

REPORT

Alberta Water Council Source Protection Project Team

Source Water Protection Approaches & Risk Management Models in Selected Jurisdictions



March 2019

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We also thank the interviewees for their time and insight that made this project possible. The interviewees were:

- John Duggan – Source Water Protection Group Leader, Colorado Department of Health and Environment, Colorado, USA,
- David Fishwick – Drinking Water Manager, Ministry of Health, British Columbia,
- Heather Thompson – Water Quality Resource Specialist, Ministry of Environment and Climate Change Strategy, British Columbia, and
- Clairly Lance – Source Protection Team Leader, Water Corporation, Western Australia.

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List of Abbreviations

AB	Alberta
AWC	Alberta Water Council
BC	British Columbia
CA	California
CO	Colorado
DWSP	Drinking Water Safety Plans
FNHA	First Nations Health Authority
IWMP	Integrated Watershed Management Plans
NS	Nova Scotia
ON	Ontario
RPZ	Reservoir Protection Zone
SWAP	Source Water Assessment and Protection
SWP	Source Water Protection
SWPP	Source Water Protection Plan
WPAC	Watershed Planning and Advisory Councils
US	United States of America

1 Introduction

The “Protecting Sources of Drinking Water in Alberta” project team (AWC project team) was formed by the Alberta Water Council (AWC) in May 2018 in response to a statement of opportunity brought forward by the Government of Alberta and its ranking as priority by the AWC in 2017. The goal of the team is to document existing source water protection (SWP) approaches and provide guidance for protecting public, private and individual drinking water sources in Alberta. The SWP project team’s work includes reviewing examples of SWP practices, processes, risks and source-water related regulatory and other initiatives in Alberta, reviewing jurisdictions outside the province, identifying key lessons from the collected information, and developing a guidance document.

The AWC project team retained Associated Environmental (“Associated”) to review SWP approaches and risk management models for drinking water sources in selected jurisdictions outside of Alberta. The goal of this study was to document and learn from existing approaches implemented elsewhere to ensure that the guidance document developed by the SWP project team draws from a wide array of technical expertise and practical experience. This report presents the rationale to select jurisdictions, the approach to gather information, and a summary of the researched information.

2 Methodology

The study involved the following steps:

1. The key areas of interest were established and translated into a questionnaire to be used in interviews (Section 2.1).
2. Jurisdictions of interest were selected based on a limited set of criteria (Section 2.2).
3. Key contacts were researched for the selected jurisdictions and interviewed using the questionnaire, with supplementary literature searches to fill information gaps (Section 2.3).

A preliminary summary of the collected information was presented to the SWP project team in a review meeting and feedback received at that meeting was used, together with results of the research, to prepare this report.

2.1 DEVELOPMENT OF QUESTIONNAIRE

A preliminary questionnaire was developed by the AWC project team and provided along with the Request for Expression of Interest in the preparatory stage of this project. After the project start, an expert workshop was convened with the goals to:

- 1) Discuss general status of SWP in Alberta at a high level and identify major drivers, issues and knowledge gaps,
- 2) Assess if the preliminary questions are sufficient to review source water models and approaches elsewhere, and
- 3) If gaps are identified, develop additional questions that would be pertinent for the review.

The workshop was attended by Associated's senior water engineers with experience developing municipal Drinking Water Safety Plans (DWSPs), senior environmental scientists with experience in source water protection plans (SWPPs), and key SWP project team members. Discussion points were used to amend the preliminary questionnaire. A final questionnaire was subsequently developed in collaboration of the consultant team and SWP project team (Appendix A).

2.2 SELECTION OF JURISDICTIONS

A preliminary list of potential jurisdictions for the review was provided by the SWP project team, but a short list was needed to accommodate limited project resources. Important criteria for the selection of jurisdictions for this study included:

- Similar geography to Alberta (land-locked areas, water scarcity, mountains, large rural areas),
- Similar stakeholders (small municipalities, Indigenous communities), and
- Existence of a Source Water Protection Planning system to provide learning opportunities.

The four jurisdictions selected for review were Australia, British Columbia (BC), California, and Colorado. All four jurisdictions have experienced issues with serious and widespread wildfires and all have Indigenous communities.

Australia is a large country like Canada and has some similar geographic regions to Alberta including mountains and a large and diverse agricultural land base, and it periodically experiences water scarcity. The landscapes of Colorado and California also include a mixture of urban areas, agriculture and mountainous terrain, and were identified as having detailed SWP guidance documents in place. BC was selected because the constitutional framework for water management is the same as Alberta and experiences similar challenges with respect to water supply, especially for small communities. Ontario and Nova Scotia had previously been reviewed by the AWC; therefore, information collected from that review was incorporated in this report where possible. Israel and Germany were not selected as their governmental structures were deemed too different from those of Alberta to be relevant to SWP.

2.3 DATA COLLECTION

Key contacts involved in source water protection efforts in each of the selected jurisdictions were identified through web searches and from Associated’s staff professional and personal network. The contacts that were interviewed are listed in Table 2-1. These contacts were interviewed by telephone and additional information was either provided directly by the interviewees or obtained through web searches. A list of some key resources consulted is provided in Table 2-2.

Table 2-1
Key Contacts Interviewed and their Affiliation

Jurisdiction	Contact Name	Title, Affiliation
Australia	Clairly Lance	Source Protection Team Leader, Water Corporation, Western Australia
British Columbia	David Fishwick	Drinking Water Manager, Ministry of Health, British Columbia
	Heather Thompson	Water Quality Resource Specialist, Ministry of Environment and Climate Change Strategy, British Columbia
Colorado	John Duggan	Source Water Protection Group Leader, Colorado Department of Health and Environment

*No interview could be arranged with people in California (likely due to the wildfires that were occurring at the time).

Table 2-2
Key Literature Sources Consulted for Review

Jurisdiction	Literature
Australia	Water Corporation. 2018. Source Protection Operations Manual. The State of Victoria Department of Environment, Land, Water, and Planning. 2016. Water for Victoria.
British Columbia	Ministry of Healthy Living and Sport. 2010. Comprehensive Drinking Water Source-to-Tap Assessment.

Jurisdiction	Literature
California	<p>Shilling, F., S. Sommarstrom, R. Kattelman, B. Washburn, J. Florsheim, and R. Henly. 2004. California Watershed Assessment Guide. Prepared for the California Resources Agency.</p> <p>California Department of Health Services, Division of Drinking Water and Environmental Management. 2002. Small Water Systems – Assessment for New Sources.</p> <p>Division of Drinking Water and Environmental Management. 1999. Drinking Water Source Assessment and Protection (DSWAP) Program.</p>
Colorado	<p>Colorado Department of Public Health and Environment. 2019. Source Water Protection and Assessment (SWAP).</p>

3 Results

The results of the study are organized in this section by major discussion topics. A complete record of results is provided in Appendix B.

3.1 VISION, GOALS, AND DRIVERS OF SOURCE WATER PROTECTION PLANNING

The overarching goal of all jurisdictions reviewed is to protect drinking water at the source. All jurisdictions recognize that a multibarrier approach is necessary for success.

The creation of SWPPs in the reviewed jurisdictions is driven by legislation, treatment costs, environmental or land drivers, peer pressure, construction of new water treatment plants, and/or incidents. A common driver of SWP is

A common driver of SWP is the desire to decrease the costs associated with water treatment.

the desire to decrease the costs associated with water treatment, because SWP can help improve water quality entering the water treatment facilities. One of the primary goals for Australian water utilities, for example, is keeping treatment costs low by avoiding significant water treatment plant upgrades while meeting the Australian Drinking Water Quality Guidelines. Though not required by law, SWP is viewed as a critical step in accomplishing these goals.

Legislation differs within Canada, the United States of America (US), and Australia. The federal *Safe Drinking Water Act* of 1996 in the US required that all States complete source water assessments by 2002 for all public water systems. The process includes identification of sources, delineation of surface water areas, identification of potential sources of pollutants, determination of susceptibility to contamination and dissemination of the results to the public. States are not required to create SWPPs or to implement

protection, but the source water assessments often serve as a useful tool that encourages local stakeholders to develop and implement voluntary programs for water protection.

In BC, the *Drinking Water Protection Act* allows a drinking water officer to require the completion of a comprehensive Drinking Water Source-to-Tap Assessment if an incident occurs; however, this has not yet been uniformly enforced to date. SWPPs have been required in situations where water suppliers could not immediately afford required treatment upgrades (e.g. filtration), and the SWPP was mandated as a condition of the authorization to defer the upgrade for a specified period. SWPPs have also been developed by First Nations communities in BC in parallel with upgrades to the water supply and treatment system. The First Nations Health Authority's (FNHA) Drinking Water Safety Program includes provisions for source protection. In BC, FNHA assumed the programs, services, and responsibilities formerly handled by Health Canada in 2013, including drinking water protection.

In Ontario, the Walkerton incident in 2000, where a municipal drinking water system contamination with *E. coli* caused seven fatalities and more than 2,300 illnesses, triggered the development of the *Clean Water Act 2006*. This Act is intended to protect public health, and one of the changes associated with the Act is to require the development and implementation of SWPPs across the province.

Peer pressure from citizens in communities that participate in SWPPs is a driver in some communities in Colorado and California, where an effective system has led to widespread SWPPs across these States (see Section 3.6.3). Sometimes citizens hear about other communities participating in SWPP and want their community to participate and other times citizens encourage their neighbouring communities to participate in SWPP. Record droughts in Australia resulted in the recognition of the importance of SWPPs across the country; however, SWPP are not required in Australia but viewed as a Best Practice. Environmental drivers of SWP in Colorado include algal blooms, wildfires, and oil and gas drilling near drinking water sources. Water treatment costs are the main economic driver.

In one case historical agricultural practices on fields overlaying the Hullcar Aquifer in BC resulted in elevated nitrate levels near or above the Canadian Drinking Water Quality Guideline in the aquifer. Agricultural rules were in place limiting the amount of fertilizer allowed and these were followed, but the rules were not protective in this case because of a highly susceptible, unconfined aquifer. This incident raised awareness about differing vulnerability of aquifers depending on the soil types that separate them from the surface.

3.2 WHO IS INVOLVED?

The organization that supplies drinking water to a community or communities is usually leading SWPP efforts. The type of organization and how it works with other stakeholders differed among jurisdictions and some examples are discussed below.

In Australia, the state water utility develops a SWPP and develops procedures to implement the plan. The Province of Ontario initially leads SWPPs then individual municipalities continue when renewals occur. In

BC, Nova Scotia, Colorado, and California, the municipalities are responsible for creating SWPPs, which are discretionary.

3.3 COLLABORATION

All jurisdictions acknowledge that collaboration of all stakeholders is ideal for SWPP development but note that effective collaboration is an area of potential improvement. Collaboration varies greatly across Canada.

All reviewed jurisdictions acknowledged that collaboration of all stakeholders is ideal; however, collaboration was noted as an area of potential improvement.

In Ontario, Source Protection Committees and the make up and size of their membership are legislated under the *Clean Water Act*. These committees consist of an equal share of stakeholders; one third from municipalities; one third representatives from the agricultural, commercial and industrial sectors, including small businesses; and one third from the general public from across the source protection region. These committees led the development of SWPPs, with shared responsibility between municipalities and Conservation Authorities¹ for the development of technical assessment reports that included the delineation of sensitive areas and threats analysis. Funding and detailed technical guidance were provided by the Ontario Ministry of Environment and Climate Change. The Source Protection Committees continue to support the implementation of SWPP policies through their connection to municipalities, provincial ministries, and source protection authorities (i.e., Conservation Authorities). Municipalities are responsible for providing updated delineation of sensitive zones and threats assessments for new or relocated intakes and the Conservation Authority incorporates this information in an assessment report update.

¹ Conservation Authorities (CA) in Ontario are local watershed management agencies. CA are mandated to ensure conservation, restoration and responsible management of Ontario's water, land and habitats.

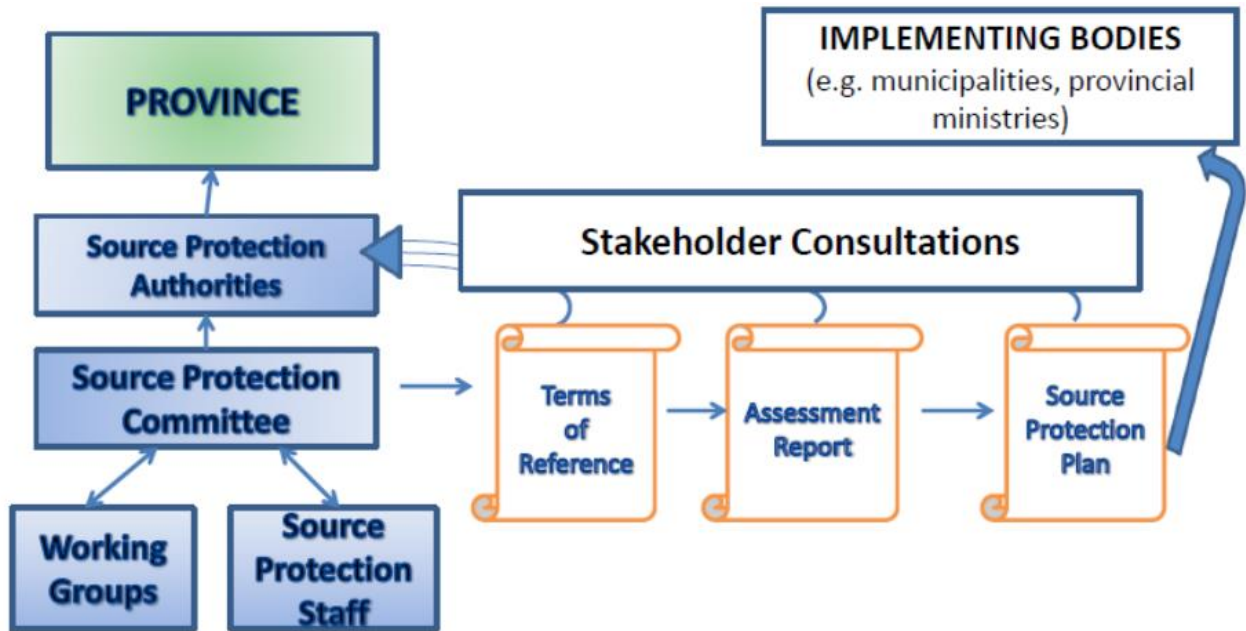


Figure 3-1
Roles and Responsibilities in Ontario's Source Protection Planning

Note: From CTC Source Protection Plan (CTC Source Protection Region 2015)

In Nova Scotia, collaboration among municipalities in case of an emergency is agreed upon in the form of a Memorandum of Understanding.

In BC, Drinking Water Officers (who are Environmental Health Officers with responsibility for water supplies) have the power to recommend that local governments collaborate if they were to request a drinking water assessment; however, in practice, collaborations are not very common or not well known by those in the Ministry of Environment and the Ministry of Health. Associated assisted with SWP planning that served Armstrong and Spallumcheen and both communities were represented on the technical advisory committee. SWP planning could be undertaken voluntarily by water suppliers interested in better understanding the risks to drinking water safety. The comprehensive assessment document (BC Ministry of Healthy Living and Sports, 2010) explicitly states that it is not appropriate to formally involve non-governmental stakeholders in the assessment process; instead a team of technical professionals, drinking water officers, and/or water suppliers are the intended audience of the document. Based on Associated's experience, forest companies, and government agencies such as parks and range management are part of the committee. The document recommends that upon completion of the assessment, the community be involved to seek input on the findings and the SWPP.

In Colorado, the State provides a list of stakeholders to municipalities. All stakeholders are invited to meetings and can chose their level of participation (i.e. ranging from information only to personal

participation in all meetings). State agencies send representatives to participate in SWP planning meetings. Collaboration among municipalities in Colorado is common partly because the pooling of grant money is recognized as a more efficient use of resources and partly because some communities share stakeholders and potential sources of contamination. The Lower Colorado River Group is a group of communities located in a region with oil and gas development that formed to address their similar interests and concerns.

In Western Australia, state-wide water utilities have collaborated with the federal government to develop the Australian Drinking Water Quality Guidelines. The Department of Water works with the water utility to enforce drinking water protection.

3.3.1 Collaboration with Indigenous Communities

Victoria State in Australia specifically funds the involvement of indigenous people in source water protection planning. There are representatives from indigenous groups who help provide context and traditional knowledge to the SWP planning team.

In BC, engagement with First Nations communities has been included in local government SWPP in cases where the water supply is shared or where the Indigenous Nation has an interest in water and fisheries resources in their territories. Although there is no formal requirement to engage First Nations in the Source-to-Tap process, it is now standard practice to engage with First Nations if the water source includes Crown land. Similarly, First Nations completing SWPPs on reserve land have engaged with stakeholders that operate within the source area (e.g. Osoyoos Indian Band).

3.4 ASSESSMENT

Assessing the risks to drinking water quality at the source is a key component and requisite to developing Source Protection Plans. Although the overall technical approach used for this assessment is similar across jurisdictions, there is no common name for it. For example, in Ontario, the resulting documents are called simply assessment reports, Calgary called this study a “Source Watershed Assessment”; other names used are “vulnerability ranking (California) and “Drinking Water Source Protection Assessment” (Australia).

Approaches and tools that facilitate the completion of this assessment in the reviewed jurisdictions were reviewed and are presented below.

3.4.1 Assessment Approaches

Assessment approaches generally involve assessing source water quality and the land near the source water, identifying if there are potential sources of contamination nearby, and ranking the risk of each potential contaminant in reaching the drinking water intake and causing water quality issues. Assessment guidance often depends on population size (Table 3-1).

In BC, a Comprehensive Drinking Water Source-to-Tap Assessment guidance document (BC Ministry of Healthy Living and Sports, 2010, Table 2-2) is available for use by larger water suppliers (e.g. municipalities), and a 'simple screening tool' (approximately 100 questions) is available for smaller water suppliers and communities (population <500). The simple screening tool document² recommends contacting the local Health Authority for assistance if necessary.

Table 3-1
Source Water Protection Planning Guidance Documents According to Community Size

Jurisdiction	Community Size Divisions
Australia	State water corporations lead SWP; all communities are included in SWPP
BC	Communities of <500 people are directed to use the simple screening tool; all others should use the Comprehensive Source-to-Tap Assessment guidance document
California	Systems with over 200 connections, 3 or more sources, and adequate Information Technology capabilities can use the TurboSWAP program; those that don't meet the criteria and have populations of <10,000 can request help from the California Rural Water Association
Colorado	Typically communities of <10,000 access assistance from the Colorado Rural Water Association
Ontario	Technical Rules apply to all municipalities, regardless of size. Assessment reports and Source Protection Plans are completed on a watershed or regional scale.

In California, the options for source water assessments are similar to BC's in that there are different options depending on the size of the community. The TurboSWAP tool, which calculates groundwater protection zones and vulnerability rankings, is recommended for larger communities. Smaller communities are directed to fill out groundwater or surface water forms applicable to the water source in the area and then submit them to the State who will then provide the necessary information (e.g., inventory of potential contaminants).

In Ontario, Source Water Protection Planning entails the scoring of the vulnerability of an intake or well using several prescribed vulnerability factors, the delineation of sensitive areas for the protection of water quality and quantity in groundwater (e.g., wellhead protection areas, vulnerable aquifers, and significant groundwater recharge areas) by means of groundwater modeling or the delineation of intake protection zones using surface water modelling. Within these delineated sensitive areas, a comprehensive inventory of threats to drinking water is compiled using geospatial land use datasets and other means of information collection. Threats can be based on an extensive list of prescribed threats ("Threats Tables") developed by

² https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/documents/bc_drinking_water_screening_tool.pdf

the MOECC, “other” threats identified by the presence or use of chemicals or threats due to past activities, such as contaminated sites. The same rigorous process is applied regardless of the size of the municipality.

3.4.2 Assessment Tools

Having an assortment of tools to assist with SWPP is very helpful provided the resources are easy to access and use. Both Colorado and California have templates/forms that the municipalities can complete and submit to the State. Colorado provides a package that includes maps and GIS shapefiles, reports, contaminant inventories, location

of intakes, and land use. Colorado provides municipalities with CDs and DVDs with information about drinking water, best management practices, and SWPP. The CDs contain an abundance of information that may be overwhelming; however, communities can access free assistance through rural water associations. California provides access to the TurboSWAP program which helps direct communities to define potential sources of contamination and to rank the risks. The program does not directly offer suggestions on SWPP but helps prioritize where communities should focus their planning efforts.

California and Colorado rural water associations are non-profit organizations funded by the state to provide free assistance to rural municipalities wanting to complete a SWPP (e.g., training for water treatment operators).

The National Rural Water Association in the US is funded by the Environmental Protection Agency and US Department of Agriculture. State rural water associations are non-profit corporations funded by government. Rural water associations help rural communities with water and wastewater operator training and with source water protection planning.

In the US, the federal government provides funds for ‘drinking water set asides’ and each State decides how to allocate those funds. Colorado offers grants of \$5,000 for each public water system or community water system that provides drinking water to at least 25 people for greater than six months per year. The grant must be matched with cash or in-kind donations, and upon completion of the SWPP the State will issue the grant money, provided it is completed within the 2-year window.

Canadian jurisdictions offer a variety of resources that differ by Province. Technical Rules under the *Clean Water Act* provide detailed instructions on how to prepare SWPPs in Ontario. Tables of drinking water threats and tables of circumstances provide additional supporting information. Fact sheets on common drinking water threats are available for education and outreach and online mapping of currently identified vulnerable areas (Ontario MOECC 2018) are available. A Comprehensive Drinking Water Source-to-Tap Assessment and a well protection toolkit are available for communities in BC. Additional resources in BC include the Freshwater Atlas (e.g., well locations, watershed boundaries), Water Resources Atlas (e.g., land ownership), Water Portal, Water Tool (e.g. existing users, water availability, monitoring data) and provincial water quality data. The data, however, are dispersed and not dedicated for SWP, and the databases are not necessarily designed for non-specialist use. As a result, smaller communities tend to need the assistance of consultants to undertake SWPP.

Table 3-2
Source Water Assessment and Protection Tools

Jurisdiction	Information Provided	Format	References
BC	GIS maps of land use, maps of well locations, water quality, Comprehensive Source-to-Tap Assessment guidance document (including risk assessment framework), simple screening tool	Various websites	BC Ministry of Health and Ministry of Land, Air and Water Protection. 2004. Simple screening tool. Government of BC. N.d. Freshwater Atlas. Government of BC. Ministry of Forests, Lands and Natural Resource Operations. N.d. Water Portal. Government of BC. Nd. Water Data & Tools.
California	TurboSWAP program used to submit assessments to California Dept. of Health	Small communities fill out forms and the state or rural water association completes the TurboSWAP process	State of California. 2019. TurboSWAP Program.
Colorado	GIS maps of land use, maps of well locations, water quality, list of local stakeholders to include in SWPP	One centralized data set provided by the state to water providers	Colorado Department of Public Health and Environment. 2019. Source Water Protection and Assessment (SWAP).
Ontario	Source Water Protection Implementation Resource Guide; Assessment Reports	Reports Online GIS layers upon request	Ontario Ministry of the Environment and Climate Change (MOECC) 2018. Source Protection Information Atlas.

3.5 ACTION PLAN

The development of an action plan or source protection plan is usually the next step after the assessment of risks to drinking water is complete. The action or source protection plan contains recommendations to address the identified risks and can entail voluntary and mandatory actions, assign roles and responsibilities and timelines for implementation.

The State of Colorado Source Water Assessment and Protection (SWAP) guidance recommends an 8-step process comprising two phases:

Phase 1 (mandatory) - Assessment includes:

- watershed delineation,
- contaminant inventory,
- susceptibility analysis, and
- SWPP report release to public.

Phase 2 (optional) - Protection includes:

- involve stakeholders in planning,
- develop protection plan,
- implement plan, and
- monitor and update protection plan.

In Colorado, the Assessment Phase was conducted by the state while the Protection Phase is optional. The information collected in the Assessment Phase is available to water providers and would ideally encourage public water providers to employ measures to ensure long-term integrity and protection of the water source.

Water utilities in Western Australia developed detailed action plans that included task lists for different staff and were tiered by level of risk. For example, catchment rangers are tasked to conduct surveillance of Reservoir Protection Zones (RPZ), collect water samples, and participate in post-wildfire water quality protection measures, such as the installation of silt curtains.

In BC, the comprehensive SWP guidance document focused on the assessment process, but the final module involves development of recommendations for actions to protect drinking water³ This is part of the comprehensive SWP plan conducted by an assessment team comprised of interdisciplinary specialists.

In Ontario, the SWPP includes specific policies to address significant drinking water threats and identifies the responsible party to implement these policies. The Technical Rules under the Clean Water Act prescribe that policies must be developed for all threats that were classified as “significant”. The decision on a “significant” drinking water threat again is based on the Technical Rules and the “Threats Tables”. Policies can be mandatory or voluntary and are always associated with the threat they are addressing, an

³ <https://www2.gov.bc.ca/assets/gov/environment/air-land-water/cs2ta-mod8.pdf>

implementation timeline, a responsible party and a list of related policies. Examples include policies for spill prevention, drought management and emergency plans, snow storage and road salt application, education and outreach, municipal incentives to encourage private land owners, fertilizer application, handling and storage, and limited livestock grazing in sensitive areas (CTC Source Protection Region 2015).

3.6 IMPLEMENTATION

3.6.1 Education and Awareness

All jurisdictions recognized that education and awareness of SWP is important; however, all jurisdictions mentioned that education and outreach to citizens and other stakeholders could be improved. Community outreach has involved contacting individual citizens or business owners identified as having a potential impact on the source water and asking for cooperation. Ideally, a larger outreach program could be developed to educate large groups at once to be more efficient and avoid “pointing fingers.”

Hosting community events such as a Water Quality Protection Night in Australia can reach a larger audience and increase awareness of SWP. In Colorado, the RWA hosted the Children’s Water Festival which featured 86 presentations to over 300 elementary students with the help of over 300 volunteers. The primary focus of outreach to specific groups that have an interest in nature is to promote public participation, to increase awareness, and to encourage early adoption of Best Practices. An added benefit to public engagement is that it can sometimes result in free labour (see textbox).

In Australia, a “fish circus” was held with angling groups to educate the group on SWP and to have people participate in revegetating eroded shoreline.

3.6.2 Tools

In Australia and Ontario, acquisition of sensitive lands is one of the most effective ways to protect source water. In Ontario, Nova Scotia, and Australia, land use and activity restrictions are common. Official Community Plans and Bylaws in Ontario include wellhead protection areas (WHPAs) to protect sensitive lands and intake protection zones (IPZs) to protect lands and water around surface water intakes. Land use and activity restrictions are empowered by the *Municipal Government Act* in Nova Scotia.

The government in Western Australia assists in protecting sensitive areas through special zoning of areas near source water. Priority classification of land and land acquisition allows water utilities to prioritize their resources to the most susceptible zones and to restrict land development in sensitive areas by zoning them as RPZs. For example, in the surface water source watersheds within the Perth metropolitan area there are 2 km protection zones. Catchment rangers, employed by the water utility, focus surveillance activities in the RPZ but also check the greater watershed area. For example, in Western Australia, the catchment rangers

conduct surveillance of catchment regions and can issue fines of up to \$200 to people caught camping, using all-terrain-vehicles, or letting cattle enter RPZs.

RPZs in Australia are government-owned areas. In rural areas, where RPZs do not exist, the water utility attempts to purchase land in the inner catchment areas with the highest risk to reduce the amount of livestock in these areas and control other risks. In areas where the land is not owned by the water utility or the government, 'hot spot maps' are created to indicate known areas of potential contaminants. These regions are then classified according to risk, and water quality monitoring is conducted accordingly.

To address potential water quantity shortages in Australia, the water market allows people with water licences to sell their water back to the system. For example, a farmer with crops requiring high quantities of water may decide to forgo planting for a season and instead sell his/her water share to the market thus enabling other farmers to secure adequate water for their crops for the season. Rather than all farmers having poor crops, resources are shared, and everyone has a reasonable income.

The Ontario Ministry of Environment and Climate Change has trained more than 200 risk management officials and inspectors across the province to support the implementation of SWPPs. They work locally with stakeholders, such as land developers, to address source protection policies that may apply to a property because it is located in a vulnerable zone and to develop a risk management plan to reduce the risk to drinking water sources of the specific development. In addition, tools such as maps, checklists, and business flow charts are available for municipalities to demonstrate how the new policies fit with existing processes and software data retention and reporting in prescribed formats.

One of the most impactful awareness tools for drinking water source

protection in Ontario are road signs at the border of a drinking water protection zone, as indicated by high media uptake and interest with the

public (Gowda 2016). Such signs are also recommended by Colorado State in their SWPP template⁴ and are frequently used in BC both near aquifers and on resource roads leading into community (water supply) watersheds. They have been common practice in Germany for decades to notify the public upon entering a drinking water protection zone - on roads but also on pedestrian trails - indicating the long-term effectiveness of this tool.

“One of the most impactful awareness tools for drinking water source protection in Ontario are road signs.” (Gowda 2016)

3.6.3 Lessons Learned

Funding for SWP is a significant barrier to the creation and implementation of SWPPs. Colorado state grants for public water suppliers have been very successful in encouraging the creation of SWPPs, collaboration of communities, and implementation of plans. Notably, there is a lack of funding for private water sources in all jurisdictions.

⁴ <https://www.colorado.gov/pacific/cdphe/swap-protection-planning-template>

Community engagement plays an important role in SWP and all jurisdictions recognized that further outreach is needed. Reaching larger groups rather than targeting individuals is not only viewed as more socially acceptable but is more efficient. Consultation with stakeholders also increases support for various policies and procedures related to SWP.

Clearly defined leadership, responsibilities, and roles of government and stakeholders are critical to creation and implementation of SWPPs. Centralized sources of information and data are also critical to efficient planning and implementation.

Financial impact to private land owners due to SWPP policies is evident in Ontario. A proposed solution is to include significant threats as priority criteria in stewardship programs (Gowda 2016). Another solution is to provide better education to land owners to allow a better understanding of their rights and responsibilities. The Source Protection Plan for the Greater Toronto Area included mandatory policies for municipalities to develop incentive programs that address significant drinking water threats located on private lands (CTC Source Protection Region 2015).

In many places, including BC and Alberta, the water supplier has no control over land use outside of their boundaries and a lack of jurisdiction over sensitive areas can be an issue. In Metro Vancouver and Australia, sensitive areas in the watershed are Crown land and those that are not are purchased to help protect sensitive areas. If purchasing the land is not an option, then the risk assessment process must include actions to involve the jurisdictions that manage the land in the watershed.

Source water protection in Australia and Colorado is considered successful when there are no water quality issues such as boil water advisories or algal blooms in drinking water reservoirs. Colorado also tracks the number of substantially implemented SWPPs by tracking the number of grants awarded (funds are awarded after the SWPP is substantially implemented). SWPP considered by Colorado state as exemplary can be found online⁵.

⁵ <https://www.colorado.gov/pacific/cdphe/explans>

4 Summary of Best Practices

This review identified several best practices that appear to support effective development and implementation of source water protection in one or more of the reviewed jurisdictions (Table 4-1). The relevance of these best practices to Alberta is indicated, where possible, based on our current understanding of the Alberta context.

Table 4-1
Summary of Identified Best Practices and Relevance for Alberta

Best Practices	Found in...	Relevance to Alberta
Governance		
Drinking water supplier leads source protection efforts	BC, Colorado, California, Australia	Would be relevant in Alberta as an extension to Drinking Water Safety Plans (DWSP) that are already the responsibility of the water supplier. Consider expanding the DWSP to look at more risks. Incorporate the requirement for SWPP into standards.
Collaboration among stakeholders	ON, Colorado	Watershed Planning and Advisory Councils (WPACs) may provide a starting point for stakeholder collaboration, but their spatial scale may be too large for small municipal SWP efforts.
Well-established system of managing water at the watershed scale (since 1950s)	ON (Conservation Authorities)	Integrated Watershed Management Plans (IWMPs) may provide similar basis for SWP, but larger scale may be a barrier.
Government-provided list of stakeholders	ON, Colorado	Stakeholders involved in WPACs may be a good start.
Offering different levels of stakeholder involvement	Colorado	Already practiced in Alberta for Watershed Planning and Advisory Councils (WPACs).
Assessment		
Level of assessment commensurate with community population and size/complexity of water source	California, BC,	Drinking Water Safety Plans already provide overview-level source water assessment. Action Plans could include additional SWP assessment for at-risk systems.
Tool Kits and centralized guidance available for communities	Colorado, California, ON, BC	This would likely be useful for AB SWP efforts.

Best Practices	Found in...	Relevance to Alberta
Public land managers, resource tenure holders, and First Nations may participate in SWP process (surface water)	BC	Likely of value in cases where the source area includes Crown land.
GIS information, such as land use, contaminant inventories, watercourses, aquifers, and location of intakes available in centralized form and public domain	Colorado, California, ON, BC	Alberta guidance documents should provide guidance on where key information is located.
Action plans identify clear roles and responsibilities	Australia, ON	This is a good practice for any plans, therefore likely applicable to AB. IWMPs already address safe and secure drinking water and are a suitable place for identifying roles. However, the fact that these are non-statutory may be a barrier.
<i>Implementation</i>		
Outreach to nature-centred interest groups and general public	Australia	Could fall under “Water Literacy” efforts by AB government. AWC and AEP could speak about SWP at various conferences.
Road Signs for Drinking Water Protection Zones and other educational and outreach activities	ON, Germany, BC	May be useful as complimentary educational vehicle after other source water protection initiatives are well entrenched.
Acquisition of sensitive lands	Australia, ON, BC	Would likely require a lot of stakeholder engagement.
Protective zoning of sensitive areas	Australia, ON, BC	Has some merit if informed by properly conducted source water assessment work within the various watersheds. Would likely need to be in partnership with various watershed advisory groups providing support.
Infrastructure design & maintenance standards in source areas (e.g. stormwater treatment, on-site wastewater treatment, riparian setbacks)	BC	This, in comparison to some of the other best practices should be relatively more straightforward to implement in Alberta.
Water licence trading to alleviate shortages during drought	Australia	South Saskatchewan Water Management Plan includes measures to protect sources during drought.

Best Practices	Found in...	Relevance to Alberta
SWP-specific, trained staff to monitor sensitive areas	Australia	This would be helpful as an acceptable standard.
SWP-specific, trained staff to work with land owners on implementation	ON	This would be helpful if sufficient resources could be made available. Site specific, face to face, interaction with landowners, is viewed as very valuable.
Grants tied to completion of SWPP	Colorado	Don't see this punitive type measure being well received by municipalities. Would suggest funding assistance to complete a SWPP being more readily embraced.
SWPP may enable water suppliers to temporarily delay required treatment upgrades (i.e. an incentive to SWPP)	BC	Alberta's treatment requirements are more stringent and as such, do not envision SWPP's being able delay treatment for the majority of cases.
More restrictive forestry/natural resources development standards apply in community watersheds	BC	Similar requirements exist in Alberta, and municipalities participate in advisory committees (e.g. City of Calgary).

5 Conclusions

This study involved the review and documentation of Source Water Protection Approaches and Tools in four jurisdictions—Australia, British Columbia, California, and Colorado—to learn from existing approaches implemented elsewhere. The study identified the following common themes among jurisdictions:

- Drinking water providers usually lead SWP planning efforts, although this may be with direction from senior government health or environment agencies.
- Collaboration among stakeholders and rights holders is considered important but has been judged by those jurisdictions to require improvement.
- Clearly defined leadership, responsibilities, and roles of government (including Indigenous Nations governments), land tenure holders, and stakeholders are critical to the creation and implementation of SWPPs.
- Financial assistance, technical and personnel resources, and centralized tools provided to municipalities, regional governments, and First Nations by upper tier government strongly encourage SWPP activities, even when they are voluntary.
- Implementation of SWP on private land is challenging but can be overcome by integrating Source Water Protection Information into stewardship initiatives and local land use planning (e.g. Official Community Plans and bylaws).

This study also identified unique tools and Best Practices that individual jurisdictions have developed to support development and implementation of SWPPs. Most of these are applicable or adaptable to the Alberta context.

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Closure

This report was prepared for the Alberta Water Council Source Protection Project Team to review Source Water Protection Approaches and Tools in selected jurisdictions outside of Alberta.

The services provided by Associated Environmental Consultants Inc. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Environmental Consultants Inc.



Dörte Köster, Ph.D.
Senior Aquatic Scientist
Project Manager

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**Alberta Water Council
Source Protection Project Team**



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Appendix A - Final Questionnaire

QUESTIONNAIRE FOR REVIEW OF SOURCE WATER PROTECTION APPROACHES IN SELECTED JURISDICTIONS

SWP Drivers and Stakeholder Engagement:

1. What are the drivers for initiating SWP and how long have these drivers been in place? (Legislation, policies, contamination, etc.)
2. Who is involved in SWP and who leads it?
3. Is there a working group/committee formed to guide the work? If so, how is it structured?
4. Is there a vision for SWP for your jurisdiction? What are some the visions of municipalities/utilities in your jurisdiction?
5. How is the vision set - internally and/or with stakeholder input? -
6. How regional is the approach? Are small communities collaborating? How is collaboration between communities done? How is stakeholder engagement done?
7. How is SWP done with indigenous communities? Differences between on and off reserve SWP? How is indigenous knowledge incorporated into SWP?

Development of SWP Plans - Approach/Process (steps, tools, resources):

Source Water Characterization and Risk Assessment:

8. What types of tools and resources are available for this step? What tools and resources are lacking?
9. How/where do they get funding to do SWP?
10. Are there standard approaches to GIS mapping (delineation) and analysis of source water areas? Are the necessary data layers easily accessible and free (or low cost)?
11. How is data accessed, analyzed and managed for water quality/quantity, land cover and land use?
12. How are hazard inventories and risk assessments done (for surface and groundwater)? Are there different levels or tiers (e.g. simple risk assessment for smaller systems)?
13. How are subject matter experts involved in this process?
14. What are the levels of risk assessed? (To what level of detail are risks assessed? E.g. general categories of contaminants vs specific contaminants like fire retardants)

Program Goals/Priorities:

15. What are the key goals of SWP in your jurisdiction?
16. How do they prioritize what to focus on and where to start? How are stakeholders involved?
17. How do they ensure alignment/integration with other initiatives?
18. What are the differences between SWP and watershed planning or how are they integrated?

Action Plan:

19. What are the main components of most SWP Plans?
20. Are there separate plans/approaches for groundwater and surface water?

21. What is the scale of the plans – regional/watershed plans vs local plans?
22. How is the lack of control over land use and other activities outside the direct jurisdiction of the water supplier handled? (e.g. legislation, cooperation, consultation, funding, etc.)

Implementation and Evaluation of Plans - Challenges/Successes/Lessons Learned

23. What are example of bylaws or best management practices being implemented?
24. What are the timelines for implementation of SWP plans?
25. What types of tools and incentives are used to encourage participation of different communities?
26. What barriers have prevented communities from developing and implementing SWP plans?
How are these barriers being addressed?
27. How is success measured and monitored?

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Appendix B - Results of Interviews and Literature Review

Subsection	Drivers, Goals	Priorities/ Integration	Collaboration/ Governance	Role of Municipality	Role of Government	Role of First Nations	Tools	Action Plan	Lessons Learned
Questionnaire reference	Qs: 1, 4, 5, 15	Qs: 16-18	Qs: 2, 3, 6	from App C of REOI	from App C of REOI	Q: 7		Qs: 19-22	Qs: 23-27
Australia	Australian Drinking Water Guidelines must be met; water utilities helped develop these and view SWP as a BMP to achieve them. Level 1 source are only treated with chlorine, level2 sources are treated with chlorine and UV, and level 3&4 sources are more complex treatment. The incentive to protect source water is to avoid having to increase treatment (and the cost associated with it).	managing water resources especially during drought; reducing impact on environment; "do more with less water"; support a healthy environment, a prosperous economy and thriving communities	Water Act 1989 - rural water corps are required to provide irrigation, drainage, and storage services (which are critical for agricultural water users) Urban water corps manage water resources and deliver water supply and sanitation services within cities and towns Government oversees the water plans for resource protection. Cities, towns, farmers, industry, business, aboriginal people. State has put together a list of priorities for each region. Explain to communities how climate change will affect water. (e.g. affects species that live in the area, increased storm surges and wildlives could affect quantity and quality of water, damage infrastructure, affect operating procedures, increased evaporation may lead to increased need for water for livestock and crops Integrated catchment management (ICM) plan in Victoria - to increase community engagement, and clarify roles, strengthen accountabilities & coordination, improve monitoring & reporting. ICM is a holistic approac to managing land, water and biodiversity from the top of a catchment to the receiving waters. 9 parts - 1)waterways, wetlands and estuaries, 2)native forests and vegetation, 3)pest management, 4)riparian land, 5)sustainable agriculture and land management, 6)land use planning, 7)sustainable irrigation, 8)integrated water management, 9)coastal management	Water corps have regional forums to discuss regional visions, priorities and plans with local government, catchment management authorities and Traditional Owners	Dept of Health - Western Australia has a Memorandum of Understanding with Dept of Health Must comply with Australian drinking water guidelines (ADWG) Dept of Water - creates drinking water source protection plans for whole watershed (Catchment Management Strategy) and they decide on priority classification of land which limits land development	Depends on the region In Victoria, indigeous knowledge is valued & indigenous people are advisors & stakeholders (see Indigenous protected areas) In Victoria, they created an Aboriginal Water Reference Group (representatives are Traditional Owners)- advise on design, implementation and evaluation of local projects funded by Aboriginal Water Program; initiatives to build capacity and engagement of Aboriginal people; Aboriginal Water Program created to understand Aboriginal water values, uses, objectives and innovations	Source Protection Operations Manual Catchment Rangers - visit catchment areas to ensure area is protected and there are no issues that could cause contamination (e.g. people camping, livestock) Land Use Compatibility Tables from Dept of Water Maps with "hot spots" to show places that have known issues Whole farm plans help farmers manage irrigation and drainage in the most efficient way	Very detailed plans for water quality operators and WQ officers (includes frequency of field visits, parameters to be tested, what to look for on field visits) Education: water quality protection nights Barrier Risk Assessments reviewed annually Observations Monitoring Plans	The state water utility organizes the source water protection and provides staff to test water and visit catchment areas. Need more education for the general public and with land owners. Success is tracked through monthly reporting of #hrs surveillance completed, livestock and people in catchment areas that should not be there, and land use changes. Case study - Fishers in Goulburn Broken Catchment held a "fish circus" with govt agencies and angling clubs to raise awareness of importance of healthy rivers. People helped revegetate a portion of a river

Subsection	Drivers, Goals	Priorities/ Integration	Collaboration/ Governance	Role of Municipality	Role of Government	Role of First Nations	Risk Assessment	Tools	Action Plan
Questionnaire reference	Qs: 1, 4, 5, 15	Qs: 16-18	Qs: 2, 3, 6	from App C of REOI	from App C of REOI	Q: 7	Qs: 8-14		Qs: 19-22
BC	<p>Ministry of Enviro (MOE) primarily responsible for SWP. Ministry of Health responsible for drinking water safety. Not legislated - optional Drinking water protection act regulates water supply systems (part 3 of the act - DWO can order a supplier to complete an assessment; most often done voluntarily)</p>	<p>Drinking water protection. Identify hazards and vulnerabilities that threaten safety and sustainability of the water supply and to recommend risk management actions to address them. Shifting toward the view that all water is connected and planning should be more connected.</p>	<p>When 2+ systems use the same source it can be most cost effective and efficient to complete a joint source water assessment. DWOs consider opportunities for collaboration but it requires cooperative efforts and cost-sharing</p>	<p>Water suppliers and local government determine the risks in the watershed.</p>	<p>MOE responsible for SW quality monitoring, compliance, and enforcement; provides info on drinking water sources for assessments; part of technical advisory group when needed. Water Sustainability Act helps protect water sources with volume use restrictions, creates water objectives and sustainability plans. Environmental Management Act - provincial water quality guidelines and objectives. Groundwater protection regulations help protect g.w. sources Ministry of Healthy Living & Sport lead in source water protection; responsible for source water quality standards; ensures land use planning addresses drinking water issues; provides info on drinking water sources for assessments; part of advisory team when needed.</p>	<p>First Nations Health Authority works to help First Nations people with access to clean drinking water. When a FN community has concerns with water a consultation process occurs - it is becoming a more formalized process.</p>	<p>Comprehensive source-to-tap assessments (CS2TA) are only required when a drinking water officer (DWO) orders it (and stipulates which modules must be completed). Smaller systems typically use the simpler screening tool. DWO may also require an assessment response plan (Drinking Water Protection Act, sec 22) and a timeline. If a comprehensive assessment is required by a DWO, it must be completed by a team of qualified professionals. System Risk Management Tool</p>	<p>CS2TA (with appendix 1B - examples of hazards) Well protection toolkit. Freshwater Atlas/Water Resource Atlas - open to public - water layers, wells, licenses, dams, aquifers, snow survey, watersheds, land ownership, etc. CABIN program Water portal - database for water quality data iMap BC</p>	<p>8 module process (not all 8 are required for every water source). Metro Vancouver has an excellent plan</p>

Subsection	Drivers, Goals	Collaboration/ Governance	Role of Government	Risk Assessment	Tools
Questionnaire reference	Qs: 1, 4, 5, 15	Qs: 2, 3, 6	from App C of REOI	Qs: 8-14	
California	Source water assessment completion is a prerequisite for access to State Revolving Fund money for local SWP projects and programs	Nov 2007 a memorandum of understanding was signed by the California EPA and the California Natural Resources Agency to create the California Water Quality Monitoring Council requiring boards, depts, and offices to coordinate water quality and related ecosystem monitoring, assessment, and reporting	Federal and state govt require source water assessments to be completed California Rural Water Assoc can help with protection plans DHS or the county can provide guidance, technical assistance, and data	DWSAP (California Drinking Water Source Assessment and Protection) program has a document to help small communities through the assessment process then the regulatory agency (Dept of Health Services or Local Primacy Agency) will help prepare the complete assessment using the TurboSWAP and Mapping Tool	DWSAP document (200+ pages) lays out the process Separate assessment/forms for surface water vs ground water TurboSWAP (used by larger systems) helps calculate the ground water protection zones; provides a list with over 100 possible contaminating activities (PCA) in 4 categories, vulnerability ranking is done automatically based on delineation, physical barrier effectiveness and PCA inventory Smaller systems should fill out the series of forms listed in the procedures for small water system assessments

Subsection	Drivers, Goals	Priorities/ Integration	Collaboration/ Governance	Role of Municipality	Role of Government	Role of First Nations	Risk Assessment	Tools	Action Plan
Questionnaire reference	Qs: 1, 4, 5, 15	Qs: 16-18	Qs: 2, 3, 6	from App C of REOI	from App C of REOI	Q: 7	Qs: 8-14		Qs: 19-22
Colorado	No legislation requiring SWP Either driven for an environmental or land use reason (e.g. algal blooms, challenges with water treatment, wildfires affecting water quality, P + N increases, oil & gas drilling nearby). There is some peer pressure not to be one of the few communities that doesn't participate.		Stakeholders are all involved in the process. 3 tiers of participation: 1) attend every meeting & very involved in all steps, 2) notified of all meetings but only attend a few, 3) don't attend meetings but receive updates on progress. All meetings are public and everyone is welcome. Communities often collaborate on their SWP. Potential contaminant sources influence the stakeholder list. Also invite EPA, forest service, state agencies (e.g. oil, gas, mining), and local agencies (e.g. community planners, septic systems)	Water providers & municipality decide to create SWPP Federal govt require source water assessments to be completed Colorado Rural Water Assoc can help with protection plans State can provide data	Provide some funding through a state-wide program (currently \$5000USD grants for public water systems with matching funds or in-kind contributions); counties are involved but don't lead SWP	Currently not known to be involved in SWP. Often have water provided by another community. US EPA leads SWP and funding for tribal entities. Tribes can choose to take primacy and comply with all EPA regulations but in practice only very large tribes can do this (lack of funding and technical help)	Municipality fills out assessment to determine risks. Small municipalities can contact Colorado Rural Water Association (a non-profit) to facilitate the entire process from assessment to source water protection planning and development of best management practices.	Very robust set of resources for SWP. Colorado Dept of Public Health and Environment provides a CD and DVD to assist with the entire process of assessment to protection planning. Many communities contact the CRWA for assistance because their services are free (sometimes a 6-8month wait). Provide groundwater and/or surface water reports depending on the region. Lots of access to maps of the area that include info on well locations, surface water intakes, known contaminant inventory, industry, land cover, land use. Available in simple maps or GIS shape files. Users simply follow the templates and use the data package provided by the state to complete the entire process. View examples of exemplary plans done (3).	8 step action plan: -Stakeholder involvement. -A steering committee to develop and implement the plan. -An inventory of all ground and surface water intakes. -Reviewing state source water assessment for potential sources of contamination. -An inventory of potential sources of contamination and local issues of concern. -A map of outlining the source water protection area. -Best management practices that address each of the potential sources of contamination and issues of possible threats to your source water. -A contingency plan to ensure a safe drinking water supply in the event of an emergency.

Subsection	Drivers, Goals	Priorities/ Integration	Collaboration/ Governance	Role of Municipality	Role of Government	Risk Assessment	Tools
Questionnaire reference	Qs: 1, 4, 5, 15	Qs: 16-18	Qs: 2, 3, 6	from App C of REC	from App C of REOI	Qs: 8-14	
ON	<p>To ensure clean, safe and sustainable drinking water for Ontarians, by protecting sources of municipal drinking water including lakes, rivers, and aquifers water.</p> <ul style="list-style-type: none"> - Source water means untreated water from Lakes Rivers, streams or underground aquifers that supply drinking water. - Main Drivers <ul style="list-style-type: none"> • Walkerton incident • Justice O'Connor Recommendations • Multi-barrier Approach to drinking water 	<p>Consider existing legislation and requirements</p> <ul style="list-style-type: none"> - Develop additional policies where necessary to manage or prohibit 	<p>Source water protection plans are collaboratively developed, watershed-based, science-based and locally driven, The province developed source water protection areas and created a local multi-stakeholder Source Protection Committee (SPC) for each area.</p>	Implementation	<p>help identify Drinking Water Threats, train Source Protection officers, provide education and outreach materials, implement policies under provincial jurisdiction</p>	<p>SPCs complete the assessment report that characterizes their watersheds and water budgets. Vulnerable areas are then identified, including</p> <ul style="list-style-type: none"> o Wellhead Protection Areas (municipal drinking water) o Intake Protection Zones (municipal drinking water) o Highly Vulnerable Aquifers (regional groundwater) o Significant Groundwater Recharge Areas (regional groundwater) 	<p>tools include delineation of sensitive areas such as wellhead protection zones in official plans, by laws to protect sensitive lands, outright acquisition of sensitive lands, and identification and monitoring of contaminant sources, wells, and septic systems</p>