groundwater, warrants a precautionary approach to ongoing nutrient application on fields above the high risk Hullcar Aquifer.²⁰

1.3 Hullcar Situation Review Process

The recommendations that follow have been developed for the Minister of Environment and Climate Change Strategy (and other Ministries more broadly) as part of a comprehensive review of the “Hullcar Situation.” This *Recommendations Report* is complemented by a series of reports generated by the provincial government that collectively provide a detailed overview of, and offer solutions to, the current concerns in the Hullcar Valley. These reports together comprise the “Hullcar Situation Summary” and include:

- **Chronology:** lists major recent actions and milestones taken by the B.C. provincial government related to the Hullcar Situation;
- **Roles and responsibilities:** outlines the 17 primary agencies and organizations with direct and indirect governance authorities in addressing the Hullcar Situation;
- **Review of the factual record:** identifies major themes and observations from the correspondence and compliance and enforcement files internal to government in regards to the Hullcar Situation; and,
- **Record of stakeholder perspectives:** documents interviews with key stakeholders, government ministries, and First Nations to understand more fully perspectives on what happened and what needs to happen going forward in an effort to provide a comprehensive view from the ground and increase understanding across the various actors involved.

The provincial government also manages an information portal specific to the Hullcar Aquifer where background information, advisories, updates and information about the Aquifer and drinking water testing are posted.²¹

The B.C. Ministry of Agriculture (AGRI) has also developed a series of technical and synopsis reports focused on nutrient management to compliment the Hullcar Situation Summary and help inform the recommendations, including:

- Hullcar Situation Review Nutrient Management Practices: Technical Report;
- Review of Nutrient Management Planning in British Columbia;
- Jurisdictional Scan of Nutrient Management Regulations;

18 See: ENV Chronology Report (2017) noting manure effluent spill at Grace-Mar Farms on February 16 2017. See also Associated Environmental report *Comprehensive Monitoring Program and Environmental Impact Assessment: Grace-Mar Farms Ltd*, pg. 2-10, that reported the storage facility at Grace-Mar Farms “was not of sufficient capacity”, and therefore out of compliance with the AWCR (s. 6). Retrieved from: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/pao/grace_mar_eia_feb_27_2017.pdf

19 Consultation to-date between Splatins and the Province on ways forward to address aquifer contamination and the growth of agricultural industry and cumulative effects with impacts on First Nation interest has been limited, and there is an expressed need by the Splatins First Nation for better notification and to move forward at a government-to-government level.

20 The 2017 and 2018 PHNTs and the follow up Benchmark tests will provide the necessary evidence to confirm or adjust the most recent practices. Some of the practices may require more fine-tuning and strict monitoring to ensure the changes are having the desired impacts.

21 British Columbia Ministry of Environment and Climate Change Strategy. (2017). *Hullcar Aquifer Information*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-permitting-compliance/hullcar-aquifer>

- Jurisdictional Scan of Agricultural Cost Share and Support Programs;
- Summary of Manure Handling Systems in the Context of Hullcar; and,
- Summary of Nutrient Management Technology Options in the Context of Hullcar.

The *Solutions Framework and Action Priorities* provided in Section 3 below specifically builds on and refines several recommendations that have been put forth by various experts and entities in recent years for solving problems in the Hullcar Valley and provincial source water protection more generally.²²

This analysis was informed by weekly government organized meetings that included cross agency participation and invited expert resource guests for updates and briefings (mid August-September 2017) and input from the listed external expert advisors. Key affected Ministries, Splatstsin First Nation, the Township of Spalumcheen and other local agencies also provided feedback to these recommendations.

The *Solutions Framework* provided here is primarily focused on the Hullcar Valley and Hullcar Aquifer situation, but has clear application to other high-risk drinking water source areas across B.C. We focussed our review on solutions related to source water protection and how they might relate to agricultural practices in the Hullcar Valley, with an eye towards the necessary provincial legal and governance changes to avoid similar situations from occurring in the future.

Recommendations in the *Solutions Framework* provided in this report target immediate (1-2 months), short-term (completed within one year) and longer-term (1 + year) actions both in the Hullcar Valley and across B.C. more broadly. The immediate and short-term actions all exist within the existing provincial legal and institutional context and so, in our view, should be initiated immediately.

Longer-term changes address the more systemic concerns and involve institutional, legal and regulatory change along with other provincial-level policy considerations. Ultimately these are just as important and should be priorities for government to comprehensively address improved source water protection.

1.4 Primary Considerations— in scope of review

To help frame and guide this review, the authors laid out a number of key criteria or primary considerations as they reviewed the materials, events and responses. The following considerations assisted in developing the recommendations and prioritizing choices and options:

- **Solutions oriented** (short term and longer term actions)
- **Science-based** (evidence based decision-making) informed by the **precautionary principle** (where uncertainty and the possibility of harm exists)
- Need for **enforcement & compliance** (to ensure beneficial management practices are met and protection of drinking water is prioritized)
- Capability to **plan in advance** where risk potential is evident
- **Improve governance** (including transparency, accountability, local role in decision-making and Indigenous co-governance)
- **Integrated watershed/ecosystem based approaches**
- **Easy to administer** (risk management approach)
- **Circular economy** (promote reuse and recycling of waste and water—incentives for technological innovation and sustainable practices)
- **Cost effectiveness**

²² This includes: University of Victoria, Environmental Law Centre. (May 2017). *Recommendations for Creating an Optimal Area Based Management Plan for the Hullcar Aquifer*. Retrieved from: <http://www.elc.uvic.ca/wordpress/wp-content/uploads/2017/05/2015-03-05-FINAL-HULLCAR-REPORT-2017May17.pdf>

2 Problem Statement – concern with source water protection in B.C.

Water and source water protection is a priority for all British Columbians. Having access to safe clean drinking water is critical for communities, the economy and ecosystem health and function. Activities on the landscape affect aquifers, streams, rivers and lakes: in short, what happens on the land impacts fresh water. In a practical sense, and as witnessed in the Hullcar Aquifer situation, it appears that not enough emphasis has been placed on keeping B.C.'s water safe—by protecting sources from contamination; clearly identifying the lead agency to take charge when there is a problem; developing a modern and comprehensive water management and regulation regime; and resourcing and implementing the *Action Plan for Safe Drinking Water in British Columbia*.²³

Currently agriculture in British Columbia is largely self-regulated through voluntary measures. Mounting ecological and human health concerns reveal that although a number of tools to help protect drinking water and manage agricultural impacts exist, they are often not used or fully deployed. The current regulatory regime does not provide sufficient clarity or incentives to adequately change practices on the landscape. Nor does this voluntary compliance system address concerns related to intensified agriculture and ongoing development, especially in high-risk areas such as unconfined aquifer drinking water sources. The result is increasing public concern leading to expensive and often-piecemeal crisis response outcomes.

Provincial monitoring programs are not providing the necessary drinking water and environmental health information to decision makers or communities early enough in high-risk areas. Significantly reduced capacity to plan or respond to slow-building concerns (such as nitrate accumulation in deep soil and migration into groundwater) limits the government's ability to

provide leadership or timely response as concerns are identified. Proactive planning has not been a priority, and government has not developed the necessary processes to trigger and create enforceable regional water or watershed plans. Lack of clarity of who is in charge and a breakdown of accountability leads to confusion and uncoordinated reactions to water concerns identified by communities. Comments and feedback from local residents suggest insufficient coordination among Ministries and communications and engagement with critical partners—including those impacted by Water Quality Advisory notices due to elevated nitrate levels in drinking water sources—to either address the issues or build public confidence. Cumulatively, these issues have contributed to the overall distress of this situation.

In identified high-risk areas a suite of actions are urgently needed, including: clear accountability and lines of responsibility; higher levels of Ministry oversight and regulatory intervention; comprehensive monitoring and reporting; improved communications; incentive for better practices and new technologies; a precautionary approach, including a nutrient application buffer requirement due to uncertainty about the nitrate balance in soil and groundwater and uptake in crops; and the ability to develop enforceable plans informed by local conditions. These actions are detailed in the following sections.

²³ For a summary of recent updates on progress associated with the *Action Plan for Safe Drinking Water in British Columbia*, see: <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/pho-drinkingwater2015-web.pdf>. However a comprehensive analysis of the Action Plan and its progress is not possible under this review due to time and resource constraints.

3 Solutions Framework and Action Principles

Solutions in high-risk and emerging problem areas will consist of a mix of:

- 1. Responding with crisis intervention (as needed)** with clearly defined roles and designated Ministry leads to resolve existing identified threats and ensure access to safe drinking water for communities.
- 2. Providing robust independently verified monitoring and reporting** with ENV taking the lead and providing oversight on monitoring programs where additional fine-tuned information is needed, such as high risk or identified drinking water areas. The Hullcar Valley case offers an opportunity to pilot appropriate monitoring and reporting approaches in high risk areas, provide insights for other locations with similar issues, and help guide the development of a broader and more sophisticated provincial monitoring network to support evidence-based statutory decision-making.
- 3. Updating the regulatory framework** including enacting a modernized *Agricultural Waste Control Regulation* (AWCR) and improving alignment among key legislation (such as the *Drinking Water Protection Act*, *Water Sustainability Act*, and *Environmental Management Act*) so appropriate protection or planning tools can be deployed efficiently and in a complementary way.
- 4. Developing better planning** which starts with more coordinated and integrated management (whole of region) approaches, and includes enforceable water and land use plans supported by enforceable Environmental Farm Plans, Nutrient Management Plans, and Irrigation Management Plans.
- 5. Creating incentives for better practices on the landscape** through financial and adaptive regulatory incentives to ensure beneficial management practices (storage, transport, application) of nitrogen sources (e.g. animal waste, chemical fertilizer)—indeed other contaminants as identified above—and to begin addressing other related pollution sources (such as septic fields).
- 6. Deploying innovative technology** to beneficially manage and utilize animal waste and remediate contaminated aquifers. This could include waste to energy production facilities, technology to dewater liquid manure, barn scrape technologies, systems for converting manure to commercially valuable fertilizer, and innovative groundwater remediation.
- 7. Improving accountability and ensuring a partnership approach** with clear roles and responsibilities and coordinated leadership where needed. Providing safe drinking water is a high priority and involves many parties and agencies both within and external to the provincial government, which can result in jurisdictional overlap and uncertainty in roles and responsibilities (and who is in charge). The Province must take leadership to ensure the drinking water threat is stabilized and to improve coordination and communication among key agencies, including MOH and the IHA, First Nations Health Authority, ENV, FLNR, AGRI, INAC, local First Nations, and local government. Innovative local governance through creation of a local watershed or aquifer board will help build a robust and adaptive ongoing partnership with local residents.
- 8. Considering alternative drinking water sources**, both in the short- and longer-term, as well as possible aquifer remediation, in consultation with local governments, improvement districts, local First Nations, and the Ministry of Municipal Affairs and Housing. However, the possibility of alternative sources should not be used as an excuse for sacrificing an aquifer. Drinking water sources are valuable resources and must be treated as a provincial priority. Unconfined aquifers in multi-use situations will always pose a challenge for long-term reliable safe drinking water sources and thus require significant additional attention.
- 9. Applying lessons learned to other areas of the Province** and developing recommendations to guide integration and modernization of the provincial water and nutrient management framework.

Action Priorities in the Hullcar Valley and Lessons for B.C.

The following action items are organized by the nine solution areas outlined above for high-risk and emerging problem areas, and are organized into three timeframes: immediate (1-2 months); short-term (within one year) and long-term (1+ years). Immediate and short-term actions are actionable within existing legal and institutional frameworks (and therefore can be done immediately). Long-term actions require law reforms and further development of tools that are needed to ensure robust source water protection and better nutrient management in the Hullcar Valley and across the province.²⁴ Importantly, all recommendations can be initiated immediately, though some actions may require more time to complete.

3.1 Responding with crisis intervention (as needed)

To resolve existing identified threats and ensure access to safe drinking water.

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ♦	COMMENTS, BARRIERS & OPTIONS
<p>Ensure residents have access to quality drinking water as needed and regular testing of drinking water wells.</p> <ul style="list-style-type: none"> Confirmation/communication between MOH (IHA) and ENV/AGRI to ensure local drinking water needs are met. 	<p>Develop/improve communications protocols between Ministries and with public (and those impacted).</p> <p>Specifically a better understanding of what triggers were present for the notification and what lessons can be learned.²⁵</p>	<p>See comprehensive review of provincial source water protection regime (<i>Appendix B: Current management and legal regime</i>, p. 25)</p> <p>Revisit the <i>Action Plan for Safe Drinking Water in British Columbia</i> (and consider initiating a comprehensive and independent review of implementation) to ensure commitments are being fulfilled and future drinking water or source protection concerns can be avoided.²⁶</p>	<p>Provide access to safe drinking water.</p> <p>♦ MOH (IHA) and AGRI (with support of IAWG) – water suppliers also have a key role.</p>	<p>Who bears cost (initial and ongoing) of providing drinking water and well testing is a challenging question. Inevitably those impacted will bear some of the cost. We propose the bulk of the cost should be shared with any clearly identified polluters ('polluter pays principle'). The Province should further establish a working fund (as needed beyond existing funding commitments).</p>

24 Almost 20 years ago the Province (Ministry of Environment) established an Action Plan (1999) to deal with non-point source pollution that provided an initial comprehensive framework. This approach should be revisited to determine applicability today. See: B.C. Ministry of Environment. (March 1999). *Water Quality: Tackling Non-Point Source Water Pollution in British Columbia*. Retrieved from: http://www.env.gov.bc.ca/wat/wq/bmps/npsaction_action.html#action

25 To improve future responses and provide lessons learned, review the 5-month time lag between ENV letter from Deputy Director (March 8, 2017) to Medical Health Officer with Interior Health Authority identifying pollution in the identified areas of concern and the eventual HAOs issued by IHA (August 2017). Letter retrieved from: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/2017-03-08_ltr_to_dr_golmohammadi.pdf

26 Although a viable policy, significant context has changed with new regulatory tools and practical insights from the Health Authorities experience in implementing this program and therefore a broad perspective for such a review is needed.

3.1 Responding with crisis intervention (as needed) *continued*

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ◇	COMMENTS, BARRIERS & OPTIONS
<p>Issue (and enforce) a temporary environmental protection order (moratorium) under the <i>Environment Management Act</i> on liquid animal waste spreading on identified areas of concern in intensive livestock operations (ILO). Include a safety buffer in nutrient application.²⁷</p> <ul style="list-style-type: none"> • Determine if additional Pollution Abatement Orders (PAOs) are required in fall/winter 2017/18 on specific properties (as an alternative to a blanket moratorium). • Consider initiating a cap on cow density for ILOs that spread on site²⁸ while beneficial management practices can be established and confirmed (including updated independently verified NMPs with safety factors);²⁹ planning processes can be initiated; and the aquifer has an opportunity to begin recovery. 	<p>Extension of moratorium to be reconsidered in the context of improved groundwater and soil monitoring, and better understanding of aquifer dynamic and nitrate transport, including the impact of various Orders and plans on actual soil (shallow and deep) nitrate levels.</p> <hr/> <p>Extend moratorium if additional soil tests suggest further future negative water quality impacts.</p> <hr/> <p>Further investigate and encourage barn scraping³⁰ instead of flushing to reduce potential risk of nitrate leaching into aquifer, and require dewatering of flush manure in intensive livestock operations.³¹</p>	<p>Establish more efficient legal tools for targeted and blanket moratoria when agricultural practices are demonstrating contamination of drinking water.</p> <hr/> <p>Review Environmental Appeal Board appeal of PAOs to inform development of future Orders and ensure sufficient evidence is provided.</p>	<p>Stop the immediate possible contributing threat and source of nitrates. ◇ ENV³² & IHA³³</p> <hr/> <p>Allow for future moratorium if actions are not leading to improved nitrate loading in the soil and receiving waters. ◇ ENV (with AGRI)³⁴</p>	<p>We considered a full moratorium as a precautionary approach to address the significant uncertainty associated with ongoing contributions to the nitrate pollution from current practices (coupled with the more clearly understood legacy concerns from past practices) but opted for targeted and temporary moratorium on clearly identified areas of concern.</p> <ul style="list-style-type: none"> • We believe this course of action will allow time for: completion of post-harvest nitrate assessments already underway; better understanding of aquifer and nutrient dynamics; full deployment of beneficial management practices including updated independently approved NMPs (with safety factors) for the next growing season; and a more evidence-based and adaptive management approach to the ongoing concern.

27 The ENV Minister can enforce this with an Environmental Protection Order (Section 85 of EMA). Order can be relaxed as additional monitoring and testing of soil and water indicate nitrate levels have reached appropriate targets and begin downward trending. Additionally, the Minister may order an Area Based Management Plan under the *Environmental Management Act* s. 89. An initial safety factor may be relaxed if on-going monitoring and soil and water testing indicate nitrate levels have reached an appropriate target and are improving. See recommendation 3.4 below. For further information on EPOs, see Appendix B: Current Management and Legal Regime – Reactive Measures: Source Protection and Nutrient Management.

28 The authors understand that this is an initial “prescriptive” step that may not provide for the additional contextual details (such as soil type, amount of rain, crop uptake variances) and flexibility, but believe it should be considered an interim step while a more results-based regime with proper oversight can be implemented.

29 A concern with NMPs is the generally recognized approximate nature of the calculations – they are primarily designed to ensure optimal growth but such conditions rarely exist. This is part of the rationale for building in a safety factor and emphasizes the need for impartial expert oversight especially in high-risk areas, as is the case with the Hullcar Aquifer.

30 Investigate liquid flush systems to more fully understand if it is a factor in nutrient loading. Results should be clearly communicated to the community, who have expressed concern over flush systems. This could be a potential action to help build trust and understanding in the community.

31 Various technologies exist to allow farmers to change to a scraper barn system, and to dewater flush system and liquid dairy manure. See appendix E.

32 The ENV Minister can enforce this with an Environmental Protection Order (Section 85 of EMA), which would override the current NMPs required pursuant to Orders issued by MOH and ENV. The Minister can issue this immediately and then has 15 days to consult with staff and outside experts and then continue it, amend it or rescind it.

33 Also possible through Hazard Abatement Orders.



34 Possible other mechanisms to enable moratorium include Cabinet Order or through *Environment and Land Use Act* (ELUA) – Section 7 gives the Minister as Chair of the ELU committee of Cabinet powers to recommend to Cabinet an order on any matter respecting environment and land use. Cabinet Order is binding on all statutory decision makers. This could apply to a moratorium on manure spreading and potentially on the contents of an ABMP

3.1 Responding with crisis intervention (as needed) *continued*

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ♦	COMMENTS, BARRIERS & OPTIONS
Ensure sufficient monitoring and enforcement staff. ³⁵		Develop a mobile provincial unit that can provide additional monitoring and enforcement support in priority and high-risk areas as issues emerge.	♦ ENV, FLNRO and AGRI	Effective oversight and regulation requires sufficient monitoring and enforcement capacity by government.
<p>Publicly release this <i>Recommendations Report</i> and supporting government documents from the overall Hullcar Situation Review along with a detailed government action and implementation plan complemented by a coordinated communications plan.</p> <ul style="list-style-type: none"> • An important element of the public release of review documents will be an updated “State of the Hullcar Aquifer” report, to provide a benchmark for what is currently known, including aquifer dynamics, nitrate lag times, water and soil quality data for all years available (and regularly updated data on nitrate levels), and on-going monitoring and testing processes. 	Continue with community liaison/ outreach work to build community understanding and support for these recommendations and necessary actions.		<p>Improve communications and increase community understanding to reduce conflict and demonstrate a commitment to seeking proactive local solutions.</p> <p>♦ All involved Ministries led by ENV and IAWG</p>	

35 A critical element of monitoring and enforcement includes provision of sufficient resources (funding and staff), to ensure orders and plans are followed and determine if the actions taken by the Province are having the intended impact.

3.2 Providing robust independently verified monitoring and reporting

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY 	COMMENTS, BARRIERS & OPTIONS
<p>Aquifer assessment and improved water quality and soil monitoring network,³⁶ including:</p> <ul style="list-style-type: none"> • Testing at least 20-30 wells at the same time in late fall and late spring.³⁷ • Identifying number of drinking water wells and improving field investigations. • Soil testing (both shallow and deep) to better understand nutrient budgets and inform NMPs.³⁸ • Information to be posted on public portal. <p>IAWG to review, confirm and act on Golder report (2017)³⁹ data gap recommendations.</p>	<p>Establish a robust independently verified monitoring network specifically to support the development of the Area Based Management Plan (ABMP) and the eventual Water Sustainability Plan (see section 3.3).⁴⁰</p> <ul style="list-style-type: none"> • The monitoring network should be developed as a complement to the ABMP and can be supported by community based monitoring as appropriate. <p>Continue implementation of confirmed Golder report (2017) recommendations as appropriate.</p> <p>Develop a detailed “State of Hullcar Aquifer(s)” public report.</p> <p>Investigate concerns around the integrity of manure “pipelines” as high threat activities to groundwater.</p>	<p>Assess Provincial AGQMN (water monitoring network) and upgrade as needed to support evidence based decision-making.</p> <p>Regular (annual) “State of the Hullcar Aquifer(s)” public report until nitrate situation is stabilized, then as required by Hullcar Water Board (see section 3.7).</p>	<p>Increase understanding of Aquifer and identify water monitoring network needs to ensure effective statutory decision-making and increase public confidence.</p> <p> ENV field studies to be supported by AGRI.</p>	<p>Developing an appropriately sophisticated monitoring network (supported by community based monitoring) to provide sufficient information for decision-makers and build public confidence requires additional resources, new partnerships and a proactive approach.</p>

36 Ensure adequate funding is provided to allow for improved water and soil monitoring. Consider expanding water quality testing to include e-coli and chloroform to address concern of Splantsin Chief and Counsel.

37 With full suite of water chemistry parameters (to include key biological, chemical and other types of contaminants) including isotope analysis of water and nitrate and caffeine to determine difference between Manure-N - Fertilizer N – Septic N data (including depth of well, number and spread of samples, seasonal) and include phosphorus test (which does not move with soil water).

38 Post harvest nitrate tests in conjunction with independently verified NMPs that include a safety factor are the most efficient means of preventing new leaching from occurring. Test soil nitrate down to 3 meters, i.e. ‘deep soil testing’ (as done by Golder Associates. (2017). *Hullcar Hydrogeology Study – Phase 1 and 2 Assessment*. Retrieved from: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/2017-02-25_golder_ims_phase_1_2_assessment.pdf), which can provide evidence of the effectiveness of the NMPs, characterize the relationship between depth and nitrogen concentrations, and provides feedback about nitrogen management effectiveness over multiple years. However, testing to 3 meters may be more time consuming and expensive, and may not be feasible on all sites. Test wells should be drilled into key areas of Intensive Livestock Operations (ILOs), and this will also inform a timeline for remediation

39 Golder Associates. (February 2017). *Hullcar Hydrogeology Study – Phase 1 and 2 Assessment*. Retrieved from: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/2017-02-25_golder_ims_phase_1_2_assessment.pdf

40 As mentioned in a previous footnote, water quantities used for irrigation in the Hullcar Valley should be within the scope of an ABMP and on-going monitoring initiatives, to develop a robust and holistic assessment of water use and water quality in the Valley.

3.3 Updating the regulatory framework

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ♦	COMMENTS, BARRIERS & OPTIONS
<p>Finalize <i>Agricultural Waste Control Regulation</i> update.⁴¹</p> <ul style="list-style-type: none"> • Ensure First Nations are consulted and offered an opportunity to provide input as soon as possible.⁴² • Engage the IAWG to assess and provide input to the new regulations in the context of the Hullcar situation to ensure the proposed updates are sufficient to address similar concerns as faced in the Hullcar. 	<p>Enact (and implement) updated <i>Agricultural Waste Control Regulation</i> (AWCR).</p> <hr/> <p>Review the sufficiency of regulatory tools under the <i>Drinking Water Protection Act</i>, especially around cumulative and time delayed contaminants when drinking water standards thresholds are approached. And recognize the interplay of the <i>Public Health Act</i> and all the powers and authorities.</p>	<p>Ensure alignment of updated AWCR with provincial legislated planning tools, including <i>Drinking Water Protection Plans (DWPA)</i>, <i>Water Sustainability Plans</i> and <i>Water Objectives (WSA)</i>.</p> <hr/> <p>Address concerns that the <i>Environmental Assessment Act</i> does not apply to large scale (or ILO) farming operations. Ensure EAA takes a proactive approach to prevent significant contamination by discouraging inappropriate farming operations from establishing or expanding in high-risk areas.</p>	<p>Improved and modernized <i>Agricultural Waste Control Regulation</i> regime to provide better clarity and protect drinking water sources.</p> <p>♦ Environmental Standards Branch (with AGRI and IAWG support)</p>	<p>We recognize the AWCR has been under review, including stakeholder engagement, for a number of years. However, we believe an expedited and focused effort to ensure an updated and modern regulatory regime is urgently needed and should address issues identified in this report (see Appendix D).</p>

41 See Appendix D – AWCR review synopsis

42 There is a concern by Splantsin First Nation that consultation on updating the AWCR has been insufficient. This is an overarching concern expressed by Splantsin Chief and Counsel member during October 30, 2017 meeting. However, partnerships on water quality and quantity monitoring and holistic planning initiatives (i.e. ABMP) with the Splantsin offer opportunities to further develop government-to-government relationships, and ensure genuine engagement between all levels of government, including First Nations.

3.4 Developing better planning

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ♦	COMMENTS, BARRIERS & OPTIONS
<p>Develop terms of reference (Project Charter) for ABMP.</p> <hr/> <p>Require that Nutrient Management Plans are independently verified (and approved by government) and contain a safety factor (e.g. 30%).⁴³</p>	<p>Develop ABMP (EMA)⁴⁴ to better coordinate activities and deal with the key strategies, such as possible cap on animal density, storage requirements, and beneficial practices for animal waste spreading, storage and transport on a farm-by-farm basis. Key aspects of the ABMP would be to:</p> <ul style="list-style-type: none"> • Coordinate adaptive management to require achievement of nutrient balance, • Require Environmental Farm Plans (EFP), Nutrient Management Plans (NMP), and Irrigation Management Plan (IMP) on a farm-by-farm basis in high risk areas. • Set water objectives that include target precautionary nitrate thresholds (3-5 mg/L). • Improve monitoring and reporting. • Establish triggers for a renewed moratorium if shallow soil tests show elevation in nitrate levels are continuing. • Create co-chaired Hullcar Water Board (see table 3.7) to help develop and oversee ABMP implementation. 	<p>Develop other potentially more effective water protection tools—such as those available under WSA or DWPA—to better deal with the Hullcar and similar problem areas in the future (e.g. setting WSA water quality objectives that align with Canadian Drinking Water Standards).</p> <hr/> <p>Convert the Hullcar ABMP (with supporting Orders) into the more robust and potentially appropriate legislated plans (either WSP/ DWPP) under the supervision of the Hullcar Water Board.</p>	<p>Improve Nutrient Management Plans by ensuring independent expert verification and appropriate safety factors as part of a comprehensive regional initiative. This is a long-term solution that builds public confidence that concerns are being addressed.</p> <ul style="list-style-type: none"> ♦ ENV lead ♦ ENV and AGRI to oversee independent development and implementation of NMPs, with safety factor taken into account. 	<p>Developing a plan from scratch takes time and a clear process. The scope of the plan must be settled early so a budget and timeframe can be prepared and build community confidence that an effective process is underway.</p> <hr/> <p>A clear implementation plan is critical, to know what decisions and processes need to change as a result of the plan.</p>

43 See for example Douglas Geller, M.Sc., P. Geo, P. Geol., Western Water Associates, who argues for a 30% safety factor to take into account variables (like reduced plant growth). However, AGRI recommends that the exact percentage be evaluated further.

44 Note that ABMP are policy statements and in this case may not be directly enforceable – they can however create requirements for statutory decision makers to act and can create a coordinated approach for additional orders and require EFPs, NMPs and IMPs. Initiating an ABMP should also trigger formal requirements to consult (and accommodate) First Nations rights. Engagement and partnership with local First Nations should be a priority as part of a collaborative consent approach.

3.5 Creating incentives for better practices on the landscape

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ♦	COMMENTS, BARRIERS & OPTIONS
<p>Review current suite of Orders and assess sufficiency for achieving soil and water nutrient targets.</p> <hr/> <p>Require independent NMPs (with safety factors) on all operations in high-risk areas⁴⁵ (see 3.3 & 3.4 above for how NMPs should be updated and integrated into the regional planning).</p>	<p>Identify tool(s) to enforce the ABMP and achieve water quality objectives.</p> <ul style="list-style-type: none"> • PAOs and other Orders should be coordinated based on the ABMP. Coordinated and appropriately targeted Orders would also reduce the concern of appeals. • WSA water objectives (s.43) and/or WSA area based regulations (s.124) should be aligned with the ABMP. • Environmental farm plans; irrigation plans; and NMPs should align with the ABMP on each property. <hr/> <p>Provide provincial funding/tax relief incentives for:</p> <ul style="list-style-type: none"> • On-farm beneficial management practices. • Review of irrigation practices and support for improved irrigation practices and technologies where appropriate. • Feasibility study for waste to energy and dewatering technologies (including barn scraping rather than flushing). <hr/> <p>Establish demonstration projects to showcase leading local practices emphasizing an “investment” approach rather than just “costs” to demonstrate economic benefits of better practices and possible future revenue streams including waste fed energy, sale of fertilizer, etc.</p> <hr/> <p>If shallow soil tests show increase of nitrates after crops harvested compared to benchmark established in pre-planting soil tests, enforce the PAO (or additional moratoriums) and require PAOs to include an agreed safety factor.</p>	<p>Assess implication of septic and other sources of nitrate contribution.</p>	<p>Ensure a suite of tools create incentives to implement beneficial management practices and improve farming activities, and behavior on the landscape.</p> <p>♦ ENV and MOH (with FLNR and AGRI to review)</p>	

⁴⁵ For example, evidence suggests that effluent should not be applied to alfalfa (as they effectively fix nitrogen) and spreading on such fields is only a form of waste disposal. See: Agriculture and Natural Resources, University of California. (May 2013). *When is nitrogen fertilization of alfalfa beneficial? Almost never!*. Retrieved from: <http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=10478>; and, Russelle, M. (2004). *The Environmental Impacts on N2 Fixation by Alfalfa*. In Proceedings, National Alfalfa Symposium, 13-15 December 2004, San Diego, CA, University of California. Retrieved from: <http://alfalfa.ucdavis.edu/+symposium/proceedings/2004/04-57.pdf>

3.6 Deploying innovative technology

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ♦	COMMENTS, BARRIERS & OPTIONS
<p>Complete a feasibility study of waste to energy (biogas) facility for the Hullcar Valley in partnership with Splotsin First Nation.</p> <hr/> <p>Encourage barn-scraping technology as opposed to barn flush technology in high-risk areas (or as identified in the ABMP).⁴⁶</p>	<p>Promote a local waste to energy facility as per feasibility study (in partnership with local First Nation)⁴⁷</p> <hr/> <p>Explore groundwater remediation options and technologies.⁴⁸</p>	<p>Explore various ownership models (including local cooperatives) to ensure community benefits from public funds and support for new technologies.</p>	<p>Waste problem addressed and new revenue generated for local operators.</p> <p>♦ ENV with Splotsin First Nation and various possible private partners.</p>	<p>May require additional subsidies to ensure economic feasibility as part of start-up operation and during regulatory transition phase.</p>

46 In conjunction with a flush system could be dewatering of existing effluent so that the produced clean water could be reused in a flush system. This would result in less water drawn from freshwater sources, as well as less lagoon space required to hold liquid effluent long-term.

47 The North Okanagan Wastewater Recovery Project – a joint partnership between the Township of Spallumcheen, Regional District of North Okanagan, and Okanagan Indian Band – offers an example of a collaborative approach to addressing domestic wastewater – and potentially animal waste from the agricultural sector – while providing treated water for agricultural irrigation, industrial cooling and /or washdown water. The treatment process would produce biosolids in addition to treated water, with the biosolids undergoing digestion for breakdown and stabilization, and dewatering to produce a cake suitable for composting or incineration. The project is further considering building in an anaerobic digestion system to produce methane gas as an energy source for heating or producing electricity and to stabilize biosolids. For further information on these technologies, see Appendix E – Deploying Innovative Technology to Address Waste (pollution)

48 See Appendix E – Deploying Innovative Technology to Address Waste (pollution)

3.7 Improving accountability and ensuring a partnership approach

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ♦	COMMENTS, BARRIERS & OPTIONS
<p>Terms of reference for ABMP should include a Plan committee co-chaired by Splantsin and local government supported by the IAWG.</p> <p>Plan Committee should advise and support development of ABMP and Water Objectives (WSA s.43).</p> <p>Complete MOU with Splantsin to support implementation of the Hullcar recommendations and build government-to-government relationship.</p>	<p>Create Hullcar Water Board⁴⁹ (co-chaired by local government and First Nation and supported by appropriate expertise) to:</p> <ul style="list-style-type: none"> • Provide oversight on water (quality and quantity) monitoring and ensure public reporting. • Guide implementation of ABMP. • Initiate/oversee additional legislated plans, i.e. WSP (WSA) and/or DWPP (DWPA). • Guide implementation of an Aquifer remediation action plan. • Showcase local leading examples of beneficial farm practices and innovative waste to energy technologies. • Improve communications between parties through forums and ongoing outreach. <p>Revisit the <i>Action Plan for Safe Drinking Water in British Columbia</i> 'Accountability Framework' to assess sufficiency and effectiveness of response in light of concerns identified in the lead up to the current drinking water crisis.⁵⁰</p>	<p>Review sustainable governance structure for water utilities/ districts in the area (and the role of improvement districts in water provision more generally provincially).</p> <p>Develop guidance for clarity and consistency of delegated decision-making structures for WSA s.126 or a possible <i>Watershed Authorities Act</i>.</p> <p>See <i>Applying Lessons Learned</i>, p. 20.</p>	<p>Better communications and leveraged local capacity to inform local solutions with improved collaboration.</p> <p>♦ ENV to catalyze and enable a local water board with sufficient capacity (including funding) and clear mandate.</p> <p>Better understanding of an appropriate accountability framework for drinking water and source protection.</p> <p>♦ ENV and MOH (MOH to lead <i>Action Plan</i> review)</p>	<p>Currently limited formal mechanisms to create local watershed authorities and ensure sustainable funding exist. As a preliminary step use WSA s. 115 or provisions under EMA 89(2)c while province develops necessary enabling legislation (see <i>Applying Lessons Learned</i>, p. 20, Long-term reforms).</p>

49 As a possible institutional starting point see Cowichan Watershed Board as an example for co-chaired board. The *Water Sustainability Act* (s. 115) allows the Minister to establish advisory boards to, among other things, establish water objectives and standards and best practices in respect of activities in relation to wells and groundwater protection. WSA s. 126 goes further to allow delegated decision-making (and over time – if appropriate – the Hullcar Water Board could evolve to take on a more formal role in water governance in the region). Initial funding from government for coordination and key community and FN participation must support the development of a Water Board.

50 As noted in Footnote 26 above, although the *Action Plan* still offers an existing viable policy framework there is value in a comprehensive review and potential update in light of recent regulatory and contextual changes and 15 + years of experience in implementation. A clear focus for the review (and potential update) should be on clarifying lines of accountability, sufficiency of resources and the necessary actions towards full implementation.

3.8 Considering alternative drinking water sources

IMMEDIATE ACTIONS NEEDED	SHORT TERM PRIORITIES	LONG-TERM REFORMS	KEY OUTCOMES & LEAD ENTITY ◇	COMMENTS, BARRIERS & OPTIONS
<p>Provide filters for contaminants or trucked in water as needed.⁵¹</p> <hr/> <p>See 3.1 <i>Crisis Response</i>, p. 10.</p>	<p>Determine if alternative longer-term source water is needed for local residents.</p> <ul style="list-style-type: none"> • Further assess risks of SSWD drawing water from an unconfined high-risk aquifer. • Consider integrated water system operated and managed regionally or access to deeper confined aquifer (Aquifer 102).⁵² • Explore filtration options. 	<p>Seeking alternative sources should not be an excuse to sacrifice an aquifer. Even if alternative options are found, aquifer should be allowed to rehabilitate and potentially used as a supplemental (or back-up) drinking water source.</p>	<p>Residents provided with reliable source of clean drinking water. Multi-barrier approach used for all sources of drinking water with residents also taking an active role in drinking water protection and supporting treatment in their communities.</p> <p>◇ MOH, IHA and ENV; Ministry of Municipal Affairs and Housing; local government and water supplier</p>	<p>While safe drinking water is generally a purveyor responsibility it can be a challenge for small systems with no (or limited) access to infrastructure funding (a problem across the province).</p> <hr/> <p>Past PHO <i>Action Plan for Safe Drinking Water</i> updates have clearly identified small systems such as SSWD needing more resources to protect water quality.</p>

51 This recommendation could be enhanced to ensure that all drinking water systems, public and private, have the appropriate treatment systems to address all contaminants associated the aqueous phase. EMA provides the legal mechanisms to ensure the pollution in the drinking water is being addressed.

52 It will be important to consult with the Ministry of Municipal Affairs and Housing, specifically Infrastructure Finance Division to provide expertise associated with the costs of maintaining infrastructure assets.

Applying lessons learned and recommended policies to other areas of the Province

Building on the above eight recommendations areas, there are a number of lessons learned from the Hullcar situation that can inform source water protection policies and improve water sustainability applicable to other areas of the Province.

PROVINCIAL PRIORITIES TO IMPROVE DRINKING WATER SOURCE PROTECTION	
Immediate actions needed	<ul style="list-style-type: none"> • Required independent (government approved) NMP with a safety factor (as part of mandatory EFPs) in all high risk source drinking water areas. • Required beneficial management practices (storage, transport, application) of animal waste (manure) on all ILOs. <p><i>Both of these priorities to be required under an updated AWCR.</i></p>
Short-term priorities	<ul style="list-style-type: none"> • Support water-sensitive farm operations and alternative animal waste processing with education, technology transfer and financial incentives. • Accelerate reform and update of AWCR. • Revisit the <i>Action Plan for Safe Drinking Water in British Columbia</i> (and consider initiating a comprehensive and independent review of implementation) to ensure commitments are being fulfilled and to assess its current sufficiency (in light of the issues identified in this report and across the province) to fulfil the stated objective of “ensuring safe, reliable and accessible drinking water for all British Columbians.”⁵³
Long-term reforms	<ul style="list-style-type: none"> • Update the <i>Water Sustainability Act</i> to enable the Minister of Environment, in addition to FLNR Minister to deploy the water sustainability tools such as triggering Water Sustainability Plans (s. 65), Water Objectives (s.43), Area Based Regulations (s.124), and Advisory Boards (s.115). ENV has an important role to play to ensure priorities of stewardship, conservation and sustainability are critical considerations driving actions to protect B.C.’s freshwater resources. • Enhance the provincial water quality and quantity observation network (publicly reported and independently verified).⁵⁴ This includes enhanced community-based monitoring partnerships as part of a provincial science strategy. • Provide provincial State of the Water reporting (every five years), including identification of all drinking water sources (starting in high risk/priority areas) to create baselines and track trends. • Align a clearly codified drinking water risk management system to identify high-risk areas that triggers additional monitoring and reporting and enhanced planning and regulatory protections to help identify threats and assess options for drinking water sources in high-risk areas.

53 As noted in Footnote 26 and 50 above, although the *Action Plan* still offers an existing viable policy framework there is value in a comprehensive review and potential update in light of recent regulatory and contextual changes and 15 + years of experience in implementation. A clear focus for the review (and potential update) should be on clarifying lines of accountability, sufficiency of resources and the necessary actions towards full implementation.

54 An important insight as a result of the circumstances associated with the Hullcar situation is concern about the sufficiency of the current provincial water quality observation network (AGQMN). Numerous references (including in the Environmental Appeal Board Decision NO: 2016-EMA-121A of the Pollution Abatement Order to Curtis Farms (2016)) suggest concern related to the sufficiency of the data gathered and the reliability (including continuity) of the information for the purposes of decision-making and actions needed. The observation well network in the Hullcar Valley is fairly representative of developed aquifers across the province. It was not designed to be a local monitoring system. Separate monitoring systems are needed for such activities. The monitoring can be customized according to the problem that needs monitoring. Right now, the provincial observation well network does monitoring for specific different purposes.

PROVINCIAL PRIORITIES TO IMPROVE DRINKING WATER SOURCE PROTECTION

Long-term reforms (*cont'd*)

- Seek opportunities to improve legislative alignment or reform the legislative regime, including:
 - Address systemic concerns around ability to trigger drinking water audits and legislated plans (DWPP, WSPs) and ensure EFPs and NMPs are enforceable.
 - Provide guidance to decision-makers and staff to better use and align ABMPs (EMA) and Water Objectives and Water Sustainability Plans (WSA) (i.e. water objectives and water sustainability plans can be better enforced).
 - Enable enforceable water-centric land use planning through new *Water Sustainability Act* and provincial Watershed Governance pilot projects to accelerate ongoing WSA regulatory development and provide lessons learned.
 - Address concerns whether the *Environmental Assessment Act* should apply to large scale (or intensive livestock operations) farming operations in high-risk areas.
 - Review and streamline drinking water service provision governance model including:
 - Review DWPA including explicitly improving ability to trigger DWPP as a tool for longer term (not just crisis) drinking water threats and overall review of the regulatory tool to achieve intended outcomes given the experience over the last 17 years.
 - Revisit and implement recommendations in the Auditor General Local Government Drinking Water report⁵⁵ and other water and source protection related audits.⁵⁶
- Create a special response unit with clear provincial agency leadership that can be deployed quickly and nimbly to provide additional monitoring and enforcement support in priority areas as issues emerge.⁵⁷
- Address concerns with the proprietary nature of Qualified Professional (QP) reports and ability by government to make them public.
- Enhance the provincial Cumulative Effects Assessments with a provincial framework that clearly situates B.C. community drinking water as priority ahead of other Crown land base activities.
- Develop and pass a *Watershed Authorities Act*⁵⁸ to more efficiently and consistently enable local bodies to oversee local water management, improve decision-making and ensure high quality drinking water.

55 Auditor General for Local Government. (May 2017). *Local Government's Role in Ensuring Clean Drinking Water – Regional District of Okanagan-Similkameen*. Retrieved from: <https://www.aglg.ca/app/uploads/sites/26/2017/06/RDOS-Performance-Audit-Report.pdf>

56 Including the various recommendations or concerns identified in progress reports of the Action Plan for Safe Drinking Water in British Columbia (see <http://www2.gov.bc.ca/gov/content/health/about-bc-s-health-care-system/office-of-the-provincial-health-officer/reports-publications/drinking-water-reports>). See also: Office of the Auditor General of British Columbia. (December 2010). *An Audit of the Management of Groundwater Resources in British Columbia*. Retrieved from: https://www.bcauditor.com/sites/default/files/publications/2010/report_8/report/OAGBC_Groundwater_Final.pdf; Forest Practices Board. (April 2014). *Community Watersheds: From Objectives to Results on the Ground*. Retrieved from: <https://www.bcfpb.ca/reports-publications/reports/community-watersheds-from-objectives-to-results-on-the-ground/>; Office of the Ombudsperson. (March 2014). *Striking a Balance: The Challenges of Using a Professional Reliance Model in Environmental Protection – British Columbia's Riparian Areas Regulation*. Retrieved from: https://www.bcombudsperson.ca/sites/default/files/Striking_a_Balance_-_Executive_Summary_PDF_0.pdf; and Office of the Auditor General of British Columbia. (March 1999). *Protecting Drinking-Water Sources*. Retrieved from: <http://www.bcauditor.com/sites/default/files/publications/1999/report5/report/protecting-drinking-water-sources.pdf>. The forth-coming Auditor General source water protection review report and Forest Practices Board riparian area and forest operations will also be valuable.

57 Such a unit could complement the current spill response initiative the details of which are beyond the scope of this report.

58 Or adapt/fully implement WSA s. 115 and 126 or EMA s. 89(2)c.

4 Conclusion and Next Steps

The concerns and challenges faced in the Hullcar Valley emphasize the importance of taking the protection of drinking water sources seriously, the urgency for a better planning and regulatory regime, and the need for a risk-based approach to ensure priority areas can be addressed before incremental problems become crisis situations.

The Province has a number of water protection and sustainability tools available, in addition to a well-articulated *Action Plan for Safe Drinking Water in British Columbia*. Action on the ground—and in the water—must match the intentions outlined in the various provincial strategies and plans currently in effect.

In the Hullcar Valley specifically both the community and farmers must manage their expectations as the drinking water situation is addressed over time. Many years (even decades) of activities have contributed to the current concern and there is likely a very significant time lag, with nitrates from past farming practices contributing to the recent contamination of local drinking water. Uncertainty regarding the extent to which current farming practices on the landscape are contributing to future elevated nitrate levels in the Hullcar Aquifer warrants a precautionary approach to nutrient application, storage and transport—including a safety factor in independent and enforced NMPs.

Nitrate levels in the Hullcar Aquifer are unlikely to drop significantly in the near future, and communities must be patient and prepare to seek alternatives while techniques for better land management and aquifer rehabilitation take effect. It is our view that farmers generally are good stewards and do not wish to pollute or jeopardize drinking water. Farmers must also expect that additional safeguards and oversight will be needed. Past practices must improve with potentially more restrictive steps required to ensure current and future practices will achieve a better nitrogen balance and enhanced source water protection in this high-risk area. Landscape practices and activities that result in significant social and ecological impacts, including farming, can and must change.

Overarching findings from the Hullcar review include a number of immediate and longer-term actions, as well as key insights and lessons learned, including:

- Ultimately, no one simple solution exists. Immediate and short-term action on a number of priorities is needed (under existing legislation and governance), with additional more substantive regulatory changes addressed over the longer term.
- The specific issues related to the Hullcar Valley reveal systemic concerns regarding the need to: better assess and balance the risk of land use practices to water sources; change practices on the landscape; prioritize source water protection; and promote proactive action—rather than reactive crisis response. Clear accountability with identified lead agencies and the deployment of an effective planning process will be critical to better respond as issues emerge and to avoid future problems.
- The Hullcar experience offers valuable insights for potential priority provincial actions to better trigger proactive planning and improve source water protection and the water management regime more generally. This unfortunate circumstance also daylights regulatory and legislative reforms that can improve accountability and help ensure safe drinking water and sustainable water management and governance province-wide.

Critical next steps emerging from the Hullcar review include:

- implementation of the suite of the recommendations from this report;
- public release of all documents informing the Hullcar review (including reports from ENV and AGRI) to build local understanding and increase public confidence; and,
- detailed public updates for one year provided by ENV and the Interagency Working Group on Hullcar Aquifer to the Minister, including progress on identified action items and post-harvest monitoring results to allow for further adaptive management and confidence in follow-through.

Appendices

APPENDIX A. OVERVIEW OF ORDERS

Hazard Abatement Orders, Pollution Prevention Orders, and Pollution Abatement Orders issued to Agricultural Operators

The Ministry of Environment and Climate Change Strategy has issued two Pollution Prevention Orders (PPOs) and seven Pollution Abatement Orders (PAOs) to agricultural operations in the Hullcar Valley since 2014, though nitrate levels in the aquifer continue to rise.⁵⁹ Interior Health issued Hazard Abatement Orders (HAOs) to Grace-Mar Farms Ltd. and H.S. Jansen and Sons Farm Ltd. on August 28, 2017.⁶⁰

Pursuant to Section 25 of the *Drinking Water Protection Act* (2001), recipients of **Hazard Abatement or Prevention Orders** are required to undertake a number of actions, including tests or other actions to assess and determine how to address or prevent the drinking water health hazard, and/or abate the drinking water health hazard (Section 25, subsection 3(b-c)). In the case of the August 28, 2017 HAOs to Jansen Farms and Grace-Mar Farms, the Orders required the recipients to have a qualified professional (QP) prepare Nutrient Management Plans for all farm operations on the Lands, and the NMPs must be amendable as necessary to reflect comments by ENV.

Under the *Environmental Management Act*, Section 81 (2003), **Pollution Prevention Orders** (PPOs) issued by ENV require agricultural operators to comply with a number of conditions, including: providing information back to the Province relating to the activities of the business; undertaking investigations or tests to prevent pollution; and constructing or carrying out measures necessary to prevent the pollution.⁶¹

Pollution Abatement Orders (PAOs) issued under Section 83 of the *Environmental Management Act* (2003) have similar requirements as PPOs, but with further requirements to abate the pollution, and

“carry out remediation in accordance with any criteria established by the [Province]”.⁶² In the case of PAOs issued to agricultural operators in the Hullcar Valley, “further requirements” included the following:

- Development of terms of reference and a work plan prepared by a QP for completing a comprehensive monitoring program and an environmental impact assessment for nitrates and other nitrogen compounds in the soil and groundwater on the lands;
- Have QP implement the monitoring program and complete the work plan;
- Submit the Environmental Impact Assessment (EIA) and results of monitoring program to the Province;
- Have QP prepare an action plan outlining measures that will be taken to abate environmental impacts identified in EIA, and submit to Province for approval;
- Implement the action plan;
- Submit to the Province within six months, and annually for two years, a summary of actions taken under the action plan, agricultural operation changes, monitoring results, and additional mitigation and restoration measures recommended; and,
- Prepare a post action plan and annual summary required by the PAO, as well as any updates to the action plan and future annual summaries at Hullcar Community Hall.⁶³

Nutrient Management Plans have been submitted by the following farms with agricultural activities that may be impacting water quality in the Hullcar aquifer: H.S. Jansen Farms (2014-2017), Douglas Regehr (2015-2016), Grace-Mar Farms Ltd. (2017), and Purple Springs Nursery Inc. (2017).⁶⁴

59 Denham, E. (June 29, 2016). *Investigation Report F16-02 Clearly in the Public Interest: The Disclosure of Information Related to Water Quality in Spallumcheen*. Office of the Information & Privacy Commissioner for British Columbia. Retrieved from: <https://www.oipc.bc.ca/investigation-reports/1972>

60 Interior Health. (August 28, 2017). *Order Pursuant to Section 25 of the Drinking Water Protection Act*. Email correspondence with IHA, September 11, 2017

61 *Environmental Management Act*, 2003, Section 81. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/03053_08

62 Ibid

63 B.C. Environmental Appeal Board, (November 23 and 24 2016). *Decision No. 2016-EMA-121(a)*. Retrieved from: <http://www.eab.gov.bc.ca/ema/2016ema121a.pdf>

64 These NMPs are available on the Province of B.C. *Hullcar Aquifer Information* website. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-permitting-compliance/hullcar-aquifer>

Two (of the seven) examples of PAOs issued to agricultural operators in the Hullcar Valley are worth noting:

1. In March 6, 2014, Jansen Farms was issued a Compliance Order relative to sections 13 and 14 of the Agricultural Waste Control Regulation.⁶⁵ Jansen Farms was granted four approvals to apply liquid manure on lands atop the contaminated aquifer.⁶⁶ Authorization of additional nutrient application by the Ministry of Environment to Jansen Farms was in accordance with the Nutrient Management Plan submitted by the QP retained by Jansen Farms, and based on soil and manure analysis results. Then, in May 2016, Jansen Farms was issued a PAO, on the grounds pollution in the form of agricultural waste was being introduced into the environment, resulting in nitrates leaching into groundwater used for drinking water.⁶⁷
2. A PAO was issued to Curtis Farms on May 12, 2016, on reasonable grounds the agricultural operations at the farm were introducing nitrates to groundwater used for drinking water.⁶⁸ This PAO was appealed on June 1st, 2017, before the Environmental Appeals Board (EAB) of B.C. Curtis Farms argued they were not responsible for nitrate contamination in the aquifer, as there is no pollution in the western part of the aquifer where their farm is located, and further, “ground water flow is in the opposite direction from the spring intake (south westerly), relative to the location of their lands.”⁶⁹ The EAB agreed with Curtis Farms, concluding “there was, and is, no evidence upon which the...Panel can be satisfied on reasonable grounds that nitrates from the Curtis Farm have reach the Aquifer such that they have substantially altered or impaired the usefulness of the environment”.⁷⁰

An overview of all Orders issued to agricultural operators in the Hullcar Valley pertaining to the contamination of the Hullcar aquifer can be found in the Chronology, to be made publicly available on the B.C. Ministry of Environment and Climate Change Strategy Hullcar Review website.

65 B.C. Ministry of Environment. (March 6 2014). *Compliance Order File No. 76600-20*. Retrieved from: <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/2014-03-06-jansen-order.pdf>

66 Approvals authorizing additional nutrient application to Jansen Farms were issued April 16 and August 27, 2014, and July 15, and August 31 of 2015. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/site-permitting-compliance/hullcar-aquifer>

67 B.C. Ministry of Environment. (May 12 2016). *Pollution Abatement Order File UA Hullcar Aquifer AMS#350091*. Retrieved from: <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/108387-jansen-pao.pdf>

68 B.C. Ministry of Environment. (May 12 2016). *Pollution Abatement Order File UA Hullcar Aquifer AMS#350103*. Retrieved from: <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/108390-curtis-pao.pdf>

69 B.C. Environmental Appeal Board, (November 23 and 24 2016). *Decision No. 2016-EMA-121(a)*. Pg. 18. Retrieved from: <http://www.eab.gov.bc.ca/ema/2016ema121a.pdf>

70 Ibid

APPENDIX B. CURRENT MANAGEMENT AND LEGAL REGIME

In this section we characterize the legal regime for source water protection and nutrient management in B.C., outlining the key provincial legislation, regulation, and policy regimes related to water, agriculture and nutrient management.

Jurisdiction

All levels of government have some involvement in the source water protection and nutrient management:

- The federal government is responsible for conducting drinking water scientific research. In partnership with provinces and territories the federal government produces and maintains the Guidelines for Canadian Drinking Water Quality published by Health Canada that sets limits on safe nutrient concentrations in drinking water.⁷¹
- The provincial government has primary jurisdiction over water management and protection, including licensing of surface water, and more recently, non-domestic groundwater use, and permitting drinking water supply and for waste disposal. It administers the *Environmental Management Act*, *Drinking Water Protection Act*, *Water Sustainability Act*, and their associated regulations, which are further detailed below.
- Local governments are empowered by the *Local Government Act* to operate drinking water systems,⁷² and manage the day-to-day operation of source protection, supply, treatment, and distribution. Local governments operate most water systems in B.C. A small percentage of drinking water is administered by irrigation and improvement districts, private utilities, First Nations, water user communities, and community water systems. In the Hullcar Valley, drinking water is administered by an improvement district—the Steel Springs Waterworks District.

Legal structure

Figure 3 (overleaf), from the Office of the Provincial Health Officer, provides an overview of ministries involved in the provincial drinking water program. (Note in the table ‘MOE’ is the Ministry of Environment [now abbreviated as ENV], and the *Water Act* has been repealed and replaced with the *Water Sustainability Act*, which is administered by the Ministry of Forest, Lands, Natural Resource Operations and Rural Development).

Provincial Drinking Water Programs are led by the Ministry of Health using the *Drinking Water Protection Act*, *Drinking Water Protection Regulation*, *Public Health Act*, *Sewerage System Regulation*, and the *Health Hazards Regulation*, and is supported by the independent Provincial Health Officer (who provides review and oversight, in addition to recommendations to the Minister). The Provincial Health Officer also has oversight of Medical Health Officers who have the authority to act as Drinking Water Officers.

The Ministry of Forest, Lands, and Natural Resource Operations and Rural Development (“FLNR”) is responsible for monitoring water levels and sampling for ambient groundwater quality monitoring network.

The Ministry of Environment and Climate Change Strategy (‘ENV’) is responsible for science, knowledge management, strategic frameworks, standards setting, policy, and legislation development. The ENV administers the *Environmental Management Act* and regulations.

The Ministry of Agriculture (‘AGRI’) administers the voluntary Environmental Farm Plan program (which includes Nutrient Management Plans (NMP)).

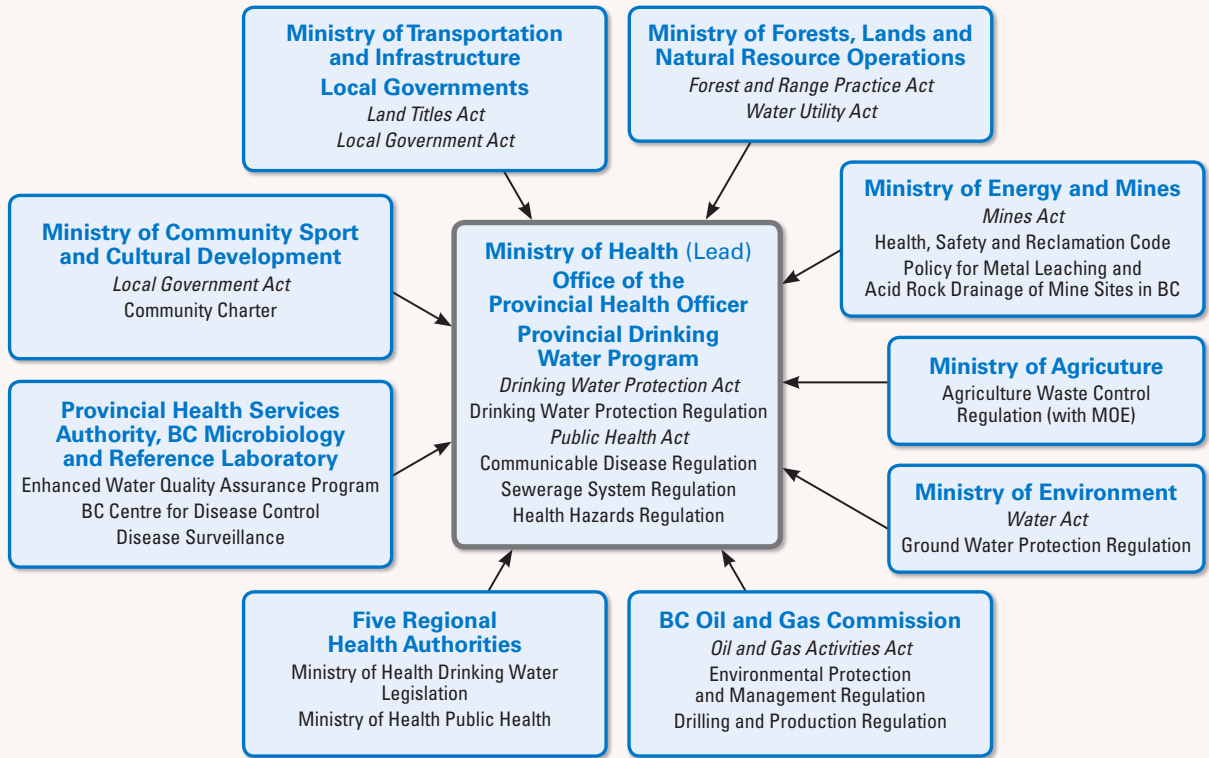
The Ministry of Municipal Affairs and Housing oversees infrastructure funding and governance related to improvement districts, the *Local Government Act* and *Community Charter*.

The following review looks at two types of provincial government legislative approaches to addressing the issues of source water protection and

71 Government of Canada. (February 2017). *Guidelines for Canadian Drinking Water Quality Summary Table*. Retrieved from: <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table-health-canada-2012.html>

72 Office of the Provincial Health Officer. (2015). *Progress on the Action Plan for Safe Drinking Water in British Columbia*. Retrieved from: <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/pho-drinkingwater2015-web.pdf>

FIGURE 3: Interagency Co-operation and Key Legislation for the Action Plan for Safe Drinking Water in British Columbia⁷³



nutrient management: preventative measures and reactive measures. Preventative measures are planning processes that are in place to prevent pollution. Reactive measures are tools that can be used once pollution has been suspected or identified.

Preventative Measures – Source Protection

The following legislative measures are aimed at preventing contamination. First the source protection legislation, then the nutrient management legislation is described.

*Drinking Water Protection Act*⁷⁴

The *Drinking Water Protection Act* ('DWPA'), administered by the Ministry of Health, covers all

water systems, except single-family dwellings (and systems excluded through the regulation). It sets out requirements for drinking water operators and suppliers to ensure the provision of safe drinking water to their customers. It designates minimum water treatment and water quality standards to be met, and what monitoring and testing is to be carried out. Drinking water officers survey and monitor drinking water systems. They administer and enforce the *Drinking Water Protection Act*, and the Drinking Water Protection Regulation. The Provincial Health Officer makes recommendations to the Minister with regard to drinking water protection planning, and oversees, reviews, and makes amendments to drinking water protection plans.⁷⁵

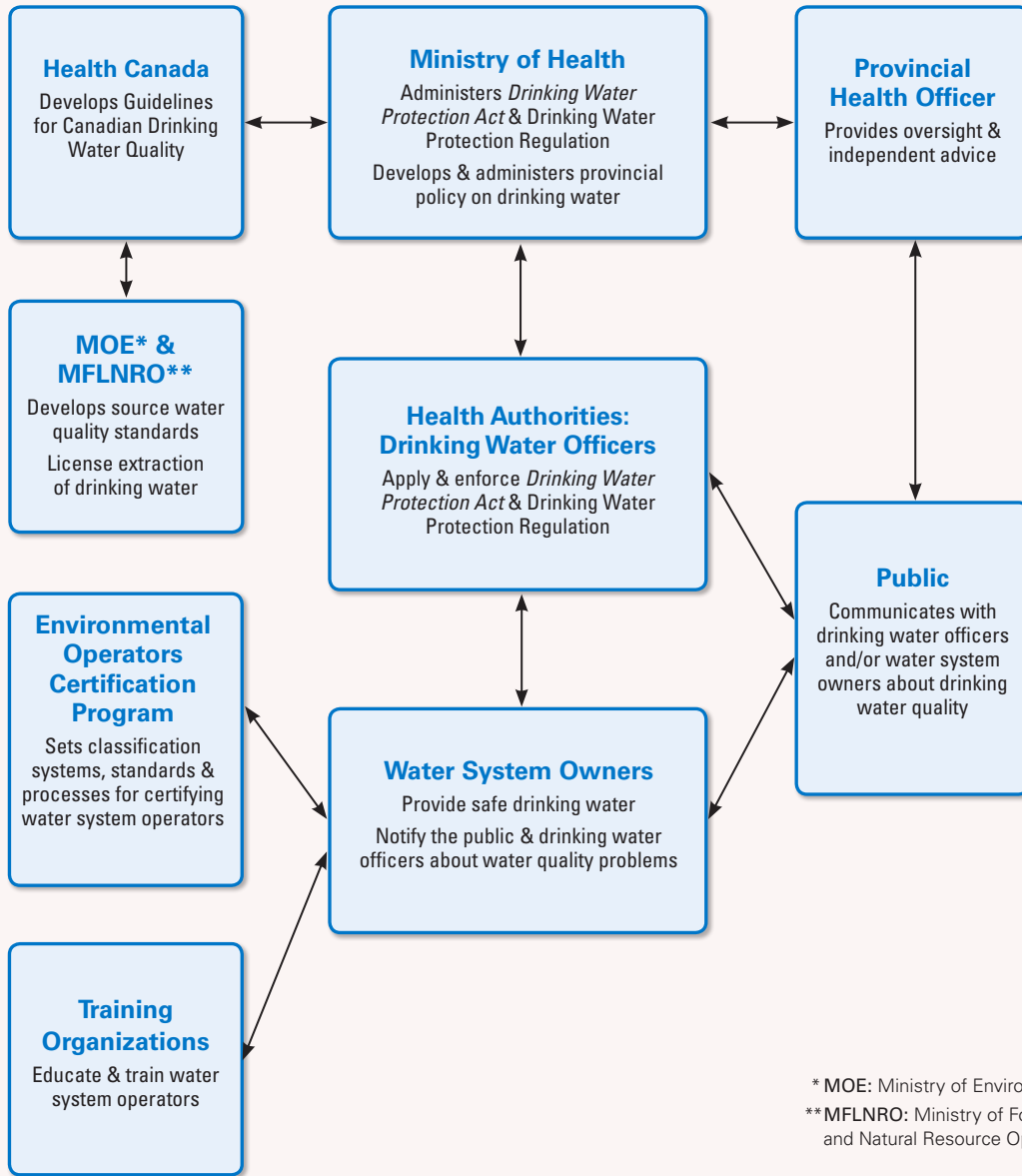
Figure 4 provides an overview of the various entities involved in protecting drinking water.

⁷³ Office of the Provincial Health Officer. (2015). *Progress on the Action Plan for Safe Drinking Water in British Columbia*. Retrieved from: <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/pho-drinkingwater2015-web.pdf>

⁷⁴ For more information on the legislation and regulations in this section, see: *Drinking Water Protection Act*, SBC 2001, c.9. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

⁷⁵ B.C. Ministry of Environment and Climate Change Strategy. (n.d.). *Legislation*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/drinking-water-quality/legislation>

FIGURE 4: Shared roles and responsibilities in protecting drinking water⁷⁶



The DWPA has several important provisions/tools for preventative source protection, including:

GENERAL PROHIBITION AGAINST CONTAMINATING DRINKING WATER (s. 23)

The DWPA creates a general prohibition against introducing, causing, or allowing anything to be introduced into a drinking water source, a well

recharge zone or an area adjacent to a drinking water source, or doing or causing any other thing to be done or to occur, if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system. However, the prohibitions do not apply if the introduction or activity is authorized or required under an enactment or the person is otherwise acting with lawful authority, or in relation to

⁷⁶ Government of British Columbia. (n.d.). *Shared Roles & Responsibilities in Protecting B.C. Drinking Water*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/drinking-water-quality/shared-roles-and-responsibilities>

an activity prescribed by regulation that is undertaken in accordance with any conditions prescribed by regulation.

**SOURCE WATER ASSESSMENTS (s.18)
AND ASSESSMENT RESPONSE PLANS (s. 22)**

The DWPA creates planning regimes with Source Water Assessments and Assessment Response Plans. Both are ordered at the discretion of the drinking water officer, and aimed at drinking water suppliers.

A Source Water Assessment may be ordered if the drinking water officer has reason to believe that this Assessment is necessary to properly identify and assess threats to drinking water in relation to the water supply system. Considerations may include the advice of a medical health officer and consultations with the water supplier.⁷⁷ The Drinking Water Officer Guide suggests circumstances in which an assessment might be appropriate, such as situations where there has been a history of threats to drinking water, changes in the quality of water in the supply system, or problems experienced by water suppliers in similar circumstances.⁷⁸

The content, area of coverage, and time for completing an assessment must be in accordance with any applicable regulations and the directions of the drinking water officer.⁷⁹ There are no specific regulatory requirements in place at this time. A decision by a Drinking Water Officer to issue this order cannot be appealed under the DWPA.⁸⁰

A Drinking Water Officer may also order an Assessment Response Plan to identify measures that may be taken to address threats identified in the Source

Water Assessment. This is ordered at the discretion of the Drinking Water Officer where a source water assessment has identified threats to the drinking water provided by the water supply system, and the water supply system is of a prescribed class.⁸¹

An Assessment Response Plan must be prepared in accordance with the regulations and the directions of the Drinking Water Officer.⁸² The regulatory requirement is that it must include provisions to identify, eliminate, and prevent cross connections with non-potable water sources.⁸³

DRINKING WATER PROTECTION PLANS (PART 5)⁸⁴

Drinking Water Protection Plans (“DWPP”) have broader powers than Source Water Assessment and the Assessment Response Plans. A DWPP can designate specific areas for planning purposes, and require statutory decision makers to consider the DWPP in making decisions under specified enactments, or restrict the exercise of their powers.⁸⁵ Provisions of a DWPP may include: restrictions on well drilling, enforcement of water source standards (including quality standards and prohibitions on actions that result in prescribed standards not being met), and empowerment or restrictions on local government authorities.⁸⁶ A DWPP must include a process for public and stakeholder consultation.⁸⁷

The DWPP may only be requested as a last resort provision where no other practicable measures available under the DWPA are sufficient to address or prevent the drinking water health hazard.⁸⁸ It must be made by order in council by the Minister. The Provincial Health Officer must consider

77 *Drinking Water Protection Act*, SBC 2001, c.9. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

78 B.C. Ministry Health. (2017). *Drinking Water Officers’ Guide*. Retrieved from: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/how-drinking-water-is-protected-in-bc/dwog_introduction.pdf

79 *Drinking Water Protection Act*, SBC 2001, c.9, s.20. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

80 Ministry of Health. (2017). *Drinking Water Officer Guide Part A*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/drinking-water-quality/how-drinking-water-is-protected-in-bc>

81 *Drinking Water Protection Act*, SBC 2001, c.9, s.22. Note that under BC Reg 200/2003, s.4 (1) all water supply systems are prescribed. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

82 *Drinking Water Protection Act*, SBC 2001, c.9, s. 22(3). Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

83 *Drinking Water Protection Act*, Drinking Water Protection Regulation 200/2003, s.15. Retrieved from: http://www.bclaws.ca/civix/document/id/loo72/loo72/200_2003

84 *Drinking Water Protection Act*, SBC 2001, c.9, Part 5. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

85 *Drinking Water Protection Act*, SBC 2001, c.9, s.35. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

86 *Drinking Water Protection Act*, SBC 2001, c.9, s.36-38. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

87 *Drinking Water Protection Act*, SBC 2001, c.9, s.32. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

88 *Drinking Water Protection Act*, SBC 2001, c.9, s. 31(1), (2)(b). Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

recommending a DWPP if one is requested by the Drinking Water Officer.⁸⁹ A local authority or water supplier may request a drinking water officer to make a request for a DWPP; however, there is no provision for a public request, or a request directly from a local authority to the Public Health Officer. However, only a Provincial Health Officer may request the DWPP be ordered, and may only make such a request where s/he considers may result in a drinking water health hazard.⁹⁰

A DWPP has optional measures to cause it to be integrated with other legislation. It may require that other planning processes consider, or be consistent with the DWPP.⁹¹ Once a DWPP has been created, the Lieutenant Governor in Council may require persons making decisions to consider the plan, and restrict exercises of powers, and restrict or impose requirements on the issuances of licences, approvals, and permits under other enactments. The implementation measures are legally enforceable.⁹² No DWPP has ever been ordered in B.C.

Required Consultations respecting drinking water (s. 30)⁹³

This tool allows the Lieutenant Governor in Council to require statutory decision makers to consult with local authorities, drinking water officers, and/or water suppliers prior to making decisions. Use of this tool is a political decision, made at the discretion of the Lieutenant Governor in Council. It applies only to administrative decision makers decisions.

*Water Sustainability Act*⁹⁴

The *Water Sustainability Act* ('WSA'), administered by the Ministry of Forest, Lands, and Natural Resource

Operations and Rural Development, came into force in 2016. The WSA governs water licensing, and use for surface and groundwater; as well as creating opportunities for protecting water resources through planning measures such as water sustainability plans and setting of water objectives.

WATER SUSTAINABILITY PLANS⁹⁵

Water Sustainability Plans ("WSP") are area-based plans that, among other things, may identify risks to water quality and measures to address them. WSPs may be requested or ordered on the Minister's initiative for designated areas if the Minister considers that a plan will prevent or address risks to water quality.⁹⁶ WSPs may be created for aquifers.⁹⁷ The WSP is either completed by the government or the responsible person designated under the *Water Sustainability Act*. Where significant changes are proposed by the plan, the plan submitted to the Minister must include the consents of water licence /drilling authorization holders whose water rights will be affected by the plan.⁹⁸ Alternatively, in lieu of consents, the plan submitted to the Minister must contain a list of affected licences/drilling authorizations, a statement of the public benefit and a statement of the funding available for the compensation for the involuntary changes.⁹⁹

The WSP may create regulations that affect statutory decisions under other statutes; restrictions or prohibitions on the use of land or resources; water license terms and conditions; and other planning processes.¹⁰⁰ The WSP may consider other planning documents such as those generated by communities, First Nations, DWPPs, and other land or water use plans.¹⁰¹ Although no further regulation is needed to

89 *Drinking Water Protection Act*, SBC 2001, c.9, s. 31(3). Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

90 *Drinking Water Protection Act*, SBC 2001, c.9, s. 31(2)(a). Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

91 *Drinking Water Protection Act*, SBC 2001, c.9, s.35(1). Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

92 Fraser Basin Council. (2011). *Rethinking Our Water Ways: A Guide to Water and Watershed Planning for BC Communities in the Face of Climate Change and Other Challenges*. Retrieved from: http://www.rethinkingwater.ca/Library/docs/FBC_WaterGuide_FINAL.pdf

93 *Drinking Water Protection Act*, SBC 2001, c.9, s.30. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

94 *Water Sustainability Act*, SBC 2014, c. 15. Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

95 *Water Sustainability Act*, SBC 2014, c. 15, Division 4. Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

96 *Water Sustainability Act*, SBC 2014, c. 15, s.65(1). Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

97 *Water Sustainability Act*, SBC 2014, c. 15, s.72(1)(a). Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

98 *Water Sustainability Act*, SBC 2014, c. 15, s.71. Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

99 *Water Sustainability Act*, SBC 2014, c. 15, s.74. Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

100 *Water Sustainability Act*, SBC 2014, c. 15, s. 76 – 84. Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

101 *Water Sustainability Act*, SBC 2014, c. 15, s.69. Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

initiate WSPs it is unclear at this time what regulatory steps would be needed to implement WSPs—it is likely the developed plan itself would specify the regulatory and implementation framework. We anticipate further guidance on how those regulatory authorities can be used and their implications.

WATER OBJECTIVES¹⁰²

Water objectives are site-specific (or even province-side) standards for water quality or quantity (as well as ecosystem health) for a designated water body that are set by regulation. The regulations are set by the Lieutenant Governor in Council and may include water quality requirements for an aquifer for specified water uses. The regulation may specify factors and criteria that should apply for evaluating the impacts of a land use on the aquifer, and ways to address those impacts. The regulation may require land and resource use decision-makers (including local government) to consider impacts on water when making their individual decisions. No Water Objectives we are aware of have been set in B.C. since the WSA came into force.

Other

Well Protection Plans¹⁰³

Well Protection Plans are aimed at communities to develop and implement protection measures to prevent pollution to their water well. A well protection may be ordered by a drinking water officer as part of a source water assessment plan.¹⁰⁴ However, they are more commonly promoted as a voluntary tool.

Community Watersheds— *Forest and Range Practices Act*¹⁰⁵

Community watersheds are areas designated under the Government Actions Regulation of the *Forestry and Range Practices Act* (FRPA) to protect populations who use surface water as their drinking water. They may

be designated by the Minister of FLNR if satisfied that the area requires special management to conserve the quality, quantity and timing of water flow, and prevent cumulative hydrological effects having a material adverse effect on water, and such protection is not otherwise provided under another enactment. To be eligible, the community watershed must provide water for a water source that is licensed under the *Water Sustainability Act* for a waterworks purpose, provides water for human consumption, and drains an area smaller than 500 square kilometers. While community watersheds originated as a tool to protect water supplies in areas with forestry activities, it is possible to establish a community watershed in other areas. There are currently 466 designated community watersheds in B.C., with most being established in the 1980s and 1990s.¹⁰⁶ FRPA does not regulate users of community watersheds other than forest and range licensees.

Irrigation Management Plans¹⁰⁷

Irrigation management plans are a voluntary tool developed by the B.C. Ministry of Agriculture. They may be recommended as part of an Environmental Farm Plan. Irrigation Management Plans are used to develop irrigation systems that match crop water needs while preventing water loss due to surface flow or leaching. Irrigation practices are not regulated directly by any legislation. However, over-irrigation can lead to leaching of contaminants into surface and groundwater by pushing nutrients out of the root zone. Leachate is moved more readily where water content in the soil is high.

Preventative Measures— Nutrient Management

***Environmental Management Act*¹⁰⁸**

The *Environmental Management Act* ('EMA'), administered by ENV, regulates waste discharges through prohibitions and authorizations. The EMA

102 *Water Sustainability Act*, SBC 2014, c. 15, s.43. Retrieved from: <http://www.bclaws.ca/civix/document/id/lc/statreg/14015>

103 Ministry of Environment. (n.d.) *Well Protection Toolkit*. Retrieved from: http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/wells/well_protection/wellprotect.html

104 Ibid

105 *Forest and Range Practices Act*, SBC 2002, c. 69, s. 150. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_02069_01

106 Government of B.C. (n.d.). *Community Watersheds*. Retrieved from: <http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/community-watersheds>

107 BC Ministry of Agriculture, Food and Fisheries. (2005). *B.C. Irrigation Management Guide*. Retrieved from: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/water/irrigation/irrigation-management-guide/577300-0_irrigmgmtguide_chapter_00_how_to_use_with_titlepage.pdf

108 *Environmental Management Act*, SBC 2003, c. 53. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

authorizes discharges of waste to the environment by a process of permits, regulations, and codes of practice. Generally, these processes are preventative because they allow the ENV to be informed of activities, and to set requirements so it can monitor compliance. The EMA at section 6(2) and 6(3) prohibits a person from introducing, or causing, or allowing waste to be introduced into the environment that was produced by a prescribed activity or operation; or while conducting a prescribed industry, trade, or business.¹⁰⁹

The EMA deals with agricultural waste specifically under the Agricultural Waste Control Regulation (AWCR). Agricultural operations are expected to comply with the AWCR, and the EMA generally. However, agricultural operations are not required to register under the EMA, and as a result, there is no database of agricultural operations or criteria for what constitute an agricultural operation. Consequently, there is no system of scheduled or routine compliance inspections. Compliance officers generally inspect agricultural operations in response to complaints, especially those related to off-site migration of waste or air emissions. Inspections may also be done as part of an area based audit. Inspections focus on the requirements under the AWCR related to the complaint, but may also include a more thorough review of requirements under the AWCR or the general requirement within the EMA that prohibits pollution. Compliance is evaluated based on alignment with the requirements as specified in the language of the AWCR and the EMA.

SPILL PREVENTION AND REPORTING CONTINGENCY PLAN (s. 79)¹¹⁰

Contingency Plans are preventative plans that contain information regarding polluting substances controlled by a person, and actions that can be taken to prevent or abate an escape or spill of that substance. A Contingency Plan can be ordered against a person who has possession, charge or control of any polluting substance. It is triggered if the Minister considers

it reasonable and necessary to have a contingency plan to lessen the risk of an escape or spill of the substance. The person may be required to undertake investigations, tests, surveys and any other action the Minister considers necessary to determine the magnitude of the risk and to report the results to the Minister, and to prepare, in accordance with the Minister's directions, the contingency plan containing information the Minister requires. Consequently, the person may be required to construct, alter or acquire, at the person's expense, any works, or carry out at the person's expense any measures that the Minister considers reasonable and necessary to prevent or abate an escape or spill of the substance. Contingency plans have not been used for agricultural waste as a polluting substance.

AGRICULTURAL WASTE CONTROL REGULATION AND CODE OF AGRICULTURAL PRACTICE FOR WASTE MANAGEMENT, APRIL 1, 1992¹¹¹

The AWCR creates an exemption to section 6(2) and 6(3) of the EMA described above for operations that follow the Code of Agricultural Practice for Waste Management, April 1, 1992 ("the Code"). Adherence to the Code is voluntary. Operations who select not to comply with the Code are subject to section 6(2) and 6(3) of the EMA. The Code describes practices for using, storing and managing agricultural waste that will result in agricultural waste being handled in an environmentally sound manner. The Code provides guidance on storage facilities, field storage, allowable applications, prohibited applications, conditions unfavorable to application, and confined area operation.

A storage facility must prevent the escape of any agricultural waste that causes pollution, and be maintained in a manner to prevent pollution. Storage facilities must not be located within 15 metres (m) of a watercourse, or 30 m of a source of water¹¹² for domestic purposes.¹¹³ The Code does not specify types of storage facilities that prevent pollution. Solid

109 *Environmental Management Act*, SBC 2003, s. 6(2) and 6(3). Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

110 *Environmental Management Act*, SBC 2003, c. 53, s. 79(2)(b). Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

111 *Environmental Management Act*, Agricultural Waste Control Regulation 131/92. Retrieved from: http://www.bclaws.ca/civix/document/id/lco78/10078/10_131_92

112 A 'source of water for domestic purposes' is interpreted as a water supply well. The setback distance refers to the distance between the supply well and the storage facility.

113 Exceptions exist for storage facilities that were constructed prior to April 1, 1992, provided that satisfactory reporting on the facility is made available to the director.

agricultural waste stored on a field must be stored in a manner that prevents the escape of agricultural waste that causes pollution. There is no guidance for acceptable methods to prevent the escape of waste from field storage that causes pollution, aside from the construction of berms or other works. Compliance officers conduct visual inspections of storage facilities to look for any escape of waste (run-off or leaching from the storage facility). Depending on the type of storage facility, they look for holes, cracks, breaks, or failures in the storage facility itself. They would utilize evidence of any downgradient contamination (in surface water bodies for example) if any exists.

Waste may be applied only as a fertilizer or soil conditioner. Compliance with this requirement is assessed based on whether the waste is applied as a fertilizer (in the case of a field planted with crops) or soil conditioner (where there is not yet any crop), with either being acceptable. Agricultural operators cannot apply waste to a field where there is no intention to grow crops. The Code prohibits application to the land if, due to meteorological, topographical or soil conditions or the rate of application, runoff or the escape of agricultural waste causes pollution of a watercourse or groundwater. It further establishes that agricultural wastes must not be applied on frozen land, in diverting winds, on areas having standing water, on saturated soils, or at rates of application that exceed the amount required for crop growth, if runoff or escape of agricultural waste causes pollution of a watercourse or groundwater, or goes beyond the farm boundary. The Code does not explain how to establish whether waste application exceeds the amount required for crop growth. Nutrient management plans are not a standard requirement for agricultural operations. Evaluating the nutrient requirement of a crop is beyond the scope of the language of the AWCR for a compliance assessment.

Confined livestock areas must be operated in a way that does not cause pollution. It stipulates that where there are more than 10 agricultural units (where one unit is equivalent to 455 kg of livestock, poultry or

farmed game) in a confined livestock area or areas within the same drainage basin then the area or areas must be located at least 30 m from any source of water used for domestic purposes.¹¹⁴

ENVIRONMENTAL FARM PLANS¹¹⁵

Environmental Farm Plans are voluntary and confidential environmental risk assessments completed for agricultural operations. They are prepared with the assistance of qualified advisors. These plans provide guidance on beneficial management practices, and may include development of a nutrient management plan.

Nutrient Managements Plans (NMPs) are used to determine through testing and calculation how to supply crops with nutrients at the appropriate rate, timing, and with the appropriate method for optimal growth. They are intended to help agricultural operations optimize their nutrient usage, while also protecting soil, water, and air resources. The Environmental Farm Plan recommends NMPs for livestock producers and producers of intensively managed outdoor horticultural crops located over moderately or highly vulnerable aquifers that are used for drinking water. NMPs also serve as an educational tool to help ensure compliance with relevant legislation. NMPs may be directed as a required action under certain Orders.

Reactive Measures—Source Protection and Nutrient Management

The following legislative measures can be taken once pollution is suspected or identified. Reactive measures related to source protection and nutrient management overlap in situations where pollution has been suspected or identified; therefore, the legislative measures for both topics are presented together.

***Environmental Management Act*¹¹⁶**

The *Environmental Management Act* (EMA) provides inspection and enforcement tools to identify and control pollution. Inspectors complete proactive inspections based on a planned schedule, which

114 Exceptions exist for confined livestock areas that were constructed prior to April 1, 1992, provided that satisfactory reporting on the area is made available to the director.

115 BC Agriculture Council. (2010). Environmental Farm Plan Reference Guide. Retrieved from: <https://www.bcac.bc.ca/ardcorp/program/environmental-farm-plan-program>

116 *Environmental Management Act*, SBC 2003, c. 53. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

considers factors such as discharge size, proximity to sensitive air and watersheds, geographic location, and the need to maintain an appropriate level of contact with regulated parties. Proactive inspections address previous findings of non-compliance, as well as verify compliance with the introduction of new regulatory requirements. Inspections may also be triggered by complaints. Enforcement tools such as administrative penalties, orders, and fines may be used to encourage compliance.

POLLUTION PREVENTION ORDER (s. 81)¹¹⁷

Pollution Prevention Orders may be given at the discretion of the Director following an inspection that discloses a potential for pollution to occur. The application of the substance to the environment must be “likely to cause” pollution, before an Order may be given. The Pollution Prevention Order may require a person to: provide to the Director information the director requests relating to the activity, operation or substance; undertake investigations, tests, surveys or any other action the Director considers necessary to prevent the pollution and report the results to the Director; acquire, construct or carry out any works or measures that are reasonably necessary to prevent the pollution; or adjust, repair or alter any works to the extent reasonably necessary to prevent the pollution.

POLLUTION ABATEMENT ORDER (s.83)¹¹⁸

If a Director is satisfied on reasonable grounds that pollution is being caused by the introduction into the environment of a substance, a Pollution Abatement Order can be issued to the controller of the operation.

Pollution Abatement Orders indicate required actions to be taken by the polluter to control, abate, or stop the pollution. Examples include hiring a qualified professional to produce and implement an environmental impact assessment, monitoring plan, and/or action plan. They may also include requirements for ongoing monitoring and reporting, or remediation.

To have jurisdiction to issue a Pollution Abatement Order, the Director must conclude that the substance introduced into the environment is causing pollution, by being satisfied that it has substantially altered or impaired the usefulness of the environment. In the case of nutrient pollution to an aquifer, the Director must be satisfied on reasonable grounds that nutrients in excess of those consumed by natural nutrient cycling in the environment have leached into the aquifer as a result of the agricultural operations of the person to whom the Pollution Abatement Order is issued.

The ‘reasonable grounds’ standard means the decision maker must on the basis of plausible evidence, objectively considered, be satisfied that the application of the substance to the environment “is causing” pollution. The standard of proof is on a balance of probabilities.¹¹⁹

Where a person is alleged to be one of many contributors to nutrient pollution, the Director must be satisfied that a person’s addition of a nutrient-containing substance to the environment is contributing to an elevated level of the nutrient such that it places human health or the health of the environment at risk.

With respect to nutrient pollution to groundwater, the director must provide evidence that nutrients are leaching into the aquifer in order to have jurisdiction to issue a Pollution Abatement Order. Evidence based on an assumption that activities are causing or contributing pollution based on the presence of nutrient containing substances on the person’s property is insufficient.¹²⁰

ENVIRONMENTAL PROTECTION ORDER (s. 85)¹²¹ AND ENVIRONMENTAL MANAGEMENT PLANS (s.86)¹²²

The Minister may at their discretion issue an Environmental Protection Order that declares an existing or proposed work, undertaking, product use or resource use has, or potentially has, a detrimental

117 *Environmental Management Act*, SBC 2003, c. 53, s. 81. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

118 *Environmental Management Act*, SBC 2003, c. 53, s. 83. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

119 B.C. Environmental Appeal Board, (November 23 and 24 2016). *Decision No. 2016-EMA-121(a)*. Retrieved from: <http://www.eab.gov.bc.ca/ema/2016ema121a.pdf>

120 Ibid

121 *Environmental Management Act*, SBC 2003, c. 53, s. 85. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

122 *Environmental Management Act*, SBC 2003, c. 53, s. 86. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

environmental impact. Once issued, the Lieutenant Governor in Council may restrict, modify or prohibit the operation of the work or undertaking or the use of the product or resource, or require the person to do anything that they require to be done in relation to the work or undertaking or the use of the product or resource either permanently or for a specified period.

If an Environmental Protection Order has been issued regarding a detrimental environmental impact, the Lieutenant Governor in Council may direct the Minister to prepare an Environmental Management Plan for the locality that is, or would be, impacted. The Plan may require that no license, permit or power under an enactment may be issued or exercised in the locality, and that no waste may be discharged in the locality except as authorized by and in accordance with the environmental protection order.

AREA BASED MANAGEMENT PLANS¹²³

Area Based Management Plans are comprehensive plans aimed at addressing an environmental management issues in a specified area. They are ordered by the Minister, who may designate parties responsible for preparation of the Plan. The Order may require the establishment of a technical advisory committee in relation to the development of the Plan, and require the participation of specified licensees, permit holders or other persons the Minister considers will be affected by the plan. Area Based Management Plans require a process for public and stakeholder consultation. Once the Plan is developed, it becomes a policy document. The Minister can require decision makers to consider the Plan, but Plan elements on their own are not enforceable. Compliance with applicable elements of the ABMP can be compelled through other enforceable tools such as permits, or approvals, that decisions makers may implement when they consider the ABMP.

The content of the plans is broadly legislated. Plans may include sections that take into consideration: the impact of point and non-point sources of waste; cumulative impacts; economic and social costs and

benefits of addressing risks to the environment through treatment; environmental management objectives and outcomes for the area; and ongoing monitoring and reporting required to implement the plan. If an ABMP requires statutory decision makers to consider the plan, these decision makers can require that other actors in the designated area meet plan objectives.

***DRINKING WATER PROTECTION ACT*¹²⁴**

Requests for reconsideration of a decision of the *Drinking Water Protection Act* will be referred to health authorities. Requests for review of certain decisions made by a Drinking Water Officer are referred to the office of the Provincial Health Officer.

HAZARD ABATEMENT AND PREVENTION ORDERS (S. 25)¹²⁵

Hazard Abatement and Prevention Orders are issued by Drinking Water Officers where they have reason to believe that a drinking water health hazard exists, or there is a significant risk of an imminent drinking water health hazard. An Order may be directed to a person whose action or omission resulted in or significantly contributed to the drinking water health hazard or risk, or a person who had possession, charge or control of a condition or thing that caused or significantly contributed to the drinking water health hazard or risk. These Orders may be applied with respect to aquifers.

A Hazard Abatement and Prevention Order may require that a person provide information, conduct tests, and report results concerning conditions or things that resulted in or contributed to the drinking water health hazard or risk. They may be required to undertake any other action the Drinking Water Officer considers necessary to assess and determine how to address or prevent the drinking water health hazard. They may subsequently be required to take actions to control, abate, stop, remedy or prevent the drinking water health hazard. They may also have to prepare and implement a hazard remediation plan or hazard prevention plan acceptable to the drinking water

123 *Environmental Management Act*, SBC 2003, c. 53, Division 2. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/03053_00

124 *Drinking Water Protection Act*, SBC 2001, c.9. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

125 *Drinking Water Protection Act*, SBC 2001, c.9, s. 25. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

officer. A person who receives an order may request a reconsideration based on presenting new evidence to the decision maker, or may request a review by the provincial health officer.

CONTRAVENTION ORDER (s. 26)¹²⁶

A Drinking Water Officer may make a contravention Order if they have reason to believe that a person has contravened the DWPA or the regulations. Contravention Orders may require the person to provide information, take or prohibit actions, remedy circumstances arising from the contravention that may cause or contribute to a drinking water health hazard. The order may also require the closure of all or part of a domestic water system until compliance is achieved.

If the person upon whom the Order is served defaults, the Drinking Water Officer may authorize others to complete the actions, and the costs will be ordered against the person in default.

Other Legislation

FARM PRACTICES PROTECTION (RIGHT TO FARM) ACT¹²⁷

The *Farm Practices Protection (Right to Farm) Act* applies to agricultural operations within the Agricultural Land reserve. The *Right to Farm Act* protects agricultural operations who are using “normal farm practices” against legal actions in nuisance brought against them by complainants. It also exempts these agricultural operations from certain municipal bylaws related to nuisance, for example noise concerns. The *Right to Farm Act* does not protect agricultural operations using “normal farm practices” from actions relating to pollution or potential pollution.

ENVIRONMENT AND LAND USE ACT¹²⁸

The *Environment and Land Use Act* (“ELUC”) provides for broad powers to the Lieutenant Governor in Council to make orders they consider necessary or advisable respecting the environment or land use at the recommendation of the Environment and Land Use Committee. The order applies despite any other

Act or regulation. Further, the order may require the exercise of power by other government actors to accord with the order. Consequently, an order issued under the ELUC trumps orders issued under other Acts and regulations, so that the other orders only apply where they are consistent with the ELUC order.

Issuing an order under the ELUC is a political decision, made at the discretion of the Lieutenant Governor in Council. The Environment and Land Use Committee does not have power to implement its recommendations independently.

¹²⁶ *Drinking Water Protection Act*, SBC 2001, c.9, s. 26. Retrieved from: http://www.bclaws.ca/Recon/document/ID/freeside/00_01009_01

¹²⁷ *Farm Practices Protection (Right to Farm) Act*, RSBC 1996, c.131. Retrieved from: http://www.bclaws.ca/civix/document/id/complete/statreg/96131_01

¹²⁸ *Environment and Land Use Act*, RSBC 1996, C. 117. Retrieved from: http://www.bclaws.ca/civix/document/id/lc/statreg/96117_01

APPENDIX C. AGRICULTURAL WASTE MANAGEMENT IN OTHER JURISDICTIONS

This appendix section presents a sampling of other jurisdiction's legislative strategies for agricultural waste management. The strategies presented vary considerably, though the purpose remains the protection of surface and groundwater resources. All listed jurisdictions regulate manure application, planning, and storage, though the mechanisms differ. These practical examples have helped inform our recommendations.

Table 1: Strategies Employed in Other Jurisdictions¹²⁹

NUMERIC CAP ON NITROGEN APPLIED TO FIELDS				
JURISDICTION	LEGISLATION	DESCRIPTION	TRIGGER	ENFORCEMENT
Alberta	<i>Alberta Operation Practices Act</i> , RSA 2000, c A-7 <i>Standards and Administration Regulation</i> , Alta Reg 267/2001 Manure Characteristics and Land Base Code (2006)	A person must have access to sufficient land for the application of manure so that the application limits for nitrogen are not exceeded, or have an approved NMP. Soil nitrogen limits are set according to soil type and range from 80 kg/ha to 270 kg/ha. No manure may be applied if soil exceeds maximum level. Land base requirements are stipulated in guidance materials. Other requirements include setbacks for application, soil testing, and record keeping.	Mandatory for all agricultural operations. Concentrated feeding operations (CFOs) must demonstrate compliance before they receive permits to operate.	
Ontario	<i>Nutrient Management Act, 2002</i> , SO 2002, c 4	None. Application rates are capped by a maximum phosphorus rate for a five-year period. Regulates application setbacks and buffers, limits on winter application, and restrictions on certain methods of manure application.	All regulated agricultural operations (those with greater than 300 livestock units).	
Washington	None			
European Union	'Nitrates Directive' <i>Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources</i>	A maximum of 170 kilograms (kg) nitrogen per hectare per year may be applied on a field. Exceptions may be permitted with proof of a greater ability to absorb nitrogen. Some E.U. jurisdictions restrict based on type of application (liquid or solid), and prohibit during certain times of year.	Mandatory for all agricultural operations.	
United Kingdom	<i>Nitrate Pollution Prevention Regulations 2015</i> Department for Environment Food & Rural Affairs, Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013 to 2016	A maximum of 170 kilograms (kg) nitrogen per hectare per year may be applied averaged over the whole farm. Exceptions are made for grassland applications, up to a maximum of 250 kg/ha per year. Prescribed land management conditions include nutrient application plans, ploughing restrictions, and crop restrictions.	All farms in designated 'nitrate vulnerable zones' as per E.U. Nitrate Directive are required to comply.	Breach of the Regulations is an offence punishable with a fine on summary conviction or on conviction on indictment.

129 Table informed by McDougall, R. (2010). *Jurisdictional scan of agricultural waste management regulations and guidelines*. Prepared for B.C. Ministry of Environment, March 2010, Victoria, BC. Retrieved from: <http://www.ecy.wa.gov/programs/wq/permits/cafo/docs/01182017StatePermit.pdf>

NUTRIENT MANAGEMENT PLAN				
JURISDICTION	LEGISLATION	DESCRIPTION	TRIGGER	ENFORCEMENT
Alberta	<i>Alberta Operation Practices Act</i> , RSA 2000, c A-7 <i>Standards and Administration Regulation</i> , Alta Reg 267/2001	Nutrient management plans are required if the person does not meet the land base requirements and nitrogen limits. NMP contents are stipulated by regulation. Annual record keeping for manure production and amount applied is required.	Required if farm does not meet land base requirements and nitrogen limits.	
Ontario	<i>Nutrient Management Act, 2002</i> , SO 2002, c 4 <i>Ontario Regulation 267/03, s 11 (3), s 13</i>	NMP contents are stipulated by regulation. Must keep record of updates to the NMP. All farms that generate more than five nutrient units must have an approved NMP for any building project (build, expand or renovate) for livestock housing or manure storage facility must have an approved NMPs that generate more than five nutrient units. ¹³⁰	NMPs are required for farms with livestock numbers greater than 300 Nutrient Units (a value dependent upon animal type and size) or located within 100 m of a municipal well, if manure generated is applied on-site.	Regulation of only large operations
Washington	<i>Dairy Nutrient Management Act</i> , RCW, c 90.64.026	All dairy producers in Washington state licensed to produce milk for sale, regardless of size, must prepare a dairy NMP. The NMP must demonstrate that manure handling and storage will not pollute waters, and the application of manure will be a minimal risk to groundwater. NMP contents are not stipulated, but must be prepared by a qualified person, follow federally-approved BMPs, and be approved by state regulatory authority. Annual record keeping is required. The State regulates large non-dairy CAFOs with more than 1000 beef animals or 2500 mature swine. Non-dairy CAFOs permitted through Department of Ecology, and must submit professionally prepared NMP for approval. Federally approved BMPs must form basis of recommendations in the Plan, and once approved, be implemented.	Mandatory for all dairy producers and all large CAFOs. ¹³¹ Smaller non-dairy CAFOs may require NMPs subject to regulator discretion.	Permitting through state agency pending approved NMP. CAFOs submit annual reporting to state.
European Union	'Nitrates Directive' <i>Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources</i>	Action programs for nitrate vulnerable zones that outline measures to reduce nitrate pollution. Annual record keeping is typically required.	Required for all states in the E.U. to develop.	
United Kingdom	<i>Nitrate Pollution Prevention Regulations 2015</i> Department for Environment Food & Rural Affairs, Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013 to 201	The amount of nitrogen that can be applied to specific crops is regulated based upon standard nitrogen values in manure. Records must be kept of the actual application of manure and crop grown, exceptions exist for low-intensity farming operations. Records of manure volume and nitrogen content required. Stricter regulations exist for the application of liquid manure due to its high readily available nitrogen content.	All farms in designated 'nitrate vulnerable zones' as per E.U. Nitrate Directive are required to comply.	Reporting requirements. Breach of the Regulations is an offence punishable with a fine on summary conviction or on conviction on indictment.

130 Ontario Ministry of Agriculture, Food and Rural Affairs. (2016). *Nutrient Management Strategy (NMS)*. Retrieved from: <http://www.omafra.gov.on.ca/english/nm/buildev/nms.htm>

131 Washington State Department of Agriculture. (2017). *Nutrient Management Plans*. Retrieved from: <http://agr.wa.gov/foodanimal/livestock-nutrient/nutrientmgmtplans.aspx>; Washington State Department of Ecology. (n.d.). *Concentrated Animal Feeding Operation General Permit*. Retrieved from: <http://www.ecy.wa.gov/programs/wq/permits/cafo/index.html>; Washington State Department of Ecology. (2006). *Concentrated Animal Feeding Operation (CAFO) National Pollutant Discharge Elimination System (NPDES) And State Waste Discharge General Permit Fact Sheet*. Retrieved from: <http://www.ecy.wa.gov/programs/wq/permits/cafo/docs/06212006CafoFactSheet.pdf>

MANURE STORAGE				
JURISDICTION	LEGISLATION	DESCRIPTION	TRIGGER	ENFORCEMENT
Alberta	<i>Standards and Administration Regulation, Alta Reg 267/2001</i>	Storage capacity, siting and construction standards are in the legislation. Must have either a protective layer or a liner between the facility and any groundwater. Must meet hydraulic conductivity standards. Must prevent collection of water. An open liquid manure storage facility must have a freeboard of not less than 0.5 metres when the facility is full, and must provide a system of secondary containment of the liquid manure if there is a reasonable possibility that liquid manure can be discharged into a common body of water. CFOs required to have nine months manure storage capacity unless able to field-store solid manure prior to application	Applies to operations that meet the definition of concentrated feeding operation. Approvals are required for large CFOs, and registration is required for medium CFOs.	
Ontario	<i>Ontario Regulation 267/03, s 65, 66</i>	Manure storage facilities must meet construction specifications (siting and capacity) that reduce the threat to groundwater for permanent solid and liquid storage facilities. Construction standards for impermeable layers. Large operations must have hydrogeologic investigation for new storage facilities. Storage capacity for 240 days applies to new storage facilities.	Any farm that requires a nutrient management strategy or NMP.	
Washington	US EPA CAFO rule <i>Water Pollution Control Act, RCW, c 90.48</i>	Federal US EPA CAFO rule requires new and expanded manure storage facilities must be designed to hold rainfall and runoff from the 100-year, 24-hour storm event at the site. State permitting requires adequate storage space for the manure. Lagoons and other liquid storage structures built must achieve a permeability of 1×10^{-6} cm/s and there must be a minimum of two feet of vertical separation between the bottom of the lagoon and the water table. Lagoons must be designed by professional engineer. Runoff from solid manure must be collected and stored with other liquid manure and process wastewater. The Permittee must operate and maintain infrastructure used on-site to prevent discharges due to physical failure of the infrastructure.	Required for all large or medium sized CAFOs. Required for all dairy-farms.	Permitting
European Union	'Nitrates Directive' <i>Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources</i>	The capacity of manure storage must exceed that required for storage throughout the longest period during which land application is prohibited, except where it can be demonstrated to the competent authority that any quantity of manure in excess of the actual storage capacity will be disposed of in a manner which will not cause harm to the environment.	All agricultural operations.	
United Kingdom	<i>Nitrate Pollution Prevention Regulations 2015</i>	Storage capacity and siting requirements. Solid manure must be stored in a vessel, in a covered building, on an impermeable surface, or, for manure meeting certain conditions, on a temporary field site. Slurry must be separated into liquid and solid fractions, the liquid drained into a suitable receptacle.	All farms in designated 'nitrate vulnerable zones' as per E.U. Nitrate Directive are required to comply.	Breach of the Regulations is an offence punishable with a fine on summary conviction or on conviction on indictment.

ALTERNATIVE MANURE PROCESSING TECHNOLOGIES				
JURISDICTION	PROGRAM	DESCRIPTION	TRIGGER	ENFORCEMENT
Alberta	On-Farm Stewardship and Confined Feeding Operation Stewardship programs ¹³²	Funding for projects that have a direct and positive impact on water quality, while also improving the management of inorganic agricultural wastes, and that make improvements to minimize risks to water quality, benefitting their business and the environment.	By application.	
Ontario	Conservation Authorities Rural Water Quality program ¹³³	Funding for eligible farm projects for manure storage, nutrient management plans, and milk house waste that protect water quality with respect to their operations. Regulation requires anaerobic digestate to be considered a nutrient source. Regulation sets out standards for operation of anaerobic digesters.	By application.	
Washington	<i>Retail Sales Tax Act</i> , RCW 82.08, at 82.08.890 “Exemptions – Qualifying livestock nutrient management equipment and facilities”	Subsidies for aerators, agitators, augurs, manure composting devices. Anaerobic digesters standard for operation.	By application.	
European Union	LIFE + Programme ¹³⁴	European Union funding for research of technologies, such as the MANEV tool for manure management decision-making.		
United Kingdom	On-Farm Anaerobic Digestion Fund (2013) ¹³⁵	Funding grants were made available for farms to investigate the potential for anaerobic digesters, and loans were provided to build anaerobic digestion plants producing up to 250 kiloWatts of power.	By application.	

132 Alberta Ministry of Agriculture and Forestry. (n.d.). *Growing Forward 2*. Retrieved from: http://www.growingforward.alberta.ca/Programs/index.htm?contentId=ON_FARM_STEWD_PRG&useSecondary=true

133 Grand River Conservation Authority. (n.d.). *Rural Water Quality Program*. Retrieved from: <https://www.grandriver.ca/en/our-watershed/Rural-Water-Quality-Program.aspx>

134 LIFE + MANEV.(2016). *Evaluation of manure management and treatment technology for environmental protection and sustainable livestock farming in Europe*. Retrieved from: http://www.lifemanev.eu/documents/doc_20161109095400576499.pdf

135 The Waste and Resources Action Programme. (n.d.). *On-Farm AD Fund*. Retrieved from: <http://www.wrap.org.uk/node/16778>

APPENDIX D. AGRICULTURAL WASTE CONTROL REGULATION (AWCR) REVIEW SYNOPSIS

This analysis is based on review by University of Victoria’s Environmental Law Centre of the various AWCR policy documents provided by the Provincial Government.¹³⁶ Without the proposed revisions set out in draft regulation, it is difficult to thoroughly comment on the proposed revisions and thus the analysis and commentary that follows may change based on the text of the actual draft regulation.

This Appendix is organized thematically and sets out the main ELC recommendations regarding the general scheme of the AWCR, nutrient management (including nutrient management plans), and manure storage. Each sub-section briefly addresses the current AWCR scheme, the proposed revisions to the scheme, and identified areas that need strengthening.

General Scheme of the AWCR

The current AWCR contains a Code of Agricultural Practice for Waste Management (“the Code”), and states that people who carry out an agricultural operation in accordance with the Code are exempt from sections 6(2) and 6(3) of the *Environmental Management Act*, SBC 2003, c 53 (which prohibits introduction of certain waste into the environment). The Code is primarily reactive and prohibits agricultural operators from carrying out certain activities if they cause pollution. It is not sufficiently specific and does not set precise guidelines for nutrient application, and most provisions apply a “one-size fits all” approach that does not differentiate between agricultural operations (i.e. doesn’t take into account an operation’s proximity to a vulnerable aquifer, etc.)

The proposed government revision creates a risk-based approach. “High risk areas” are subject to more stringent requirements than non-high risk ones. For example, in high risk areas a nitrogen (“N”) test level of 100 kg N/ha triggers a requirement to have a qualified professional (“QP”) prepare a nutrient management plan (NMP)¹³⁷; in non-high risk areas the threshold is 150 kg N/ha. The risk status of an

area is determined via a “High Risk Schedule” that an agricultural operator can consult to see whether they need to follow more stringent requirements. The Schedule will define high risk areas including considerations such as:

- high rainfall (600 mm or more);
- highly vulnerable aquifers and moderately vulnerable aquifers that are drinking water sources;
- sensitive receiving environment, (e.g. due to high phosphorus loading and sensitivity); and,
- identify these areas (i.e. with a list of aquifers and sensitive receiving environments and/or maps).

Another aspect of this proposed risk-based approach, which is less clearly set out in the proposed revisions document, is agricultural operators’ self-assessment of environmental risks related to their agricultural operation and activities (which may be supported by a non-regulatory guidance template.) The proposed revision states that topic specific requirements (i.e. related to storage, land applications, etc) will be set out for managing high-risk conditions or activities—for example, the revision includes a requirement that operators not locate temporary field storage on an area with standing water, as there is “high risk” for leaching and runoff.

Consistency with ELC recommendations:

- AWCR requirements must be set out in law, not policy or non-regulatory guidance; and must be clear and leave little room for misinterpretation or improperly applied discretion.
- Compliance with the regulation must be simple to evaluate.
- The High Risk Schedule would have to be sufficiently explicit and detailed to ensure proper identification of all “high risk” conditions, activities, and areas. If the High Risk Schedule is not comprehensive enough, areas and activities that should be regulated will be missed. This is a pressing concern: if the government uses the

¹³⁶ This Appendix considers proposed government revisions to the Agricultural Waste Control Regulation, BC Reg 131/92 (“AWCR”) set out in the October 7, 2016 document titled “FINAL POLICY underlying proposed revisions to the Agricultural Waste Control Regulation [Confidential Draft]” (“the proposed revisions”), and discusses how the proposed revisions may fall short of the recommendations in the Environmental Law Centre’s May, 2017 Report, “Recommendations for Creating an Optimal Area Based Management Plan for Hullcar Aquifer” (“the ELC Recommendations”).

¹³⁷ Proposed revisions to the Agricultural Waste Control Regulation include replacing Nutrient Management Plans (NMPs) with Nutrient Application Plans (NAPs). While NAP is the terminology used in the proposed revisions, we are assuming that an NAP is the same as a NMP – thus we have used the more common NMP term throughout this section for consistency.

same approach to defining high risk aquifers set out in the current voluntary Environmental Farm Plan program (canvassed in government Hullcar Situation Review documents) many crucial aquifers—including the **Hullcar Aquifer**—will not be designated high risk.¹³⁸ This is why many jurisdictions regulate virtually all dairy farms with Nutrient Management Plan requirements (see below).

Nutrient Management

Under the current Code, waste may only be applied to a field as a fertilizer or soil conditioner (undefined terms). The Code prohibits:

- land application if runoff or the escape of agricultural waste causes pollution of a watercourse or groundwater;
- application on frozen land;
- in diverting winds;
- on areas having standing water;
- on saturated soils; or,
- at rates of application that exceed the amount required for crop growth, if runoff or escape of agricultural waste causes pollution of a watercourse or groundwater, or goes beyond the farm boundary.

Nutrient management plans are not required for any agricultural operations, unless pursuant to a specific Order (i.e. Pollution Abatement or Pollution Prevention Order).

The proposed government revision makes general changes, and introduces a risk-based approach to N and phosphorus (“P”) management (only N is discussed below; P was outside the scope of this work). The general proposed changes are as follows:

- Revision defines fertilizer and soil conditioner, and requires nutrients to be applied based on agronomic rates and crop requirements.
- Agricultural operations must account for all applied nutrient sources when calculating the nutrient application rate, as well as soil residual levels.

- Manure may only be applied to bare fields in the fall if it will be taken up by the crop and will not be at a risk to leach into groundwater, or runoff into watercourses.
- New setback of 15 metres from the top of a watercourse bank or high water mark is required for land applications of manure and other nutrient sources.
- Effective controls need to be in place to minimize the risk of agricultural waste products entering watercourses or going off the property during land application.
- In high-risk areas, applications will be prohibited from November 1 to February 1 in specified regions, and during specified weather conditions.
- For high risk areas not in specified regions, and absent specified weather conditions, applications will only be allowed in October, February and March if nutrients are required and will be available for the crop, and a risk assessment is prepared for the field to indicate low risk for runoff.

The proposed revision also introduces a risk-based approach to N. Farmers must not apply N in a way that exceeds the agronomic nitrogen rate, a defined term. Operators must conduct a Post-Harvest Nitrate Test (PHNT) for outdoor field based crops to determine the amount of N left in the soil after harvest, which also helps evaluate how well the agronomic application rate is being met. The proposed policy is to then use a Risk Matrix with PHNT thresholds and risk of leaching to determine what actions are required at what level. For example, if the PHNT is 150 kg N/ha or more for a certain soil depth, the operator must have a qualified professional prepare a NMP. The NMP must be designed to meet an agronomic N balance of 0 for all fields and minimize loss of N to the environment. Producers required to have NMPs must demonstrate compliance with the plan and reasonable actions to decrease annual PHNT and minimize losses.

In high risk areas that are above a highly vulnerable aquifer or moderately vulnerable aquifer used as a drinking water source, a lower PHNT threshold of

¹³⁸ See page 4 of the British Columbia Ministry of Agriculture – Innovation & Adaptation Services Branch. (2017). *Review of Nutrient Management Planning in British Columbia*. A part of the Hullcar Situation Review. Prepared for POLIS Project on Ecological Governance. This page states that “Livestock Producers and Producers of Intensively-Managed Outdoor Horticultural Crops Located over Moderately or Highly Vulnerable Aquifers that are Used for Drinking Water” are recommended to complete a nutrient management plan. It states that examples of these aquifers within the province include, but are not limited to, the Abbotsford-Sumas, Hopington, Grand Forks, Vedder River Fan aquifers and other aquifers referred to in Schedule 5 of the Municipal Sewage Regulation. The Hullcar Aquifer is not included in this list, nor is it included in the list of aquifers in the *Municipal Sewage Regulation*, BC Reg 129/99.

100 kg N/ha triggers the requirement to have a QP prepare a NMP, which must include an explicit requirement for sampling/laboratory analyses, crop production recommendations and crop yield records, signed off by a QP. This NMP must also meet the zero agronomic N balance requirement described above, and compliance requirements. Records must be kept for all NMPs demonstrating the plan has been implemented. With respect to the PHNT generally, the Director may request or require tests to be taken or records to be kept.

ELC Recommendations

The proposed government revisions state that, with respect to N, NMPs are only required for operations that exceed a certain PHNT threshold (with a lower threshold for high risk areas). Questions arise about only applying NMP requirements to “High Risk Areas” and non-high risk areas that exceed certain PHNT thresholds. **The problem is that this may not regulate all the problematic areas.**

We recommend that government follow Washington State’s approach, and require mandatory NMPs for all dairy farms as well as for other designated agricultural operations.

Washington State has singled out dairy producers and requires them to have NMPs. In Washington State, all dairy producers that are licensed to produce milk for sale, regardless of size, must prepare a dairy NMP—and they are the only type of operation required to have a mandatory NMP.¹³⁹ This makes it clear that Washington believes dairy farms pose enough risk to water that they require additional regulation.

In addition, as of March 3, 2017, Washington

also requires all permitted Concentrated Animal Feeding Operations (CAFOs) to have a Manure Pollution Prevention Plan (MPPP).¹⁴⁰ The MPPP must describe how the permittee is meeting certain permit requirements that are similar to a nutrient management plan (for example, a requirement to have all sources of manure, litter, process wastewater, and other organic by-products sampled and analyzed for nutrient content prior to beginning land application, and a requirement to only apply nutrients in accordance with a yearly field nutrient budget, and at appropriate rates and times to comply with permit conditions.)¹⁴¹

An alternate option (which government could pursue if they do not want to specifically single out dairy farms) is to recommend that mandatory NMPs be required for dairy farms of a significant size (nine cows in Denmark,¹⁴² 300 in Ontario¹⁴³) as well as other agricultural operations of a certain size.

For example, Ontario requires farms to have an NMP when livestock numbers are equal to or greater than 300 “nutrient units” (for reference, three hundred nutrient units = 300 small-framed cows), or when a phased-in farm unit is located within 100 metres of a municipal well.¹⁴⁴ Table 1 in the Nutrient Management Tables for Ontario Regulation 267/03 lists various types of animals, and the number of each it takes to constitute one nutrient unit, including cows for beef and dairy, pigs, chickens, goats, horses, sheep, etc.¹⁴⁵ Given that some of the Ontario numbers seem high (i.e. 300 cows, whereas Denmark requires NMPs for nine cows or more), the B.C. government would want to independently determine the appropriate nutrient unit thresholds for each type of animal, as opposed to simply adopting the Ontario approach.

139 Washington State Department of Agriculture. (2017). *Nutrient Management Plans*. Retrieved from: <https://agr.wa.gov/FoodAnimal/Livestock-Nutrient/NutrientMgmtPlans.aspx>

140 ‘Permitted CAFOs’ are large CAFOs and certain designated small CAFOs, both dairy and non-dairy. Washington State Department of Agriculture. (2017). *Nutrient Management Plans*. Retrieved from: <https://agr.wa.gov/FoodAnimal/Livestock-Nutrient/NutrientMgmtPlans.aspx>

141 See Washington State Department of Ecology. (2017). *Concentrated Animal Feeding Operation: National Pollutant Discharge Elimination System and State Waste Discharge General Permit*. Retrieved from: <http://www.ecy.wa.gov/programs/wq/permits/cafo/docs/01182017CombinedPermit.pdf>; Washington State Department of Ecology. (2017). *Concentrated Animal Feeding Operation: State Waste Discharge General Permit*. Retrieved from: <http://www.ecy.wa.gov/programs/wq/permits/cafo/docs/01182017StatePermit.pdf>

142 British Columbia Ministry of Agriculture – Innovation and Adaptation Services Branch. (2017). *Jurisdictional Scan of Nutrient Management Regulations – A part of the Hullcar Situation Review*, p 12-13.

143 University of Victoria, Environmental Law Centre. (May 2017). *Recommendations for Creating an Optimal Area Based Management Plan for the Hullcar Aquifer*. Retrieved from: <http://www.elc.uvic.ca/wordpress/wp-content/uploads/2017/05/2015-03-05-FINAL-HULLCAR-REPORT-2017May17.pdf>

144 Ontario Ministry of Agriculture, Food and Rural Affairs. (2015). *Understanding When Farms Require a NMS, NMP or NASM Plan*. Retrieved from: <http://www.omafr.gov.on.ca/english/engineer/facts/10-035.htm#4>

145 Ontario Ministry of Agriculture, Food and Rural Affairs. (2012). *2012 Nutrient Management Tables for Ontario Regulation 267/03 Made under the Nutrient Management Act, 2002 – Table 1 Nutrient Unit Livestock Information*. Retrieved from: <http://www.omafr.gov.on.ca/english/nm/regs/nmpro/nmstab01-12.htm>

In addition, NMPs must:

- a) Be objective and not subject to Professional Reliance bias. The Province should certify planners who draft nutrient management plans (or Nutrient Application Plans under an updated AWCR)—and monitor implementation by conducting inspections (at minimum one random inspection per year, or more often if deemed necessary due to the perceived amount of environmental risk).¹⁴⁶
- b) Meet Beneficial Management Practices standards set out by Government, as required in Washington State.¹⁴⁷
- c) Require each farm to create an Annual Report on NMP compliance, including regular monitoring data (as California does in the Central Valley region).¹⁴⁸

The proposed government revisions to the AWCR include a high-risk area prohibition on applications during winter, which is subject to ongoing evaluation of weather conditions in real time. Identified beneficial practice strongly discourages all winter applications.¹⁴⁹

Manure Storage

Permanent Manure Storage Facilities

The current Code requires manure storage facilities to be set back 30 metres from water sources used for domestic purposes, and 15 metres from watercourses. These facilities must be maintained in a manner to prevent the escape of agricultural waste that causes pollution, and in a manner to prevent pollution. Storage facilities must have sufficient capacity to store waste until it can be used as a fertilizer or soil conditioner, or removed. To be stored on the farm, agricultural waste must be produced or used on the farm.

The proposed government revision does not change current setbacks; however, it adds a 4.5 metres setback from the property line for new or expanding facilities. Liquid manure must be stored in a permanent storage structure. Waste may be stored off-site, or distributed to another agricultural

operation. Effluent, leachate, and contaminated runoff from storage must be prevented from entering watercourses, leaching into groundwater, or going off the property—although notably, the explanatory note states that the intention is not ‘zero tolerance’ and there needs to be visible runoff, signs of leachate, or contaminated runoff. Permanent storage structures must not leak or overflow. New or expanding (greater than 10% capacity) earthen liquid manure structures must be designed by a QP. Corrective actions must be taken for leaking or overflowing storage facilities prior to resuming use. For high-risk areas where there is a vulnerable aquifer, new or expanding permanent liquid manure storage structures must be designed by a QP, and must have an appropriate protective base layer and minimum vertical distance to the seasonal high water table. In high-risk areas, monitoring wells may be required for new earthen storage structures for leak detection, “if there is a concern.”

Field storage of agricultural waste

Under the current Code, agricultural waste may be stored on a field for two weeks or less if it is used within two weeks and is stored in a manner that prevents the escape of waste causing pollution; there is no required set back distance from domestic or other water sources. Waste can be stored for more than two weeks if it is stored no longer than nine months, and is sited at least 30 metres from any watercourse or source of water used for domestic purposes. In both scenarios, waste must be stored in a manner that prevents the escape of agricultural waste causing pollution. Berms or other works are required if necessary to prevent escape of waste that causes pollution. In areas of the province that receive greater than 600 mm of rain from October to April, field stored solid agricultural waste must be covered from October 1 to April 1.

The proposed government revision includes a requirement for rotating the location of the field storage area from year to year, and reducing the maximum storage time to seven months. The proposal also prohibits placement of field storage on standing water, saturated soils, or areas prone to flooding.

¹⁴⁶ University of Guelph Business Development Centre. (n.d.). *Nutrient Management Consultants*. Retrieved from: <https://www.nutrientmanagement.ca/directories/nutrient-management-consultants/>

¹⁴⁷ See the beneficial management practices proposed in Appendices C and D and footnote 37 of the ELC report.

¹⁴⁸ British Columbia Ministry of Agriculture – Innovation and Adaptation Services Branch. (2017). *Jurisdictional Scan of Nutrient Management Regulations – A part of the Hullcar Situation Review*, at p 11-12.

¹⁴⁹ University of Victoria, Environmental Law Centre. (May 2017). *Recommendations for Creating an Optimal Area Based Management Plan for the Hullcar Aquifer*. Retrieved from: <http://www.elc.uvic.ca/wordpress/wp-content/uploads/2017/05/2015-03-05-FINAL-HULLCAR-REPORT-2017May17.pdf>

Leachate from temporary field storage must be collected and contained. A new setback of 4.5 metres from the property line is proposed. In high-risk areas, temporary field storage must be covered in areas with high annual rainfall (600 mm or more) during the rainy season, during high/intense rainfall if required to prevent leachate/contaminated runoff from going beyond the property line or into a watercourse, and during strong, diverting winds if required to prevent transport of particular or solid matter beyond the property line or into a watercourse. The proposed revision states that non-regulatory guidance will be provided to help assist operators in determining high risk conditions, including suggestions such as “checking the weather forecast, venting index, wind speed... and site-specific conditions, such as degree of slope of field towards a watercourse...”. Over highly vulnerable aquifers, or moderately vulnerable aquifers that are sources of drinking water, temporary field storage must be on a protective base layer.

ELC Recommendations

The proposed revisions for permanent and field manure storage both fall short of ELC recommendations. **To prevent pollution of groundwater and contain manure for the period that it cannot be land-applied with low environmental risk, and make it easier to verify if pollution is**

occurring, all permanent manure storage should be required to have a liner to prevent leaching beneath the facility. To reduce risks further require a cover to prevent storage facilities from filling with precipitation (which can lead to runoff), and overflow protection.

This matters: research has shown that all unlined manure lagoons end up discharging to either groundwater or hydrologically connected surface water.¹⁵⁰ Alberta requires liners for CAFO manure storage facilities and collection areas; Washington State expert Dr. Byron Shaw states that CAFO waste storage impoundments require an impervious liner with a true leak detection system.¹⁵¹

Temporary field storage requires effective regulation as well. Notably, B.C. has already contemplated installing impermeable liners under field storage of manure to manage nitrates in the Draft Order for the Hullcar Valley Area Based Management Plan.¹⁵²

All the above mentioned requirements should apply to new and existing facilities.

150 University of Victoria, Environmental Law Centre. (May 2017). Recommendations for Creating an Optimal Area Based Management Plan for the Hullcar Aquifer. Retrieved from: <http://www.elc.uvic.ca/wordpress/wp-content/uploads/2017/05/2015-03-05-FINAL-HULLCAR-REPORT-2017May17.pdf>

151 Ibid

152 Ibid

APPENDIX E. DEPLOYING INNOVATIVE TECHNOLOGY TO ADDRESS WASTE (POLLUTION)

A number of commercially available and in research¹⁵³ phase technologies exist for dewatering manure and creating valuable bi-product (including dried pellets), converting agriculture waste into energy, and nutrient recovery technologies that offer additional revenue generating opportunities for farms (i.e. selling fertilizers).

Deployment of innovative technologies will likely need to be supported by and encouraged through relevant environmental and energy policies. These technologies can compliment a shift in regulations that impact changes on the landscape, and provide an opportunity to turn agricultural waste into useful and commercially viable bi-products.

Waste-to-Energy Technology Options

- **Anaerobic digestion (AD):** Anaerobic digestion is a means of generating biogas from various feed-stocks. Dairy operations are particularly well suited for AD systems. The methane produced in anaerobic digestion can be used to provide renewable energy through combustion for electricity generation, or as a raw material for the production of biomethane used as a transportation fuel. Leftover material, known as digestate, is rich in nutrients and suitable as a fertilizer. Significant potential exists across B.C. for deploying anaerobic digestion systems, especially in areas with dairy operations (i.e. Fraser Valley), with appropriate support to ensure plants are financially viable.¹⁵⁴ Anaerobic digestion provides an opportunity to generate energy for the farm, diversify farm income, and increase rural investment. For more information, see: Summary of Nutrient Management Technology Options in the Context of Hullcar (September 2017, B.C. Ministry of Agriculture).

- **FortisBC's Renewable Natural Gas Program** buys methane produced by approved agricultural operators with anaerobic digestion systems.
- **CH-Four Biogas** has a number of in-use systems across North America that could provide a framework for application in Hullcar Valley (including a biogas system currently in operation in Delta, B.C.)

Waste Processing (including dewatering liquid manure): involves separation of liquid and solid manure using gravity or mechanical system. The result from separation processes includes converting manure to commercially valuable fertilizer (i.e. struvite) or using bi-product (known as digestate) as bedding or fertilizer. Dewatering liquid manure technology includes:¹⁵⁵

- **Centrifuges:** unit that spins at high speed to separate materials of different densities, such as fine solids and liquids, and typically remove 70-85% of solids in fresh manure waste (i.e. flushed dairy or swine manure). Used in conjunction with a dewaterer and roller press to remove fibrous solids. Exists in mobile or stationary units. Widely adopted in the U.S. and E.U.
- **Drying and pelletizing:** stationary technology that evaporates liquids using belt dryer. Currently applicable to liquid dairy manure. Widely adopted in the E.U.
- **Membranes:** act as filters to separate liquids and solids, with application mostly to liquid dairy manure. Ultrafiltration is a membrane technology using pressure or concentrated gradients to separate solids and liquids through a membrane. See Livestock Water Recycling (below) for example of this technology in operation. Primarily designed for large-scale farms.

153 Although outside the scope of our Solutions Framework review, this section is a summary of findings from the review, and provides a highlight of available technologies. The information in this section is meant to compliment reports provided by the Ministry of Agriculture, developed as part of the Hullcar review. For more information see: B.C. Ministry of Agriculture. (2015). *Waste Management Factsheet: An overview of on-farm biogas production*. Retrieved from: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/waste-management/manure-management/382600-1_an_overview_of_onfarm_biogas_production.pdf; B.C. Ministry of Agriculture. (September 2017). *Summary of Nutrient Management Technology Options in the Context of Hullcar*, CH-Four Biogas Inc. (n.d.). *British Columbia On-Farm Anaerobic Digestion Benchmark Study*. Retrieved from: https://www.bcac.bc.ca/sites/bcac.localhost/files/AD%20Benchmarking%20Study_0.pdf; Electrigaz Technologies Inc. (December 2007). *Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia*. Retrieved from: <http://www.catalystpower.ca/pdf/fv.pdf>

154 Electrigaz Technologies Inc. (December 2007). *Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia*. Retrieved from: <http://www.catalystpower.ca/pdf/fv.pdf>

155 For more information on these technologies, see Ministry of Agriculture (September 2017). *Summary of Nutrient Management Technology Options in the Context of Hullcar*.

- **Microwave technology:** solids are reduced (reducing disposal costs), nutrients recovered, and methane produced (energy). This technology requires small anaerobic digester, struvite crystallizer (phosphate recovery system), liquid/solid separator, and heat exchangers.¹⁵⁶
- **Flocculation:** chemical process that binds small solids in manure, allowing for easier connection and separation, before being dewatered using mechanical processes. Suitable for liquid dairy manure.

A number of companies offer ready to use manure management (including dewatering) technologies applicable to agricultural operations in the Hullcar Valley. A few examples include:

- **Livestock Water Recycling (B.C., Canada):** removes manure contaminants and isolates fertilizer nutrients from liquids using membrane technology. Solids are removed during the process, and output is clean water for livestock operations or use around barn. Process extracts up to 75% of water from manure, with remaining output is 17% liquid nutrients (stable ammonium and potassium), and 8% solids (rich in phosphorus and organic nitrogen). Not mobile. In operation across U.S.
- **Boost Environmental Systems (B.C., Canada):** uses microwave heat and hydrogen peroxide to reduce volume and composition of manure. Waste is fed into anaerobic digester to produce energy, and liquid is used as commercially valuable fertilizer called struvite. Used at UBC Dairy Education Centre (Agassiz, B.C.). Microwave system is modular and scalable to different sized farms.
- **Multiform Harvest (WA, U.S.):** system recovers phosphorus for reuse in production of fertilizers, reduced biosolids production, ideal for operations that use biological phosphorus removal and anaerobic sludge digestion.
- **Dorset Green Machines (Aalten, NL):** conveyor belt

drying system, with objective of converting wastes into valuable by products, including dried pellets.

- **Trident Processes (B.C., Canada):** nutrient recovery system, capable of integration with anaerobic digester technology. Separates manure solids and liquid effluent, including screw press technology to dewater coarse fiber, and coagulation of fine solids in effluent. Based on modular design and fully scalable, in use at two farms in North America, including Seabreeze Farms (Delta, B.C.).

Scraper vs Flush Systems

Scraper manure removal systems use a mechanical device to scrape the manure from barn floors. These systems can be automated or require human labour (i.e. scraping with a tractor or skid steer). A variety of scraper systems are commercially available (i.e. cable or chain). Flush systems use water to handle manure, and result in increased amounts of liquid manure.¹⁵⁷ When deciding on the system, it is critical to understand the water holding capacity of the soil of the fields where the manure will be applied, as well as animal housing and bedding type.

Groundwater Remediation

Oxford County, in southern Ontario, offers an interesting case study where an unconfined aquifer with elevated levels of nitrates was remediated over a two-month period, by injecting a soluble carbon amendment into the aquifer to supply the microbial degradation of nitrate in the groundwater. A network of groundwater monitoring wells was installed throughout the remediation area to track nitrate concentrations in aquifer flow system.¹⁵⁸ This remediation approach was used while BMPs were implemented on land use activities. Such technologies could avoid the need to construct water treatment facilities while BMPs are sufficient enough to reduce nitrate concentrations in groundwater.

156 Lo, Victor. (n.d.). *Technologies for Organic Slurries Management and Nutrient Recovery*. Department of Civil Engineering, University of British Columbia. Retrieved from: http://www.ryerson.ca/content/dam/science/water/Victor-Lo_Ryerson.pdf

157 It is beyond the scope of this review to detail manure handling systems. For more information, please see: Ontario Ministry of Agriculture, Food and Rural Affairs. (January 4 2016). *Sand-Laden Manure Handling and Storage*. Retrieved from: <http://www.omafra.gov.on.ca/english/engineer/facts/10-007.htm>; and British Columbia Ministry of Agriculture. (October 2017). *Summary of Manure Handling Systems in the Context of Hullcar*.

158 Rudolph, D. (2015). *Towards Sustainable Groundwater Management in the Agricultural Landscape*. Canadian Water Network. Retrieved from: <http://www.cwn-rce.ca/assets/End-User-Reports/Agri-Food/Rudolph/CWN-EN-Rudolph-2015-5Pager-Web.pdf>

