Report 8: December 2010

AN AUDIT OF THE MANAGEMENT OF GROUNDWATER RESOURCES IN BRITISH COLUMBIA

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The Honourable Bill Barisoff
Speaker of the Legislative Assembly
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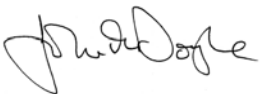
Dear Sir:

I have the honour to transmit herewith to the Legislative Assembly of British Columbia my 2010/2011 Report 8: *An Audit of the Management of Groundwater Resources in British Columbia.*



John Doyle, MBA, CA
Auditor General

Victoria, British Columbia
December 2010

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AUDITOR GENERAL'S COMMENTS

JOHN DOYLE, MBA, CA
Auditor General

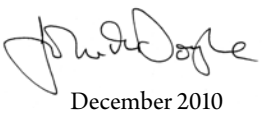
Government has identified groundwater as "a hidden treasure." In much of the province, it is the primary water source for residences, industry and agriculture, and contributes significantly to the maintenance of healthy ecosystems. More than one million British Columbians (25% of the province's population) are estimated to rely on groundwater for daily use.

This precious resource can be all too easily depleted or contaminated, and needs to be protected for both current and future generations. However, I found that government is not yet a good steward of this treasure.

With increasing demands on groundwater resources, an appropriate framework to manage it sustainably must be put in place. The requirements for such a framework are well understood by government and some initiatives are already underway. As well, I am pleased to see that government recognizes groundwater's vulnerability and has made its protection a priority. The commitment to improving the protection of groundwater for its many uses, as stated in the Province's plans to modernize water legislation, is encouraging.

The ministry responsible for groundwater protection has accepted my recommendations and I look forward to receiving updates on their plans and actions for implementation.

I would like to thank the many officials and staff at the Ministry of Environment and other agencies for their assistance and cooperation during this audit.



December 2010

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EXECUTIVE SUMMARY

Groundwater is an integral part of Earth's natural hydrologic, or water, cycle. Water that infiltrates the surface (groundwater) may replenish aquifers, may discharge back to the surface to replenish streams and lakes or may find an opening in the land surface and come out as freshwater streams. Groundwater can spend over 10,000 years stored beneath the Earth's surface.

As elsewhere in the world, British Columbia's groundwater resources are critical to satisfying drinking water, agricultural and industrial needs. More than an estimated 1 million British Columbians (25% of the province's population) rely on groundwater for daily use, and this number is growing. Groundwater also plays a vital part in maintaining the health of the environment. Diligent and effective management and protection of groundwater is therefore essential if its quantity and quality is to be assured.

The main agency responsible for groundwater management in the province is the Ministry of Environment.

We carried out this audit to determine whether government is ensuring the sustainability of groundwater resources in British Columbia. We asked the following questions:

- Is the Ministry of Environment's information about groundwater sufficient to ensure the sustainability of the resource?
- Is groundwater being protected from depletion and contamination and to ensure the viability of the ecosystems it supports?
- Is groundwater access being controlled and do key organizations have the authority needed to take appropriate local responsibility?

We concluded that government is not effectively ensuring the sustainability of the province's groundwater resources. Specifically, we found that:

- the ministry's information about groundwater is insufficient to enable it to ensure the sustainability of the resource;
- groundwater is not being protected from depletion and contamination or to ensure the viability of the ecosystems it supports; and
- control over access to groundwater is insufficient to sustain the resource and key organizations lack adequate authority to take appropriate local responsibility.

Government has recognized that groundwater is vulnerable and has made protection of it a priority. In Living Water Smart, the province's water plan, government committed to improve the protection of the quality and quantity of groundwater. To that end, the Ministry of Environment is leading the *Water Act* modernization process. New legislation is expected by 2012.

SUMMARY OF RECOMMENDATIONS

WE RECOMMEND THAT THE MINISTRY OF ENVIRONMENT:

1. ensure that classification of the province's aquifers is completed for all priority areas and that the WELLS database is kept up to date. The ministry should also ensure that aquifers are characterized, starting with those classified as having the highest priority.

2. expand the Provincial Observation Wells Network and review the Provincial Ambient Groundwater Quality Monitoring Network to ensure there is sufficient monitoring of groundwater levels and quality across the province.

3. take the lead on coordinating the consolidation of all of the groundwater monitoring information collected by provincial ministries and other agencies to reduce duplication of effort and to ensure the best use of limited resources.

4. develop a groundwater information management strategy that takes into account detailed scientific information and identified trends, and ensure that the information required to support this strategy is collected, analyzed and available through one location.

5. develop and deploy systems to protect groundwater from depletion and contamination and to ensure the viability of the ecosystems it supports.

6. develop a framework that clearly outlines the roles and responsibilities for managing groundwater provincially and locally, and ensure that agencies are able to take responsibility for groundwater in their area.

7. ensure that integrated watershed management plans are developed for all priority watersheds.

RESPONSE FROM THE MINISTRY OF ENVIRONMENT

The audit report presented valuable information on the importance of groundwater. Government recognizes the need to protect the quality and quantity of our groundwater. The province's Groundwater Program is celebrating 50 years; operating groundwater quality and quantity monitoring networks; identifying and characterizing high priority aquifers to support decision making; conducting scientific analyses, such as water balance models that look at the connection between surface and groundwater. The program helps promote public awareness, understanding and appreciation of the resource and sets technical and regulatory standards and guidelines to promote best practices. The Ground Water Protection Regulation (GWPR) (under the Water Act) includes requirements to protect groundwater (e.g., standards for construction, maintenance and identification of groundwater wells). Phase 2 of the GWPR (not yet enacted) includes additional measures to protect groundwater, such as well standards and mandatory submission of well records.

A review of the Groundwater Program, initiated in early 2010, is assessing program objectives, monitoring and research needs, data analysis and reporting, and developing a groundwater information management strategy with key actions to ensure the continued protection of this valuable resource. The Ministry is working with the Ministry of Natural Resources Operations (MNRO) to complete the program review.

At the time the audit report was prepared, the main agency responsible for the management of groundwater was the Ministry of Environment (MOE). Recent changes in the provincial government's organization have the responsibilities largely split between MOE and MNRO. MOE is responsible for science and knowledge management, strategic framework, standards, policies and legislation development. MNRO is responsible for the operation and delivery of natural resource services across the province (e.g. groundwater quality and quantity monitoring, licences and approvals). The audit recommendations focus on actions for MOE, but are applicable to both MOE and MNRO.

The MOE is addressing audit recommendations through the review of the Groundwater Program, the commitments in Living Water Smart; BC's Water Plan, the current work to modernize the Water Act (BC's primary law for managing our water resources), and Phase 2 of the GWPR.

Living Water Smart includes a number of commitments to safeguard BC's water resources. It commits to improving the protection of the quality and quantity of our groundwater. This includes regulating groundwater use in priority areas and large groundwater withdrawals. It also commits to improving water laws.

While the Ministry has a number of initiatives underway that will continue to protect groundwater quality and quantity, to fully implement the audit recommendations will require substantial additional funding and staff. Costs associated with upgrading the existing databases for groundwater data and to classify and characterize aquifers are in the order of $4.5 million over the next five years. It is difficult to evaluate the financial implications of consolidating all of the groundwater monitoring information collected in BC. However, database specialists estimate costs of up to $5 million. The implementation of the modernized Water Act will also have associated costs for data collection, monitoring and reporting, and for the information management and technology.

The audit makes a number of recommendations pertaining to government's sustainable management of groundwater:

RECOMMENDATION 1: ***The Ministry of Environment ensure that classification of the province's aquifers is completed for all priority areas and that the WELLS database is kept up to date. The ministry should also ensure that aquifers are characterized, starting with those classified as having the highest priority.***

The Ministry is continually identifying aquifers that remain to be mapped in BC. Because of the interest this type of mapping has locally, it is appropriate to seek out opportunities to partner with local governments to conduct this work.

Water well data in drilling reports are fundamental to acquiring knowledge and understanding about the Province's groundwater resource. It is challenging to keep the database up to date as data submissions by well drillers is voluntary and data standards are not enforceable. However, Phase 2 of the Ground Water Protection Regulation (not yet enacted) contemplates mandatory submission of well drilling reports (well records) by drillers, as well as legally enforceable standards for information contained in those reports.

Characterizing aquifers requires considerably more effort than classifying aquifers because the objective is to obtain much more comprehensive information on an aquifer to be able to address specific issues (e.g., water availability for allocation, impact of groundwater withdrawals on surface water). Characterization also requires specialized expertise and periodic updating. Therefore, this work should be undertaken for the highest priority aquifers.

The Ministry recognizes the need to collect, analyze and manage groundwater scientific information and has been collaborating with various agencies, such as GeoScience BC and the Geological Survey

of Canada, and local governments, to characterize groundwater aquifers. A modernized Water Act will require aquifer characterization to ensure science-based groundwater management decisions.

Response to Recommendation 1: The Ministry will continue to collaborate and seek opportunities to leverage external funding with interested local governments and other agencies to carry out aquifer classification mapping. By 2011, the Ministry will also develop a list of priority areas for aquifer characterization. The Ministry will work with MNRO on collecting and managing groundwater data.

Phase 2 of the Ground Water Protection Regulation, when enacted will require mandatory submission of well records and minimum reporting standards.

RECOMMENDATION 2: ***The Ministry of Environment expand the Provincial Observation Wells Network and review the Provincial Ambient Groundwater Quality Monitoring Network to ensure there is sufficient monitoring of groundwater levels and quality across the province.***

An independent review of the Observation Well Network completed in 2009 confirms that 74% of the current observation wells are ideally situated to monitor the highest priority aquifers. The report also recommends that over the next 10-15 years, an additional 50-75 observation wells should be added to the network. This is consistent with current MOE and MNRO plans for this network.

The objectives of the Ambient Groundwater Quality Monitoring Network have not been critically reviewed since its inception in the 1980's. A review of this network will be initiated in 2011. This review will focus on identifying monitoring objectives, data analysis and reporting needs to help assess groundwater quality in priority areas, and assist in management decisions at all government levels (including local governments).

Response to Recommendation 2: The Ministry will continue to implement the recommendations of the 2009 independent review to expand the Provincial Observation Wells Network in priority aquifers over time. The Ministry will initiate a review of the Ambient Groundwater Quality Monitoring Network in 2011 to help assess groundwater quality in priority areas.

RECOMMENDATION 3: ***The Ministry of Environment take the lead on coordinating the consolidation of all of the groundwater monitoring information collected by provincial ministries and other agencies to reduce duplication of effort and to ensure the best use of limited resources.***

Government and non-government organizations that collect groundwater information include municipalities, First Nations communities, Regional Health Authorities, Health Canada, Environment Canada, groundwater consultants, local governments, industry, the Oil and Gas Commission, and other BC government ministries.

Consolidating this data would provide a better understanding of the location of groundwater wells and groundwater quantity and quality. However, there are a number of challenges associated with this concept. Ownership of the data is a substantial issue as are data format, standards and accuracy. It is, therefore, difficult to evaluate the financial implications of consolidating groundwater data in BC. Commitment and cooperation of agencies and parties, including MOE, MNRO and Ministry of Health Services, Regional Health Authorities and non-government groups, would be necessary to implement this recommendation effectively. Associated costs could be up to $5 million (i.e., database start up costs not including operational costs).

Response to Recommendation 3: The Ministry will work with MNRO, the Ministry of Health Services and Regional Health Authorities to explore the feasibility of coordinating the consolidation of groundwater monitoring data collected by various parties.

RECOMMENDATION 4: ***The Ministry of Environment develop a groundwater information management strategy that takes into account detailed scientific information and identified trends, and ensure that the information required to support this strategy is collected, analyzed and available through one location.***

The Ministry initiated a review of the Groundwater Program in 2010. Some main findings of the review to date include the need for better access to data and to interpret and report on data in a timely manner. Access to groundwater data and information is critical to promoting stewardship of the groundwater resource. The Ministry manages groundwater data and information in a number of different databases (e.g., well drilling reports, groundwater levels, water quality). MOE and MNRO are looking into the feasibility of linking these databases.

The need to interpret and report on groundwater data in a timely and meaningful way is also important to decision making. The Ministry is currently reviewing how best to report on Provincial Observation Well Network data and identifying linkages to other decision support activities (e.g., drought forecasting, State of Water Report). As part of the program review, the Ministry will develop a groundwater information management strategy with specific action items that will be developed with MNRO.

Response to Recommendation 4: By 2011, the Ministry will complete the review of the Groundwater Program in collaboration with MNRO. The program review will include the development of a groundwater information management strategy with associated actions (e.g., seek funding to link databases containing groundwater data, examine the feasibility of consolidating groundwater data in one location, for those data that meet quality standards, and explore how best to interpret and report groundwater data).

RECOMMENDATION 5: *The Ministry of Environment develop and deploy systems to protect groundwater from depletion and contamination and to ensure the viability of the ecosystems it supports.*

To protect groundwater from depletion, Water Act Modernization (WAM) is proposing to regulate all large withdrawals of groundwater throughout the province, and wells in priority areas. It is proposed that the groundwater regulation regime would parallel the regime for surface water and proponents would be required to submit groundwater information. This regulatory system would promote sustainable groundwater use, and prevent conflicts between users. The interaction between surface water and groundwater would be considered in all decisions to protect existing users, stream health, and the contribution of groundwater to base flows. There would be improved legislative tools to promote water conservation.

The prevention of groundwater contamination will be achieved through additional standards for well construction under Phase 2 of the GWPR.

WAM will lead to better protection of aquatic ecosystems and hence, stream health by implementing a number of Living Water Smart commitments.WAM will review when and how stream health is considered in decision making. It will require more efficient water use in water licences, improve monitoring and reporting, and how water is regulated during times of scarcity. WAM will include the consideration of water in land and resource use decisions, and provide stronger tools to respond to stream health degradation.

Response to Recommendation 5: The Ministry is working to modernize the Water Act by 2012, which will better protect groundwater from depletion and contamination, as well as provide for the sustainable management of aquatic ecosystems.

RECOMMENDATION 6: *The Ministry of Environment develop a framework that clearly outlines the roles and responsibilities for managing groundwater provincially and locally, and ensure that agencies are able to take responsibility for groundwater in their area.*

WAM will position BC as a leader in water stewardship, able to respond to current and future pressures on the water resource. Roles and responsibilities for managing groundwater will be clearly identified for decision makers and groundwater users. This will clearly identify requirements for accessing groundwater, construction of wells, as well as land use regulations to protect recharge areas and prevent contamination. Shared governance models that enable delegation of some responsibilities or authorities to the local level, where there is capacity and willingness, will also be explored.

In addition to the framework under WAM discussed above, the roles and responsibilities for groundwater management within the provincial government will be clarified as part of the Groundwater Program review.

Response to Recommendation 6: The Ministry will clearly define the roles and responsibilities of the various agencies involved in the protection and management of groundwater through Water Act Modernization and the Groundwater Program review.

RECOMMENDATION 7: *The Ministry of Environment ensure that integrated watershed plans are developed for all priority watersheds.*

Living Water Smart commits to supporting communities to do watershed management planning in priority areas. WAM is proposing an area based approach that will allow planning and management tools to be applied in priority areas to address chronic water quantity and quality problems. Experience with Part 4 of the Water Act has shown that there are challenges to developing and implementing Water Management Plans. These lessons will be considered in WAM and incorporated into new watershed sustainability planning tools and decision processes. Experience has also shown that effective plans are developed when all stakeholders and First Nations participate. WAM will review new governance arrangements that may be necessary to develop and implement watershed sustainability plans. The integration of planning for land use and water use will be required to address local water, land and development issues.

Response to Recommendation 7: The Ministry will continue to promote existing tools to help with the development of watershed plans and will work to enable the development of watershed sustainability plans through the modernized Water Act.

GROUNDWATER EXPLAINED

Surface water is easily visible, but groundwater is not. When water from precipitation and runoff seeps into the ground, it becomes stored within the pores of permeable rock and between loose material such as sand in layers known as aquifers. These aquifers can produce useful quantities of water when tapped by wells.

Groundwater is critical to satisfying drinking water, agricultural and industrial needs the world over. It is also a vital part of the global hydrologic, or water, system and a critical factor in supporting the healthy functioning of the environment (Exhibit 1).

While surface water supplies the majority of Canadians' needs, almost 10 million Canadians, including more than an estimated 1 million British Columbians (25% of the province's population) rely on groundwater for daily use, and this number is growing. In Canada, groundwater is a Crown resource and, for the most part, it is the responsibility of the provincial governments to protect and manage.

Water use in Canada

In a 2005 Organisation for Economic Co-operation and Development (OECD) report, Canadians ranked as the second highest users of water out of a comparison with 30 OECD countries. What is often referred to as the "myth of abundance" in this country, combined with low water prices, is felt by many observers to be the reason for this.

British Columbia

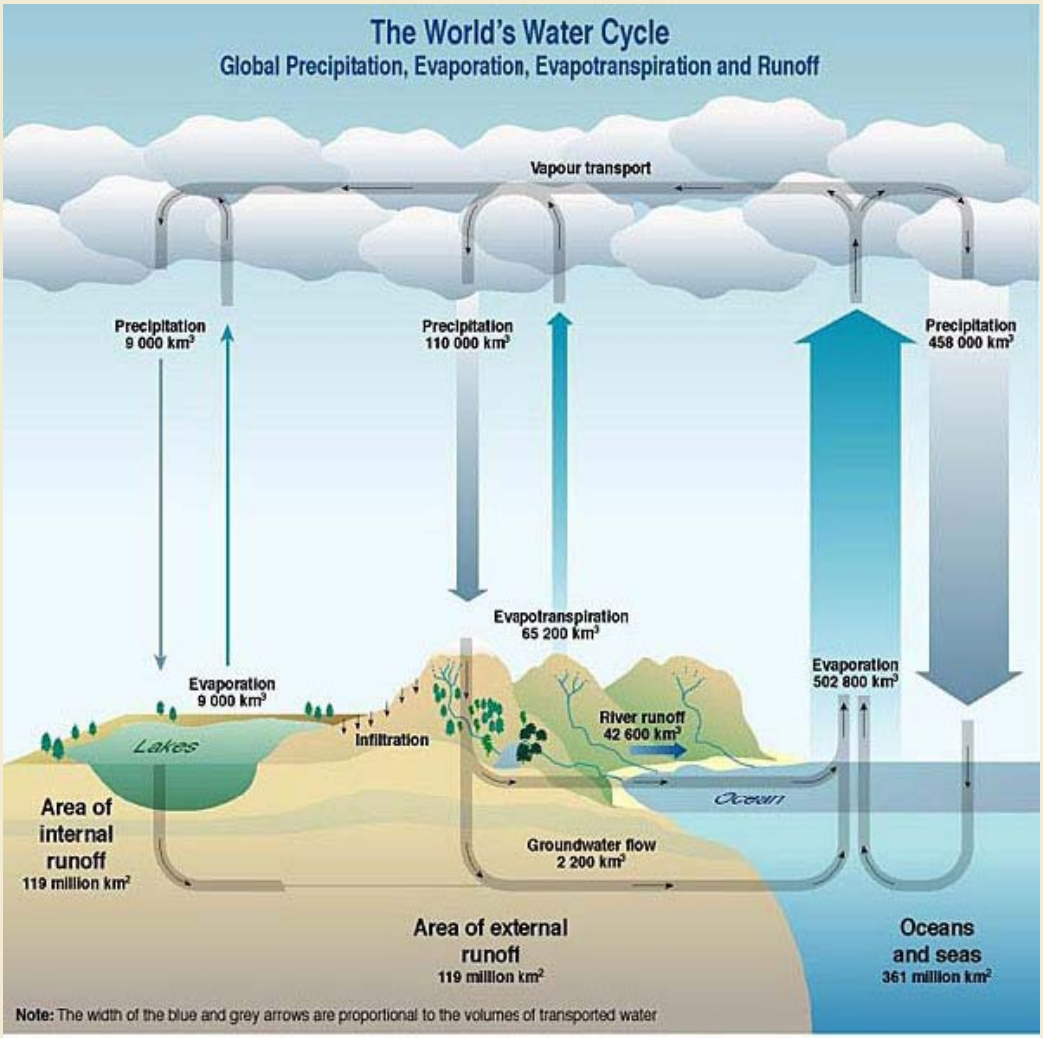
In 2005, one of the provincial government's five great goals was for the province to "Lead the world in sustainable environmental management, with the best air and water quality, and the best fisheries management, bar none." An initiative identified in the government's 2006/07 to 2008/09 Strategic Plan and linked to that goal was the introduction of a $16 million *Drinking Water Action Plan* and *Groundwater Protection Plan* aimed at improving and protecting water quality in the province.

Living Water Smart, published in 2008, outlines government's vision and plan to keep British Columbia's water healthy and secure for the future. The plan, which refers to groundwater as "our hidden treasure," states that the use of groundwater in the province is currently not regulated leaving this resource highly vulnerable.

The province's *Water Act,* established in 1909, is the primary piece of legislation directed at water management. In 1960, the *Water Act* was extended to apply to groundwater, but the amendment has never been brought into effect. The current government sees modernization of the *Water Act* as being an essential part of delivering the vision laid out in *Living Water Smart*. According to the latter:

- water laws will improve the protection of ecological values, provide for more community involvement, and provide incentives to be water efficient;
- legislation will recognize water flow requirements for ecosystems and species;
- new approaches to water management will address the impacts from a changing water cycle, increased drought risk and other impacts on water caused by climate change;
- government will regulate groundwater use in priority areas and large groundwater withdrawals;
- the *Ground Water Protection Regulation* will protect the quality and quantity of our groundwater; and
- government will require all large water users to measure and report their water use.

Exhibit 1: The volume of water transported in the global hydrologic cycle and water residence times



Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999; Max Planck, Institute for Meteorology, Hamburg, 1994; Freeze, Allen, John, Cherry, *Groundwater*, Prentice-Hall: Engle wood Cliffs NJ, 1979.

Source: United Nations Environment Programme

AUDIT PURPOSE AND SCOPE

We carried out this audit to determine whether the provincial government is ensuring the sustainability of groundwater resources in British Columbia.

We derived our audit objectives from the Council of Canadian Academies' 2009 report, *The Sustainable Management of Groundwater in Canada: Review of the Expert Panel on Groundwater*. In that report, the panel was tasked by Natural Resources Canada with answering the question, "What is needed to achieve sustainable management of Canada's groundwater resources, from a science perspective?" The report identified five interrelated goals that encompass the concept of groundwater sustainability (Exhibit 2). The findings in the report are the basis of our expectations as stated in this audit report.

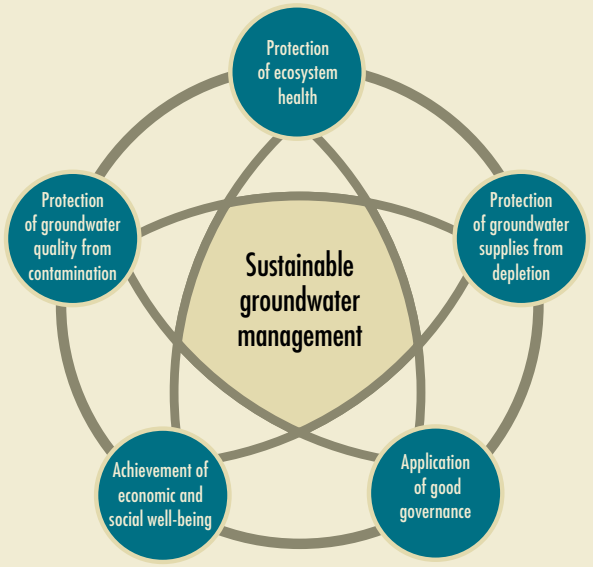
Our audit aimed to answer three main questions:

- Is the Ministry of Environment's information about groundwater sufficient to ensure the sustainability of the resource?
- Is groundwater being protected from depletion and contamination and to ensure the viability of the ecosystems it supports?
- Is groundwater access being controlled and do key organizations have the authority needed to take appropriate local responsibility?

Our audit looked at government's overall management of groundwater resources, but focused on the work of the Water Stewardship Division in the Ministry of Environment, which is the lead ministry in this area. These questions were discussed with and accepted by the senior and operational management at the Ministry. The role and actions of other ministries and agencies – Agriculture and Lands; Energy, Mines and Petroleum Resources (including the Oil and Gas Commission); Forests and Range; Healthy Living and Sport; Health Authorities; and Community and Rural Development – were included as they also play important roles in the management of groundwater. As of October 25, 2010, there was a realignment of some of these ministries and their responsibilities. We also interviewed other stakeholders that are involved in the management of groundwater including staff in local and federal agencies.

We did not audit ministry information on specific aquifers. Our interest was in assessing the management of groundwater resources and not in assessing resource data.

Exhibit 2: Groundwater sustainability pentagon



Source: Council of Canadian Academies, 2009

We carried out our audit from December 2009 to July 2010, examining significant activities undertaken by government during the period 2002 to 2010. Subsequently, further discussions, analysis and assessments were conducted prior to completing the report. We conducted the audit in accordance with section 11 (8) of the *Auditor General Act* and the standards for assurance engagements established by the Canadian Institute of Chartered Accountants.

OVERALL CONCLUSION

We concluded that government is not effectively ensuring the sustainability of the province's groundwater resources. Specifically, we found that:

- the ministry's information about groundwater is insufficient to enable it to ensure the sustainability of the resource;
- groundwater is not being protected from depletion and contamination or to ensure the viability of the ecosystems it supports; and
- control over access to groundwater is insufficient to sustain the resource and key organizations lack adequate authority to take appropriate local responsibility.

Government has recognized that groundwater is vulnerable and has made its protection a priority. To that end, the Ministry of Environment is leading the *Water Act* modernization process. New legislation is expected by 2012.

KEY FINDINGS AND RECOMMENDATIONS

The ministry's information about groundwater is insufficient to enable it to ensure the sustainability of the resource

In some areas of British Columbia, groundwater is the only physically and economically viable source for individual and community water supply systems and for agricultural and industrial uses. Groundwater is often what maintains base flows in rivers and streams during periods of drought, and is critical to fish and wildlife habitat and spawning areas.

Information on the existence and characteristics of groundwater resources is therefore essential to support effective decision making that ensures groundwater's sustainability. We expected the ministry to have sufficient information about groundwater, to monitor the state of groundwater resources and to coordinate the consolidation of groundwater information collected by other stakeholders. We also expected the ministry to use this information to inform a long–term strategy for managing groundwater sustainably.

"The provinces, as the primary regulators of groundwater, map and monitor the resource; assess its recharge and discharge; evaluate sustainable yield; develop and maintain models; assess groundwater extraction impacts on streamflows and groundwater-surface water interactions; collect and compile groundwater information; and generally manage groundwater resources."

Council of Canadian Academies, 2009

Sufficiency of groundwater information

We found that there is not sufficient information about the available supply of groundwater within provincial aquifers and the demand related to each. However, government has a general understanding of aquifers through its aquifer classification system and, for some areas, a detailed understanding because of characterization work undertaken. In addition, the ministry maintains a database of groundwater wells.

Aquifer classification

Classification of aquifers in British Columbia began in 1994, based on usage and vulnerability to contamination. One of the main objectives of classification is to provide a framework for subsequent stages of detailed aquifer mapping and assessment (that is, characterization, described below).

The total number of aquifers is not known and much of the province has yet to be mapped. To date, 916 across the province have been classified (Exhibit 3). Approximately one quarter of these aquifers are highly vulnerable to contamination, 14% of which are classified as heavily used aquifers. Large municipalities such as Langley, Abbotsford and Prince George rely on groundwater for their drinking water supply. For maps of aquifers classified by vulnerability to contamination, see the appendix.

While aquifer classification establishes a useful overall picture of groundwater presence, the ministry indicates that it does not provide the level of detail that is needed to manage the resource. The province no longer funds the classification program, however, the ministry advised us that it has recently been able to dedicate some resources to classification.

Aquifer characterization

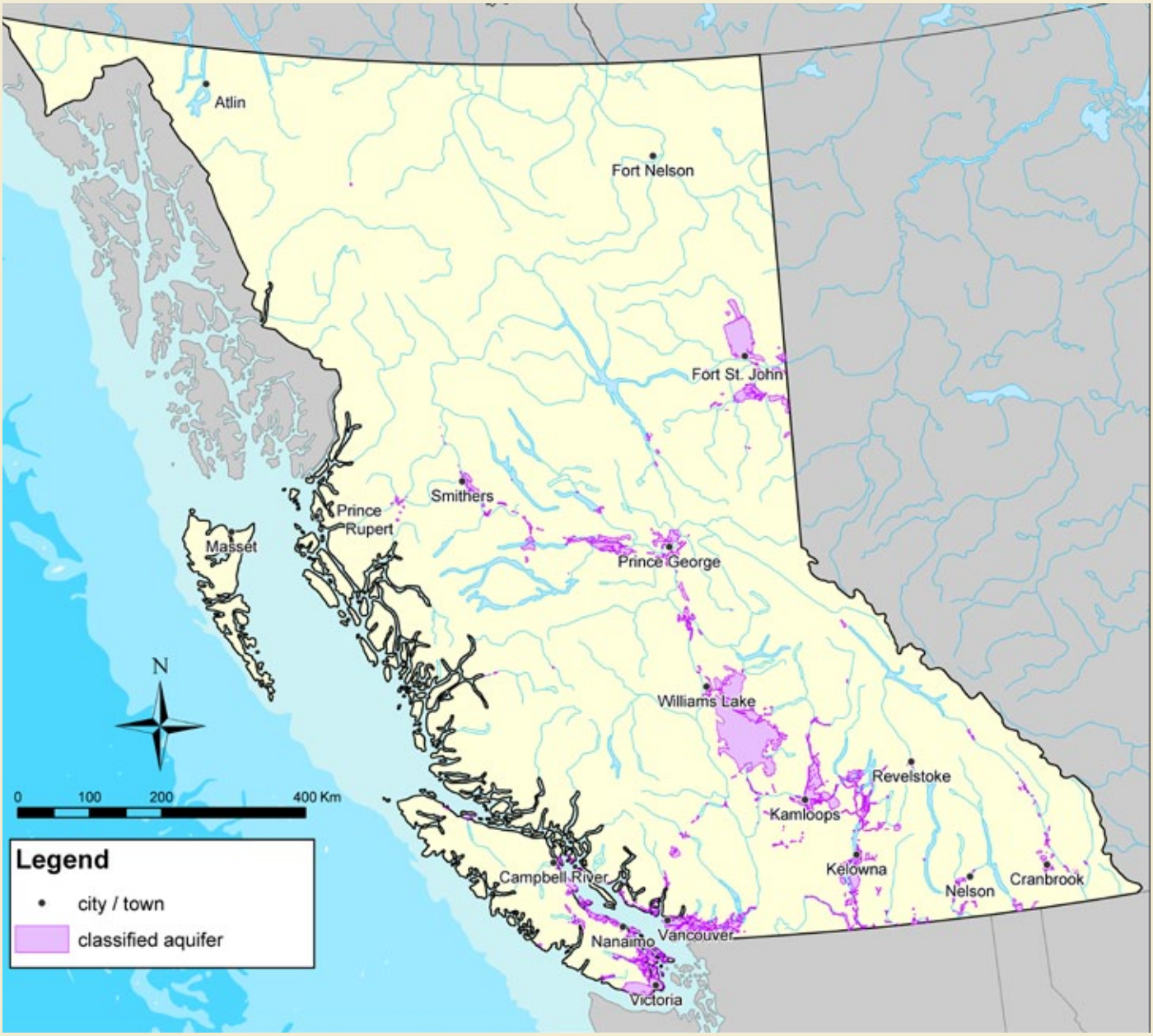
Characterizing an aquifer allows much greater understanding of it than can be obtained through classification alone – as well as of the surrounding watershed and recharge area. Methods of characterization include three-dimensional mapping and water balance assessments that provide more robust data on which to base decisions, although they are more expensive to conduct than classification.

The characterization work undertaken in British Columbia is limited and has been done on a piecemeal basis primarily by contractors working with local government and academics, often without provincial government involvement. Characterization work that has been undertaken relies on data from the WELLS database.

The ministry has recently begun to work with the Geological Survey of Canada and Regional District of Nanaimo to characterize groundwater in the Nanaimo Basin. As a result of this work, the ministry will also be collaborating on the development of common standards for data collection and analysis to allow for meaningful analysis and comparison of data and results.

Exhibit 3: Map showing the 916 aquifers classified in British Columbia (2007 data)

Note: Areas where no aquifers have been defined (pale yellow) should not be interpreted as lacking groundwater resources.



Source: Ministry of Environment

The WELLS database

The ministry maintains a database of groundwater wells (wells that access aquifers) in the province, referred to as the WELLS database.

Under the *Ground Water Protection Regulation*, the submission of well records is voluntary. By ministry estimates, there are approximately 200,000 groundwater wells in the province, although only about 100,000 are identified in the WELLS system.

In addition to groundwater wells, oil, gas and geothermal wells drilled in the province have the potential of affecting groundwater quality. However, information on oil and gas wells is maintained separately by the Oil and Gas Commission and is not readily available to ministry staff, and information on geothermal wells is not maintained at the provincial level.

RECOMMENDATION 1: ***We recommend that the Ministry of Environment ensure that classification of the province's aquifers is completed for all priority areas and that the WELLS database is kept up to date. The ministry should also ensure that aquifers are characterized, starting with those classified as having the highest priority.***

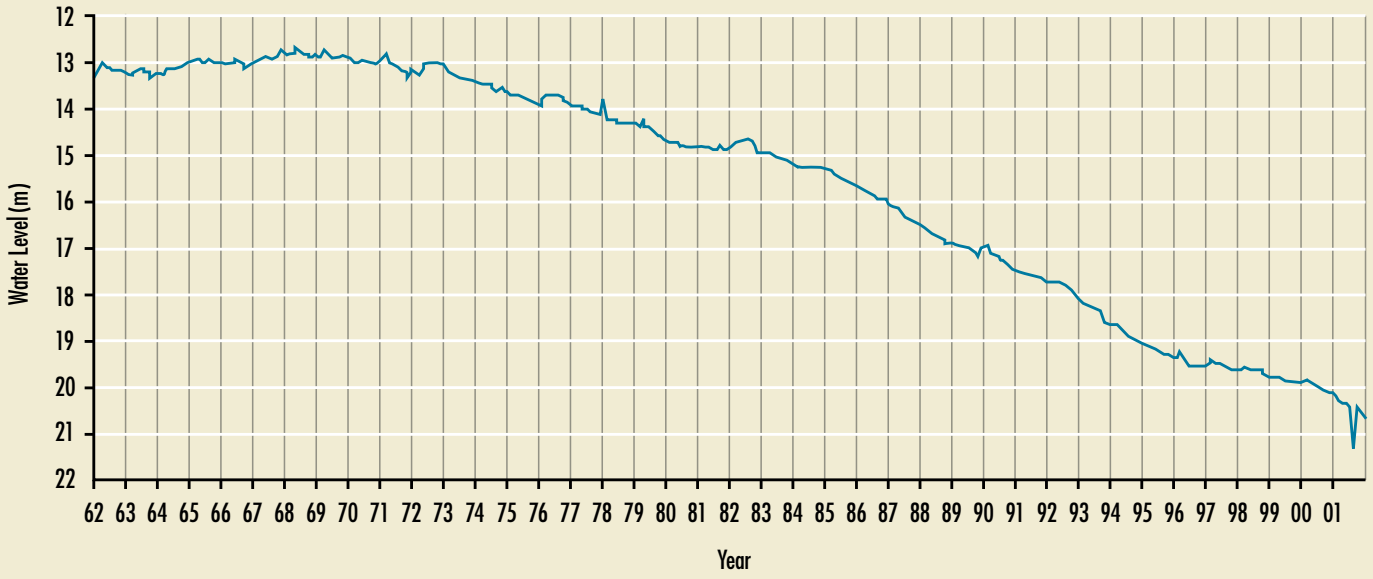
Monitoring of groundwater

Groundwater monitoring is needed so that the ministry has current information on the state of groundwater quantity and quality. The ministry has two networks for monitoring groundwater: the Provincial Observation Wells Network and the Provincial Ambient Groundwater Quality Monitoring Network. We found, however, that neither the data provided by these networks nor the frequency of testing is sufficient to support effective decision making in some areas of the province.

The Provincial Observation Wells Network

The Provincial Observation Wells Network was established in 1961. As of July 2009, the network has 145 active observation wells covering major developed groundwater areas of the province. Through the use of remote sensors installed in some wells and periodic water sampling, the network monitors the levels and, to some extent, the quality of groundwater. Exhibit 4 shows data from one of the observation wells in Langley where the level of water in the well has fallen by 7 metres in 40 years.

Exhibit 4: Depth to water level in Provincial Observation Well #007, located in Langley (1962 – 2001)



Source: Ministry of Environment

A review of the network prepared for the ministry in June 2009 identified a need to expand the network in the immediate term in certain key areas within each Ministry region to support local water services and water management decision–making. The review revealed that expanding the network with an additional 146 new wells would be ideal, but a more prudent approach over the next 10–15 years would establish an additional 50–75 new observation wells in key areas and priority aquifers. The review also stated that the current network is not entirely suitable for monitoring the effects of climate change, coal bed methane development, pine beetle infestation and deforestation, and the drilling of geothermal wells.

Provincial Ambient Groundwater Quality Monitoring Network

The Provincial Ambient Groundwater Quality Monitoring Network was established in 1986 to examine groundwater quality concerns in the province and monitor trends over time. Network areas were selected where groundwater was being used as the drinking water supply, where there were significant land use activities, or where there were shallow water table aquifers vulnerable to contamination.

Some of the regional water quality concerns identified include:

Region	Water quality concern
Vancouver Island	*salt water, fluoride, bacteria, arsenic, manganese*
Lower Mainland	*nitrates, salt water, fluoride, arsenic, manganese*
Southern Interior	*nitrates, fluoride, arsenic, sulphate, uranium*
Kootenay	*heavy metals, sulphate*
Northern	*arsenic, radioactivity*

Information is stored on the Environmental Monitoring System, although the system is difficult to use and the information is not available to the public. We were told that water quality testing is undertaken annually or semi-annually in the Lower Mainland and less frequently elsewhere. We were also advised that it was difficult to identify trends in the data, but it could be used to illuminate emerging water quality issues.

RECOMMENDATION 2: ***We recommend that the Ministry of Environment expand the Provincial Observation Wells Network and review the Provincial Ambient Groundwater Quality Monitoring Network to ensure there is sufficient monitoring of groundwater levels and quality across the province.***

Coordination and consolidation of knowledge

Information on water quality is gathered and maintained by many agencies, not just the Ministry of Environment. Provincial health authorities maintain databases on drinking water quality as well as issuing drinking water advisories. At a federal level, Health Canada maintains information on drinking water quality within First Nations. At an individual level, private well owners are responsible for testing their water. However, none of the above information is required to be shared centrally so the ministry or other agencies can access it.

First Nations Water Supply

The Province has very little information on water supply and quality in First Nations communities in British Columbia as they fall under federal jurisdiction. Indian and Northern Affairs Canada (INAC) and Health Canada are the two primary federal departments that work with First Nations and provide funding for infrastructure and water quality monitoring.

On First Nations land that have been leased out for residential or economic development use, quality oversight is to be provided by Health Canada; however, leaseholders are responsible for all aspects of infrastructure and operation.

In the last year, Health Canada piloted the testing of private wells in four First Nations communities. We were advised that the pilot program identified a number of private wells where water quality did not meet the *Guidelines for Canadian Drinking Water Quality* and that recommendations were provided to homeowners.

Private Well Owners

The *Drinking Water Protection Act* defines standards for domestic and municipal drinking water systems, but those standards do not apply to private wells that supply water to single family residences. We were advised that a number of private well owners do not test their water at all. One of the key reasons identified was the confusing number of tests that could be applied.

Health Authorities

Health authorities are responsible for issuing drinking water advisories or notices. As of October 21, 2010, there were 638 active advisories and notices in British Columbia, some dating back to 1988. These range in severity from Water Quality Advisories ("modest threat") to Do Not Use Water Notices ("a significant public health

threat exists"). As the source of the water is not identified, it is unclear whether they apply to surface or groundwater. In some regions, it is also difficult to discern the reason for the notice or advisory as there is no province-wide tracking system for water quality data.

"Do Not Drink" Notice Issued for Greater Vernon (Coldstream)

On January 13, 2010, during our audit visit to the ministry's regional office, a community groundwater well became contaminated and a "do not use" water notice was issued.

While the groundwater well (Antwerp #1) has a history of contamination because of the shallow nature of the aquifer, in this particular instance manure had been spread on snow. Following a mild period, it is believed rain washed the manure over the snow and into an adjacent abandoned well, contaminating groundwater well. Some 3,000 residents were affected by this event.

The issue was identified when a resident notified authorities that the tap water smelled of manure. On January 13, provincial emergency services and several other agencies worked into the night to notify residents not to use the water.

The notice was in effect for over three weeks until an alternative water supply was accessed for the residents. A Pollution Prevention Order was issued in the first quarter of 2010, along with an order to close the abandoned well. As of October 2010, we have been advised that the contamination remains under investigation by ministry staff.

RECOMMENDATION 3: ***We recommend that the Ministry of Environment take the lead on coordinating the consolidation of all of the groundwater monitoring information collected by provincial ministries and other agencies to reduce duplication of effort and to ensure the best use of limited resources.***

Long-term strategy

A groundwater information management strategy is needed to ensure that groundwater is managed in a sustainable manner. However, the ministry has no such overall strategy that is built on a comprehensive, coordinated body of scientific data incorporating identified trends. In spite of this, some long-term research by two ministries is looking at issues of relevance to groundwater sustainability.

Strategic planning

In its strategic plan for 2008, the Water Stewardship Division recognizes the challenges facing water resources from increasing demand, the effects of climate change, the shifting role of government, evolving relationships with First Nations, and greater public demand for safe drinking water. In addition to Living Water Smart and the *Water Act* Modernization process, the division is also leading the development of a Water Science Strategy for British Columbia, which will take a long-term view of research priorities and knowledge gaps. The division was able to secure provincial government funding and in August 2010, the division held a water symposium in Victoria, Prince George and Kelowna to help development of this initiative. Input from the Symposium will be used to generate a framework for the Water Science Strategy in 2011.

Long-term research

While the province clearly recognizes the need for information and adaptation, ministry-based long-term research looking at the sustainability of groundwater is insufficient overall. We did, however, find examples in two ministries that are engaging in long-term research looking at science needs in this area:

Ministry of Forests and Range

Forests are an integral part of the hydrologic cycle, and the effects of forests on groundwater are important. The Ministry of Forests and Range has therefore considered in some of its research studies the impact of forest practices on groundwater.

Notably, the ministry has eight Long-Term Research Installations (field sites) in the province that are assisting with the development of forest management practices, regulations and guidelines. Of the eight, one is now inactive and the other seven are partially inactive or dependent on other agency funding to function. Of the two sites that collect groundwater information, one is at Carnation Creek, a small watershed in southwestern Vancouver Island. The site

includes a 40-year-old study of fish-forestry interactions – the world's longest continuous study of this nature. Information related to the watershed's physical and biological processes has been collected over three decades and includes data on stream temperature, flow and groundwater level. While groundwater information is no longer collected at Carnation Creek, the ministry has recently partnered with SFU to examine groundwater at Upper Penticton Creek.

Ministry of Agriculture and Lands

Water is a critical input to agricultural production. The Ministry of Agriculture and Lands has developed, along with other agencies, a water demand model. The aim of the model is to use accurate data to assess current and future agricultural water demands for the Okanagan area. The ministry is now looking to apply this model to the Fraser Valley.

The ministry and various stakeholders have also identified the important need to reserve water for agricultural lands. Currently, no agricultural water reserves exist in British Columbia.

Accessibility and application of knowledge

Much ministry information on groundwater is publicly accessible and free, but some of the databases can be difficult to use and there is no one comprehensive database to link the information together. For example, the BC Water Resources Atlas, which is the main tool used for accessing groundwater data, does not contain information on drinking water quality or on non-water-supply wells (that is, oil and gas and geothermal wells). Furthermore, the website notes that the information is currently under review and subject to verification, and that the ministry cannot confirm its currency, accuracy or completeness although we were advised that this is a standard qualifier for water information.

RECOMMENDATION 4: ***We recommend that the Ministry of Environment develop a groundwater information management strategy that takes into account detailed scientific information and identified trends, and ensure that the information required to support this strategy is collected, analyzed and available through one location.***

Groundwater is not being protected from depletion and contamination or to ensure the viability of the ecosystems it supports

The Ministry of Environment is responsible for managing, protecting and conserving all water, land, air, plant life and animal life, with regard for the economic and social benefits they may confer on British Columbia. If the province's groundwater resources are to be sustained, the ministry needs to protect them.

We therefore expected sufficient and appropriate legislation and other regulatory mechanisms to be in place to protect groundwater resources from depletion and contamination, and to ensure the viability of the ecosystems that they support.

Protection from depletion

British Columbia is the only province in Canada that does not have a general licensing or permitting system for groundwater withdrawals. This means that a well can be drilled and groundwater extracted without regulatory permission.

The ministry's *Environmental Trends in British Columbia: 2007* states that approximately 35% of its observation wells showed declining water levels as a result of human activities for the period 2000–2005. According to a December 2007 Environment Canada document, *A Federal Perspective on Water Quantity Issues*, British Columbia faces pressures on groundwater from high population growth, development, overuse, increasing irrigation demand and climate change.

Flowing artesian well near the Cowichan River on Vancouver Island. There is no legal requirement for flowing artesian wells to be stopped in order to protect groundwater from depletion.
Source: Ministry of Environment (credit: David Martin)

The ministry recognizes that current provincial legislation is not adequately protecting groundwater from depletion.

There are three pieces of legislation in the province that offer a degree of protection to groundwater from depletion:

- under the *Water Utility and Utilities Commission Acts* for withdrawals of groundwater for use by a public utility (although the public utility is not required to report on their groundwater extraction rates);
- under the *Environmental Assessment Act* for withdrawals of groundwater occurring at over 75 litres per second; and
- under the the *Oil and Gas Activities Act* for operations that could have a material adverse effect on quantity, quality or flow of water in an aquifer.

All other groundwater withdrawals are not controlled.

The *Water Act* and the *Ground Water Protection Regulation*

The province's *Water Act* applies to both surface and groundwater, although the Act specifies that the section relating to the licensing, diversion and use of water does not apply to groundwater unless regulations are brought into effect. This has not been regulated and, currently, the only regulation that does apply to groundwater under the Act is the *Ground Water Protection Regulation*.

In 2002, the Minister of Water, Land and Air Protection appointed a Groundwater Advisory Board to make recommendations for the *Ground Water Protection Regulation* with the understanding that the regulation would be developed in three phases.

Phase 1 of the regulation was enacted in June 2004 and was fully in force starting November 2005. The regulation established for the first time standards for drilling, altering and closing wells, and required qualified well drillers and well pump installers to register with the Province. However, the legislation does not require well drillers to advise the ministry of their actions, so the ministry has had limited opportunity to enforce this regulation. As a result, Phase 1 has provided no protection against groundwater depletion.

Phase 2 of the regulation focuses on well siting, flow testing, water quality reporting, well pump installation, mandatory submission of well records, flowing artesian wells, additional standards for well construction and storage of toxic substances near wells. This phase was scheduled to be completed in December 2007 at a cost of $760,000 a year and requiring an additional seven full-time equivalent positions, however, it has not been enacted.

Phase 3 of the regulation is intended to deal with the use, allocation and management of groundwater, which would provide better protection against depletion. Phase 3 has not been enacted.

We were told by ministry staff that implementation of Phases 2 and 3 of the *Ground Water Protection Regulation* had been deferred in 2008 and integrated with the *Water Act* modernization project. The plan in *Living Water Smart* states that, "by 2012, government will regulate groundwater use in priority areas and large groundwater withdrawals."

Protection from contamination

Contamination of groundwater can occur naturally or as a result of human actions (Exhibit 5). For example, high levels of arsenic and uranium are naturally present in some areas, while pollution from factories and septic systems is human caused.

While a number of regulations and acts in British Columbia contain elements aimed at protecting groundwater from contamination, there is no coordinated legislative framework. The cost of not adequately protecting groundwater can be extremely high, as demonstrated by the community of Dog Creek Road (see below).

Regional groundwater staff in the Water Stewardship Division are available to undertake only limited source protection work. And while staff in the ministry's Environmental Protection Division are responsible for ensuring compliance and enforcement of a significant number of regulations, the protection of groundwater makes up only a small component of that division's activities. As a result, relatively little compliance and enforcement effort is actually directed towards groundwater.

Exhibit 5: The hazards posing a threat to the quality of groundwater

Source: British Geological Survey © National Environment Research Council 1998

The outcome of groundwater contamination on Dog Creek Road

The Dog Creek Road community is a residential area south of Williams Lake. Residents are all on private well and septic systems.

In 1980, the Ministry of Environment constructed an observation well to monitor groundwater levels and quality in the area. At that time, nitrate-nitrogen levels were already elevated, indicating that groundwater quality was contaminated by various activities, including sewage disposal and the leaching of fertilizer and animal manure.

In 2005 and 2006, the ministry expanded groundwater monitoring to include a selection of privately owned wells, testing for human-related groundwater contaminants and comparing the quality with those specifications in the Guidelines for Canadian Drinking Water Quality. At Dog Creek Road, the ministry found that human activity is negatively impacting groundwater quality and that the Guidelines for some contaminants were exceeded in 27 of the 28 wells tested.

The cost of moving to a community sewer and water utility administered by the local regional district has been estimated at $84,000 per property owner, to be paid over a 25 year period.

Protection of ecosystem viability

Groundwater discharge to streams is important for maintaining stream base flows and temperatures. It also supports essential ecosystem functions such as:

- providing habitat for aquatic plants and animals;
- moderating the impact of cycles of drought; and
- sustaining wetlands.

Ecosystem: a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

The ministry has recognized the importance of maintaining in-stream flow for ecosystem viability. In September 2009, for example, the Minister of Environment issued a temporary curtailment of surface water use on the Nicola River to protect the Kokanee salmon population.

"Ministry invokes order to save salmon" Kamloops Daily News (September 21, 2009)

For the first time in the province's history, B.C.'s environment minister [Barry Penner] ordered water licensees to stop drawing from the Nicola River. Barry Penner said Sunday the order had to be made because one rancher had reduced his use, but hadn't completely stopped. "Water levels are low. The consequence of that is it poses a severe stress on fish that need to come up and spawn".

A low winter snowpack, combined with a hot, dry summer have left the Nicola River flows at about 45 litres per second, Penner said. The order remains in effect until flows are up to 350 litres per second.

The Province's *Fish Protection Act* did not allow for ministerial orders to be issued in times of drought until last month. Penner said the hot, dry conditions could be seen as creating a problem for spawning salmon, so he went to cabinet to allow for water-use orders to be made.

However, we found that maintenance of ecosystem viability is not a consideration within the province's aquifer classification system. The ministry has developed indicators of ecosystem health that includes trends in surface water quality and the percentage of observation wells that show declining water levels, but there is no focus on indicators that assess the protection and management of groundwater resources for ecosystem purposes.

Current legislation does not require the management of groundwater to protect the viability of the ecosystems it supports. The one exception is the *Contaminated Sites Regulation* under the *Environmental Management Act*. Here, environmental quality guidelines have recently been strengthened to provide ecosystem protection. The guidelines apply to groundwater where it flows from a contaminated site and is used, or has a reasonable probability of being used, for aquatic life, irrigation, livestock or drinking water.

"Record-keeping of extractions is one area where Canadians could and should have certainty. If decisions for additional allocations from a basin are to be in the best interest of the basin's socio-economy and ecosystems, there should be no uncertainty about the volumes that permitted users are already removing, how the water is being used, and the extent and location of the return flows."

Council of Canadian Academies, 2009

The guidelines were revised in July 2010 and will further strengthen the protection of groundwater for ecosystems. They come into effect February 1, 2011.

RECOMMENDATION 5: ***We recommend that the Ministry of Environment develop and deploy systems to protect groundwater from depletion and contamination and to ensure the viability of the ecosystems it supports.***

Control over access to groundwater is insufficient to sustain the resource and key organizations lack adequate authority to take appropriate local responsibility

Drawing upon government's goal to "Lead the world in sustainable environmental management, with the best air and water quality… bar none" we expected that the Province would not only protect groundwater, but also ensure that groundwater is being managed effectively. For the purposes of this audit, we used as measures of effective management, controlled access by all users to groundwater and appropriate authority for decision making purposes.

Specifically, we anticipated that groundwater would be allocated to maximize its potential contribution to economic and social well-being and to ensure fair and adequate access.

We also expected to find the Province delegating appropriate and sufficient local responsibility for groundwater management. Further, we expected that groundwater resources would be managed at an integrated watershed level as explained below.

The primary consumers of groundwater use it for domestic, commercial, ecological, agricultural and industrial purposes (e.g. oil, gas and mining).

Access to groundwater

In British Columbia, access to Crown resources such as surface water, oil and gas, minerals and forests is controlled. Extraction happens only with a permit or license. Groundwater is also a Crown resource, but its access is not controlled in a similar manner.

Comparison with surface water

Once an application to access surface water has been received by the ministry, potential impacts to the environment and to other users are identified and ministry staff determine if there is sufficient water available to warrant issuing a new water license.

In addition to application fees charged for surface water permitting, there are annual license charges. For 2010, a surface water license started at $25 for a domestic user, for use of up to 114 cubic metres of water per day. However, there is no charge for groundwater because it is not licensed.

We noted that the ministry has been considering opportunities to recognize the value of groundwater. In 2002, as part of the implementation of the *Drinking Water Action Plan*, the ministry recommended recovering costs from all water users (surface and ground).

In the *Water Act* Modernization Discussion Paper issued in February 2010, one objective given is that groundwater extraction and use be regulated in priority (critical) areas and for all large withdrawals. There is also reference to the possible use of water pricing structures. An option identified is that of allowing the use of penalties, pricing or incentives to encourage water efficiency. Enhancing control over access to groundwater is consistent with government's goal of being a leader in sustainable environmental management.

"Canadians must start paying more for water and embrace water conservation measures or risk the depletion of one of Canada's most valuable resources. Increasing the cost of water is one of the best incentives for conservation. Canadians subject to water metering use less water than their rural counterparts who have no means of accounting for water usage."

Conference Board of Canada

Appropriate local responsibility for groundwater

Although groundwater is a Crown resource, management of it requires the involvement of many parties at all levels of government. We found, however, that many local agencies lack the statutory authority they need to take appropriate responsibility for the resource, for example, mandated drilling authorizations. The ministry is soliciting input on the management of surface and groundwater from local agencies through the *Water Act* modernization process.

In 2004, the Province enabled the development of community-based Water Management Plans. These are intended to be area-based plans that minimize water quality risks and address or prevent conflicts between users. To date, the Township of Langley, through an interagency planning team, is the only municipality to have prepared a Water Management Plan for approval by the Minister of Environment.

Township of Langley

The Township of Langley is situated in the Lower Mainland and has some 100,000 residents. Approximately 80% of the Township's water supply comes from municipal and private wells. Ongoing monitoring indicates declining water levels in the more intensively used aquifers.

Groundwater Management Area roadside sign, Township of Langley
Source: Office of the Auditor General staff

In July 2006, a Ministerial Order was signed by the Minister of Environment setting out the terms of reference for developing a water management plan. The plan provides for the costs to be shared between the Province and the Township of Langley. We were told that the cost of developing the Water Management Plan exceeded $300,000, excluding in-kind costs. The cost of implementing the plan is estimated to be approximately $650,000 per year, although in the first five years the likely cost will be closer to $1 million annually. These costs are based on full implementation of the plan and assume the costs will be shared between the Township and the Province. The plan was submitted to the Minister in December 2009 and, as of October 2010, the plan had not been approved.

City of Chilliwack

The City of Chilliwack is a community of approximately 80,000 people, located about 100 kilometres east of Vancouver. Drinking water for the city is obtained from the Sardis-Vedder aquifer. The City of Chilliwack won the Best Drinking Water in Canada award in 1997 and 1999.

The City is aware that the aquifer is heavily used and highly vulnerable to contamination. It estimates that the cost to treat the water if the aquifer were ever contaminated would be about $30 million. As a result, allowable uses in the catchment zone have been restricted, and geothermal wells, gas stations, dry cleaners and any business using pesticides are prohibited. The City has also targeted educational campaigns at residents, local industry and agriculture about the vulnerability of the aquifer.

City managers told us that, to further manage this Crown resource, it needs the Province to clearly define roles and responsibilities between the two authorities.

Vedder River (and aquifer), Chilliwack, BC
Source: Office of the Auditor General staff

The Okanagan Basin

The Okanagan Basin is one of the areas in British Columbia facing especially large challenges from water shortages. Since 1970, the Okanagan Basin Water Board has been tasked with identifying and resolving critical water issues for the Okanagan watershed.

While access to groundwater is not controlled, the board is taking steps to assess demand and supply. It is expected that this research will provide better information to guide authorities in making groundwater allocation decisions that are based on priority needs, and aquifer capacity and sustainability – an acute challenge especially in times of drought.

RECOMMENDATION 6: ***We recommend that the Ministry of Environment develop a framework that clearly outlines the roles and responsibilities for managing groundwater provincially and locally, and ensure that agencies are able to take responsibility for groundwater in their area.***

Integrated watershed management

While protecting ground and surface water is recognized as important, primarily for ensuring a steady supply of safe drinking water, experts now recognize that taking a broader, integrated approach to water management at the watershed level is critical to the long-term protection and management of groundwater resources. The Walkerton experience underscores this point. The contamination of groundwater that supplied drinking water in Walkerton, Ontario, in May 2000 resulted in seven deaths and 2,300 residents falling ill. As Conservation Ontario noted, two important lessons were learned:

"Lesson One: Humans are part of the environment. Our society is not, and cannot, be isolated from the environment in which we live."

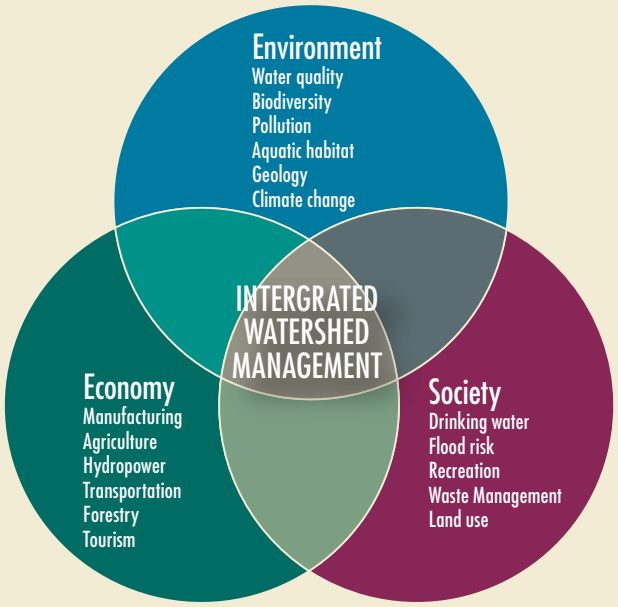
"Lesson Two: Taking a fragmented, issue based approach to managing our environment is time consuming and expensive. The focus on source protection does little to build capacity to deal with other environmental hazards. Source protection should be nested into a broader planning, policy and program approach called integrated watershed management."

The concept of an integrated watershed management approach as advocated by Conservation Ontario is illustrated in Exhibit 6. According to the agency, "What we do on the land impacts the quality and sustainability of our natural resources – particularly water – so we can't ignore these influences when we are making decisions about the environment."

The ministry has plans and strategies to deal with contaminated sites and sources of pollution; however, they are not fully integrated on a watershed level and do not take into account cumulative effects. Part of the reason is that the financial and human resources required to develop integrated watershed management plans are significant, involving multiple agencies.

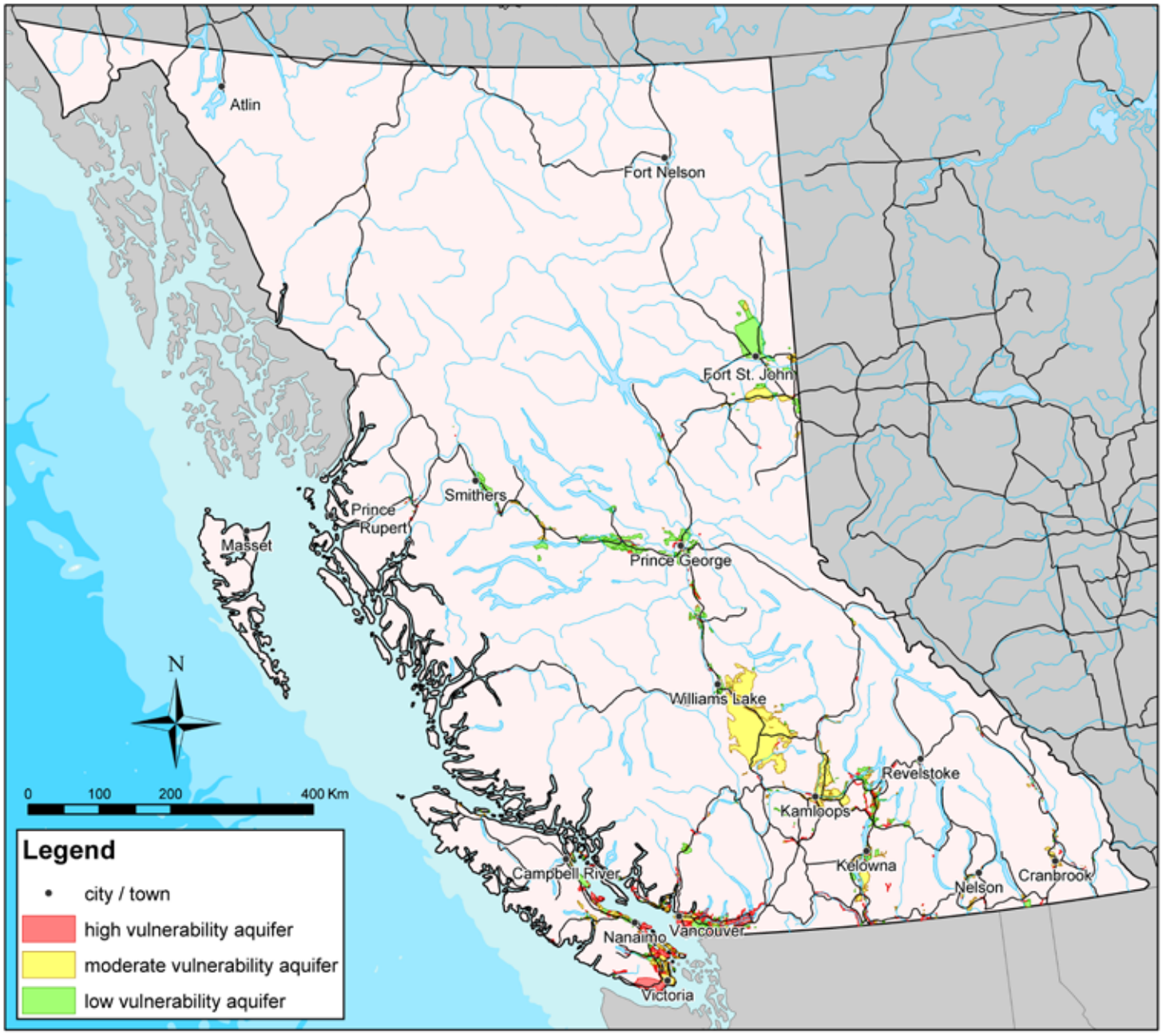
RECOMMENDATION 7: ***We recommend that the Ministry of Environment ensure that integrated watershed management plans are developed for all priority watersheds.***

Exhibit 6: The components of an integrated watershed management approach to achieving source water protection



Source: Conservation Ontario

APPENDIX: AQUIFER MAPS CLASSIFIED BY VULNERABILITY TO CONTAMINATION



Source: Ministry of Environment

The land-base and aquifer map layers used to create this map were digitized at different map scales to improve the visibility of the aquifers. As a result, the maps do not align perfectly.

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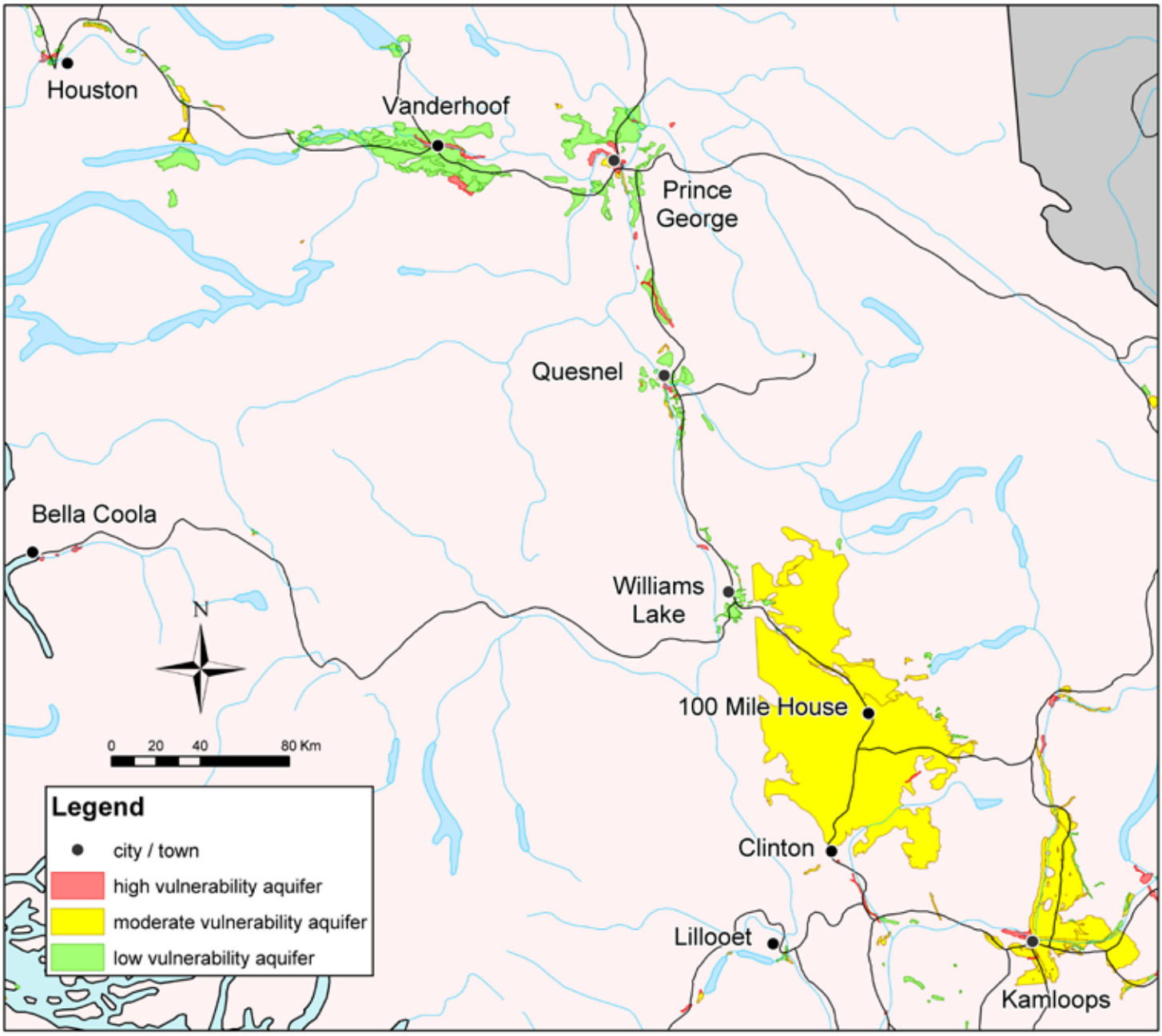

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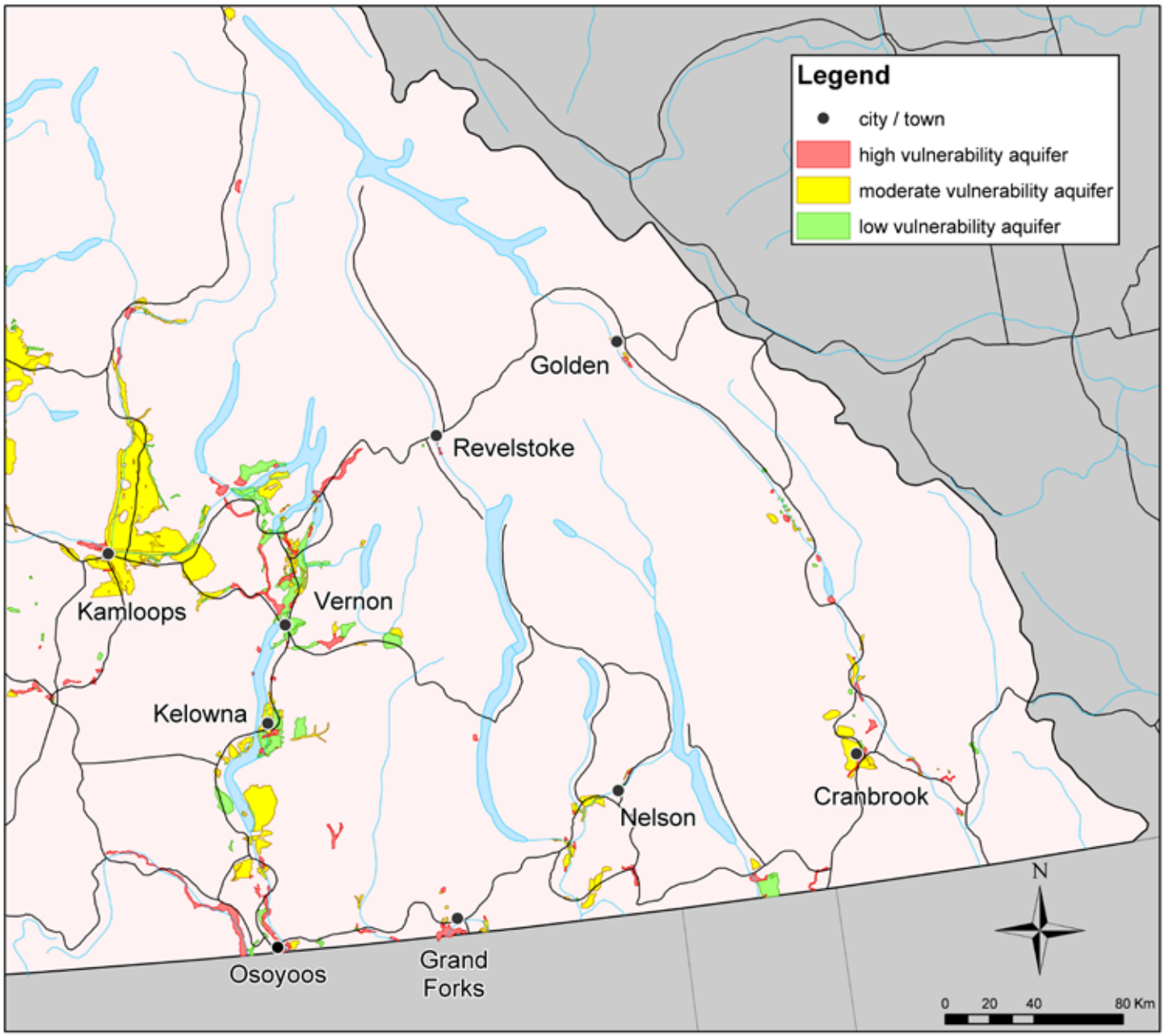

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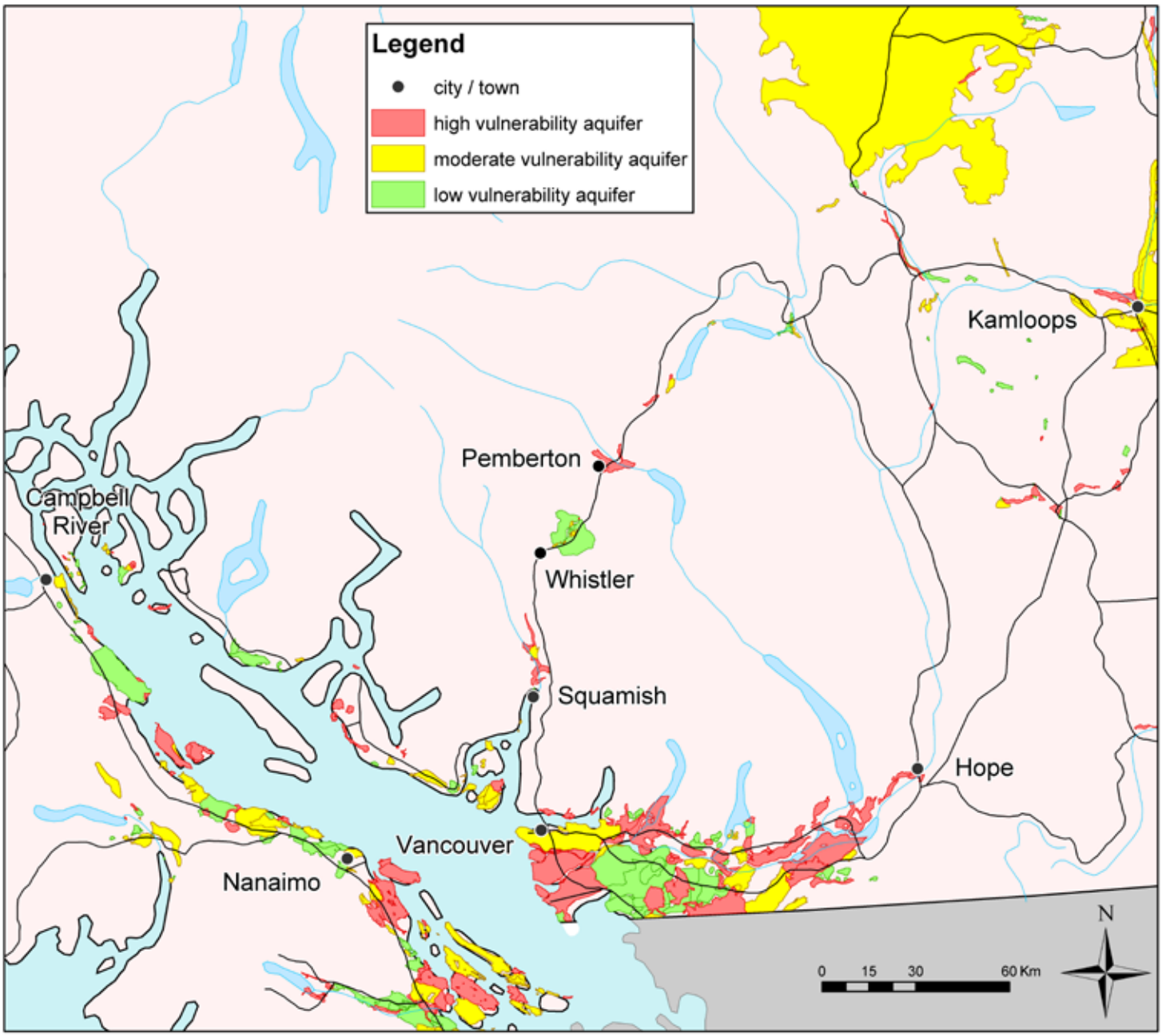

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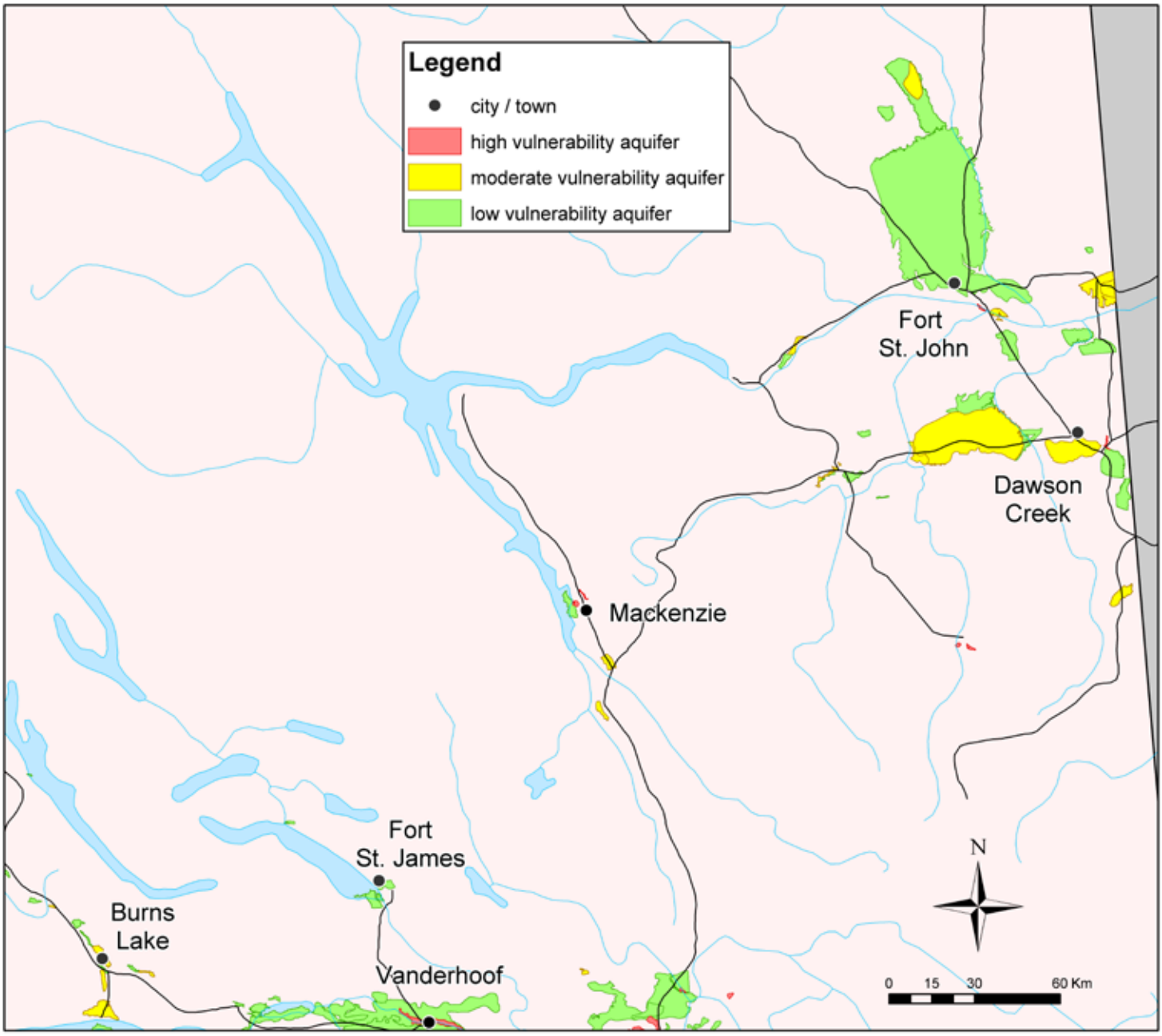

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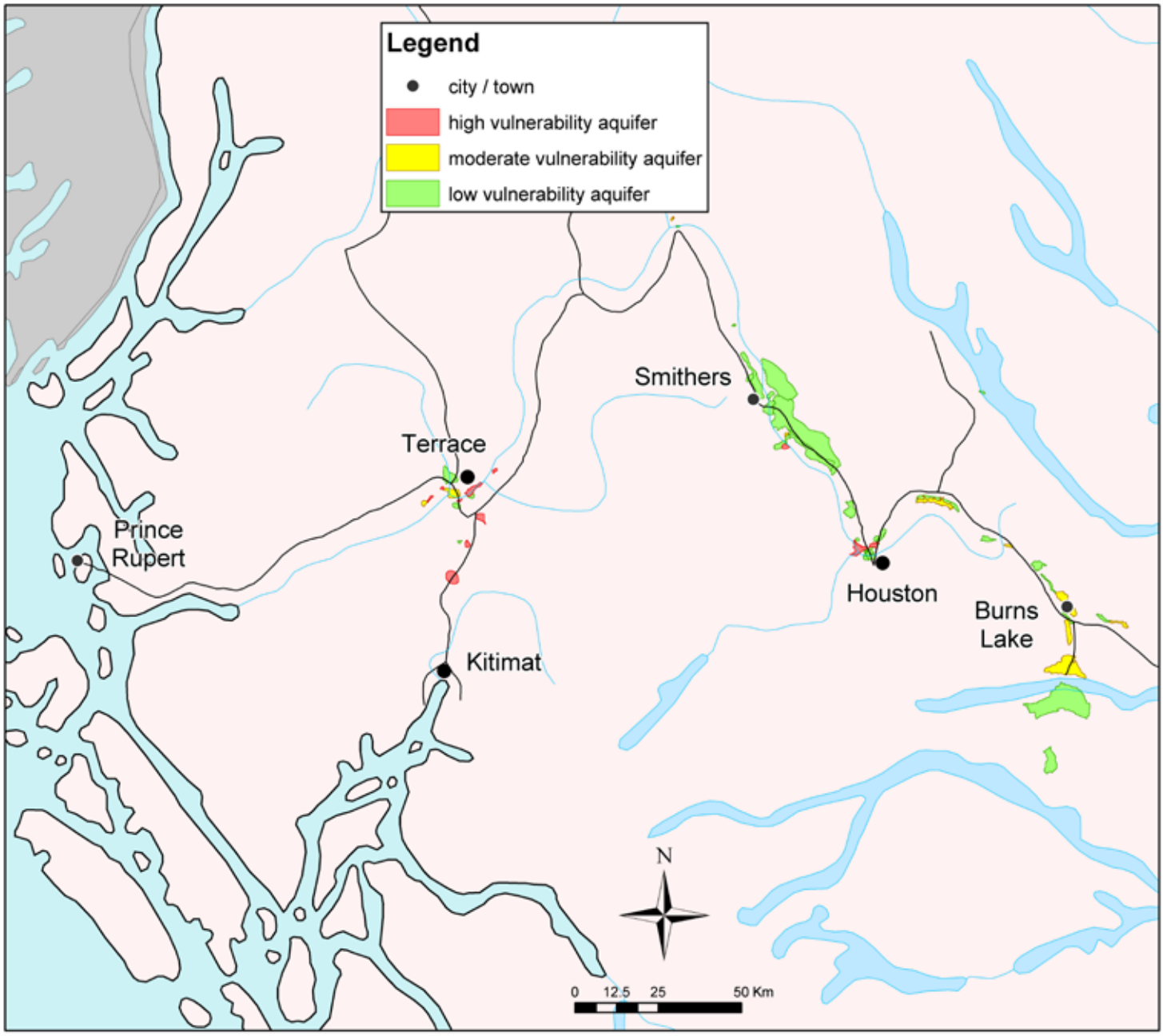

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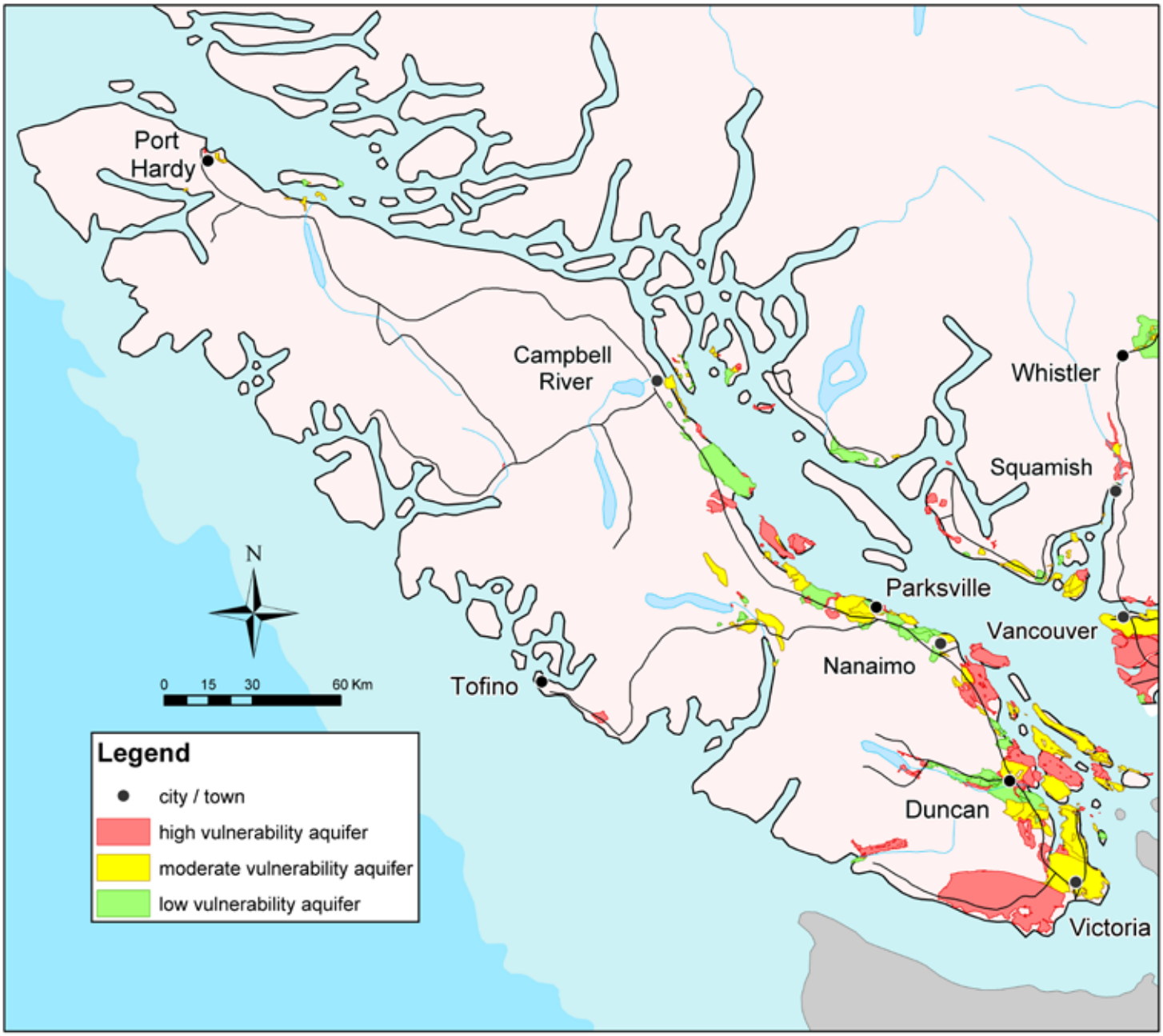

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