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GROUNDWATER USE IN CANADA

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INTRODUCTION

This case study focuses on groundwater use in Canada. It explores patterns of groundwater use across the country and notes some of the significant gaps in the data. Its purpose is to compile the data and information available about groundwater use in Canada, to enable better understanding of groundwater use - who is using it, for what purposes, where, when and with what impacts on the resource.

In order to highlight some of the possible regulatory issues concerning groundwater use, this study also briefly reviews and evaluates use trends in the bottled water industry, and the regulatory schemes applicable to that industry in each of the provinces and territories.[1] Because this study's focus is sustainability, the latter discussion is limited to considering regulatory measures aimed at protecting sustainability of groundwater. Regulatory measures designed primarily to safeguard public health are not evaluated.

Groundwater and groundwater studies are important. As stated in the *Canadian Framework for Collaboration on Groundwater*:

> Close to ten million Canadians rely on groundwater for their drinking-water supply. All Canadians rely indirectly on groundwater because it is the primary source of water for livestock watering and crop irrigation. As groundwater is an integral component of the hydrological cycle, the health of our streams, lakes, wetlands, and associated ecosystems depends upon groundwater. Groundwater also sustains economic activity by providing significant water supplies for industries involved in manufacturing, mining and petroleum. Although groundwater is a renewable resource, it is not limitless and requires wise management to protect its integrity, security and sustainability.[2]

The fact that groundwater performs so many important human, ecological and environmental services underlines the need for understanding how human uses of groundwater may impact groundwater sustainability. Human use of groundwater and other anthropogenic phenomena, such as urbanization (as well as many other development activities not directly addressed in this study[3]), can significantly impact groundwater health and supplies, and consequently, ecological and human health. Data collected at

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1 We chose the bottled water industry not to suggest that it has any greater impact than any other industry, but simply to highlight an example of one use of groundwater, and in this case, a use that is on an uptrend.

2 Government of Canada, *Canadian Framework for Collaboration on Groundwater* (2003), at p. 1.

3 For example, groundwater is vulnerable to contamination from a range of human activities and developments, such as: waste from intensive livestock operations, fertilizers and pesticides, oily and other spills, leaking underground storage tanks, etc. Covering land with concrete and other impervious materials also impedes groundwater's natural ability to recharge from precipitation. Groundwater may also be affected by such human-induced effects as climate change, or natural cycles such as drought. See e.g. "Groundwater studies in Ontario: Mapping a hidden treasure", (Queen's Printer for Ontario, March 2004); also Y. Michaud, C. Rivard, R. Lefebvre, A. Rivera and D.A. Pupek, "Preliminary assessment of groundwater resources in southeastern New Brunswick in the context of climate change" (March 15-16, 2004, Moncton, NB); and Alfonso Rivera, Diana M. Allen and Harm Maathuis "Climate Variability and Change - Groundwater Resources" Chapter 10 (pp. 77-83) in Environment Canada, National Water Research Institute, *Threats to Water Availability in Canada* (Ottawa: Minister of Public Works and Government Services Canada, 2004).

observation wells[4] in British Columbia have revealed measurable impacts from human use of groundwater:

> The percentage of observation wells with declining water levels due primarily to human activities increased from 10% in 1965-1970 to 14% in 1995-2000. Declining water levels related to human activities are mostly a result of intensive local groundwater pumping for industry, agriculture and municipal water supplies and, in urbanized areas, decreased recharge due to impervious surfaces."[5]

In researching and preparing this paper, we conducted a brief review of literature on groundwater use in Canada, and compiled data, as available, from both government and non-government sources. We analyzed the data, seeking to identify and highlight use patterns and trends and especially any issues related to sustainability of the groundwater supply. For each jurisdiction, we also specifically compared the incidence of water bottling operations and the legal framework regulating the bottled water industry insofar as the taking might affect sustainability of the groundwater resource.

In the end, this case study underlines groundwater's integral role in the everyday lives of Canadians. Groundwater is used in all kinds of industries; it flows in our public water systems; and it has a growing commercial importance. This study shows that Canada does not yet have a complete set of data for fully understanding how we use it, an essential building block for regulations to control groundwater use and protect sustainability.

AVAILABILITY OF DATA, AND DATA GAPS

Data[6] on groundwater use, when combined and interpreted with data on groundwater resources,[7] is critical to equipping groundwater regulators with the information necessary to make decisions related to use issues, such as:

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4 Many jurisdictions in Canada have extensive systems of groundwater monitoring wells, enabling the recording of such things as water level trends and chemical composition of water. Such wells can provide some warning that a rechargeability issue is looming.

5 20 out of 139 wells monitored showed declining water levels due primarily to human activities in period 1995-2000 . "5 are in the Lower Mainland, 3 are in the Okanagan and 7 are along the southern east coast of Vancouver Island and the Gulf Islands." BC Ministry of Water, Land and Air Protection, State of Environment Reporting, "Groundwater in British Columbia" (2001 data), online at http://wlapwww.gov.bc.ca/soerpt/7groundwater/wellsglance.html. With its observation well system, British Columbia tracks declining water levels, heavy demand wells, and the number of wells with reported groundwater quality (contamination) concerns.

6 As pointed out in the *Canadian Framework for Collaboration on Groundwater* (at p. 27), "…the term 'data' refers to measured values, such as water levels, chemical analyses, hydraulic conductivities, or well locations, that have not been interpreted within a specific context. The term 'information' refers to the interpretation of data within a specific context and with specific hydrogeological knowledge, such as relating water-table fluctuations to seasonal conditions and pumping levels."

7 A critical key to understanding the significance of groundwater use is to understand groundwater supply and rechargeability. The latter involves identifying the existence and nature (water type) of groundwater resources or aquifers, where the aquifers can be mapped, how the aquifers interact with other aquifers and with surface waters or surface contaminants, and whether the aquifers are healthy – i.e., able to properly re-charge and free from contamination. Both Manitoba and Saskatchewan have done extensive mapping, documenting and classifying of aquifers: see websites of Saskatchewan Watershed Authority, Saskatchewan Research Council, and Manitoba Water Stewardship Water Branch for more information. In recent years, Ontario has devoted

- How the volume of takings compares to the availability of supply;
- What the likely impacts might be, and which kinds of uses are most likely to be detrimental to groundwater quality or quantity;
- When or where groundwater supplies are likely to be most stressed; and
- Whether some aquifers are more likely to be vulnerable to takings than others, given the quantity or nature of the takings.

We gathered data from federal, provincial/territorial and local government sources, and from industry and non-government researchers, where available. The quality and availability of data were uneven. Use data in Canada more often tracks *water* use than *ground*water use; and it is even more difficult to find data that tracks groundwater takings by detailed categories of use, as opposed to aggregated use categories.

We identified the following specific data gaps:

- Several jurisdictions (Ontario, Quebec, Nova Scotia, Yukon, Northwest Territories and Nunavut) did not have use data readily available. In some cases (Ontario and Quebec), we were able to obtain data from private sources (Gartner Lee and Quebec Water Bottlers Association respectively).
- There is a general shortage of data on actual use of groundwater. Most jurisdictions had some data available on volumes of groundwater allocations (under a permit or licensing regime); but, few jurisdictions had readily available data to confirm the *actual* volume of use. Only Manitoba and Alberta were able to provide some actual use data.[8] Protection of commercially-sensitive information was sometimes given as a reason for withholding actual use data.[9]
- Unevenness in data collection and categorization of use amongst jurisdictions made comparisons from one jurisdiction to another cumbersome. Also, most jurisdictions have organized their use data into very general categories of use, rather than a finer resolution or categorization scheme. This makes it difficult to ascertain which particular uses are the most prominent.

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considerable resources ($19.3 million) to researching and mapping its groundwater resources. "Groundwater studies in Ontario: Mapping a hidden treasure", (Queen's Printer for Ontario, March 2004). Alberta is also actively engaged in the process of building an accessible inventory of its groundwater resources, and regards this filling of gaps as "essential to good decision-making": see Alberta, "Water for Life" website at http://www.waterforlife.gov.ab.ca

[8] BC's data appears as "actual use" data, but since groundwater takings are not regulated, the volumes can only be inferred from monitoring and are not actual measures: BC Ministry of Water, Land and Air Protection, "Environmental Indicator 2000", at p. 1. As part of its review of its Permit to Take Water Program, Ontario is now considering requiring some users to report actual use of water, including municipal water supplies, major industrial dischargers and water takings that remove water from the watershed: see Proposed Regulation, June 2004, further to EBR Registry No. RA04E0011. Manitoba's *Water Rights Regulation* at s. 8 requires actual use record-keeping by licensees; Manitoba is currently working to establish a database of actual use data.

[9] The Canadian Bottled Water Association has lobbied the Ontario government not to release actual use data to the general public, stating that to do so "could put individual bottlers at a competitive disadvantage" and "…Ontario's bottled water industry as a whole could be placed at a disadvantage compared to neighbouring jurisdictions." See CBWA, "Comments on the Proposed Amendments to Ontario regulation 285/99…" dated May 21, 2003, found online at http://www.cbwa-bottledwater.org/en/news.html.

- There is a shortage of data placing provincial groundwater use in the context of national use of water and groundwater.

- Trend data for non-municipal use of groundwater is either not available or not readily available.

This study is certainly not the first to note the gaps in Canadian groundwater data. In 2000 and 2001, experts from across the country gathered at the First and Second Workshops on Groundwater,[10] and identified numerous issues of concern regarding groundwater knowledge and management in Canada, including the shortage of data and lack of research on groundwater issues. These workshops led to the establishment of a National Ad Hoc Committee on Groundwater, which in turn published a "vision document" - the *Canadian Framework for Collaboration on Groundwater* – which proposed to define "the basis for securing the fundamental information necessary to manage and protect the groundwater resource."[11] It is hoped that Canada and the provinces will implement the Framework's goals collaboratively. "[A]cquiring a high standard of groundwater information and knowledge," and "establishing effective linkages of groundwater-information systems" are two of the listed goals.[12]

While not the first to note the gaps in data, this study is, however, the first to attempt a comprehensive catalogue and assessment of the availability of data regarding groundwater use across the country.

INTERPRETING THE DATA AVAILABLE

LEVEL OF DEPENDENCE ON GROUNDWATER

On a national scale, the degree of Canadians' dependence on groundwater is significant and has been noted by the federal government:

> In Canada, 8.9 million people, or 30.3% of the population, rely on groundwater for domestic use. Approximately two thirds of these users live in rural areas. In many areas, wells produce more reliable and less expensive water supplies than those obtained from nearby lakes, rivers and streams. The remaining users are located primarily in smaller municipalities where groundwater provides the primary source for their water supply systems.[13]

Table 1 compares the provinces and territories on the basis of two measures of dependence on groundwater resources: the number and proportion of the jurisdiction's population that is dependent on groundwater for their drinking water supply; and the proportionate share of the jurisdiction's overall use of water that is met by groundwater resources.

Table 1 reveals that Prince Edward Island demonstrates the highest critical dependence on groundwater supplies, meeting 100% of the province's drinking and other freshwater needs. New Brunswick and Nova Scotia are also very dependent on groundwater, with 66.5% and 45.8% of their populations respectively dependent on that source. In the Yukon, groundwater meets a large proportion of the population's everyday

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[10] Referred to in Government of Canada, *Canadian Framework for Collaboration on Groundwater* (2003).

[11] *Ibid*, at p. 1.

[12] *Ibid*, at p. 2.

[13] Environment Canada, "Groundwater – Nature's Hidden Treasure", (Freshwater Website publication) online at http://www.ec.gc.ca/water/en/info/publs/FS/e_FSA5.htm.

water needs, though surface water is used to meet needs like placer mining and agriculture. The only Yukon communities that are partially dependent on water supplies other than groundwater are Whitehorse (which has the majority of the population) and Carcross (the latter of which is totally dependent on surface water[14]). Whitehorse is now studying the merits of switching entirely to a groundwater supply.[15]

In Saskatchewan, plentiful groundwater supplies are considered to have played an important role in the province's socio-economic development – even more important than surface water supplies, which are relatively scarce.[16]

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[14] Yukon State of the Environment Interim Report 2001, at p. 3.

[15] Personal communication with Bob Truelson, Yukon Government Water Quality Section, Water Resources Branch.

[16] Saskatchewan Research Council website, found online at: http://www.src.sk.ca/html/research%5Ftechnology/environment/geo%5Fgroundwater/hydrogeology/

TABLE 1 GROUNDWATER USE IN CANADA*

Province/ Territory	Population reliant on Groundwater (Number) [1996 data]	Population reliant on Groundwater (Percent) [1996 data]	Groundwater use as % of Total Water Use in Province [Current data]
BC	1 105 803	28.5%	10%[17]
AB	641 350	23.1%	3%[18]
SK	435 941	42.8%	N/a
MB	342 601	30.2%	N/a
ON	3 166 662	28.5%	2.5%[19]
QC	2 013 340	27.7%	N/a
NB	501 075	66.5%	N/a
NS	426 433	45.8%	N/a
PEI	136 188	100%	N/a
NL	189 921	33.9%	N/a
YK	15 294	47.9% (but see[20])	75.4% total licensed water use[21]
NWT	18 971	28.1%	N/a
SUM	**8 993 579**	**30.3%**	**N/a**

*** The left two columns of data are reproduced from Statistics Canada, "Freshwater Resources", pp. 1-32 in *Human Activity and the Environment: Annual Statistics 2003*, at p. 25. In compiling and estimating these data, Statistics Canada extrapolated from Municipal Use Database (MUD) 1996 data and assumed that the population not covered by the MUD, 1996 is rural and that 90% of this population is groundwater reliant (except in PEI, where 100% of the population is known to be ground water reliant). Data in the right-hand column are derived from sources which are noted in each case.**

Aggregated provincial data such as those in Table 1 mask regional dependencies within provinces, which can be significant. For example, in British Columbia, the Gulf Islands communities (located between the Mainland and Vancouver Island) are almost completely dependent on groundwater for their drinking water and other freshwater needs. As we discuss further in "Uses and Impacts – Groundwater Sustainability Issues", *infra*, this dependency has placed the limited groundwater supplies in the Gulf Islands under considerable pressure.

MUNICIPAL RELIANCE ON GROUNDWATER

While Table 1 displays information that speaks to the overall picture of provincial reliance on groundwater sources, Table 2 focuses on municipal use of groundwater. Table 2 is derived from data contained in

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17 BC Ministry of Water, Land and Air Protection, "Ground Water Issues in British Columbia" online at Ground Water website http://wlapwww.gov.bc.ca/wat/gws/gissues.html N.B. Data was gathered in 1981.

18 Alberta Environment, *Focus on Groundwater*, at p. 1

19 Canadian Bottled Water Association, "Protecting Our Water Resources,Growing Ontario's Bottled Water Industry". Found online at http://www.cbwa-bottledwater.org/en/Leave_Behind.htm

20 An article on the website Taiga.net reported, " 'More than 99 percent of Yukoners depend upon groundwater for their water supply at least a portion of the time,' says Rick Janowicz, a hydrologist with the Department of Indian Affairs and Northern Development." "Groundwater Runs Deep" (Column 222), found online at http://www.taiga.net/yourYukon/col222.html

21 Data source: Yukon 1999 State of the Environment Report, combined with personal communication with Kevin Rumsey of Yukon Water Resources Branch, Changing Water Resources Department.

Environment Canada's Municipal (Water) Use Database (MUD), 1999, which contains water and sewage systems information from Canadian municipalities having populations greater than 1000.[22]

The greatest dependencies in Table 2 are marked with bold font. For example, the Yukon has the highest percentage of its municipalities dependent on groundwater, with 4 out of 4, or 100% of its municipalities reporting reliance on groundwater sources. With 142 municipal systems reliant on groundwater, Quebec has the greatest number of municipal systems reliant on groundwater. Ontario, however, has the largest population (1 280 183) dependent on groundwater. Note that Quebec, which has a population of 574 864 dependent on groundwater exclusively, has a significant additional population of 41 892 dependent on *combined* groundwater/surface water sources.

TABLE 2 MUNICIPAL USE OF GROUNDWATER[23] (MUNICIPALITIES WITH POPULATIONS >1000 ONLY)

Province/ Territory	# of Municipalities Where Source is GW or Combined GW/Surface and Proportion of Total in Province	Population Whose Municipal Water Source is GW Only and Proportion of Total Canadian Population Whose Municipal Source is GW
BC	63 out of 144 (43.75%)	382 202***** (13.68%)
AB	36 out of 125 (28.80%)	121 739 (4.36%)
SK	43 out of 68 (63.24%)	111 699 (4.00%)
MB	21 out of 48 (43.75%)	53 893***** (1.93%)
ON	113 out of 267 (42.32%)	**1 280 183 (45.82%)**
QC	**142** out of 405 (23.05%)	574 864***** (20.57%)
NB	40 out of 74 (54.05%)	144 520 (5.17%)
NS	13 out of 38 (34.21%)	35 635 (1.28%)
PEI[24]	7 out of 9 (77.78%)	50 476 (1.81%)
NL	19 out of 86 (22.09%)	29 972 (1.07%)
YK	4 out of 4 **(100%)**	8 861 (0.32%)
NWT	0 out of 17 (0%)	0 (0%)
SUM	**492 out of 1285**	**2 794 044 (100.01% – rounded %s)**

***Note: BC reports an additional population of 1202 whose systems have combined GW/surface water sources; Manitoba an additional population of 1485 whose systems have combined GW/surface water sources; and Quebec an additional population of 41 892, whose systems have combined GW/surface water sources.**

There is a need, however, to be somewhat cautious interpreting MUD data. The fact that the data only capture municipalities with populations greater than 1000 is a serious limitation, especially for determining groundwater use. This excludes rural and small town residents, who are significant in number; moreover, because so many rural and small town residents use private or community wells, the omission of these populations means that the overall provincial picture of groundwater use is necessarily incomplete.

For example, Table 2's data suggests that only 21 out of 48 municipalities or 43.75% of Manitoba's municipalities use groundwater sources. In fact, Manitoba has about 300 public water systems, and fully

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22 MUD data is gathered every five years by Environment Canada and is released in an Excel spreadsheet format. It is publicly available online at http://www.ec.gc.ca/water/en/manage/use/e_data.htm

23 Data from MUD, 1999.

24 Reporting for PEI is incomplete. Currently there are 13 municipal water systems in PEI, all of which are completely reliant on groundwater.

53.5% of them are groundwater sourced systems.[25] Similarly, Newfoundland and Labrador has indicated elsewhere that it has 243 public groundwater supplies (including small systems of 5-50 homes) sourced by groundwater.[26]

By comparison, Statistics Canada with its data in the two left columns of Table 1 attempted to overcome the population limitation of the MUD by projecting figures for rural Canadians reliant on groundwater, based on an assumption that 90% of rural populations are groundwater-reliant. (The assumption made seems reasonable, though perhaps a bit high,[27] for all jurisdictions except for perhaps the Northwest Territories, where due to permafrost, surface water may be preferred over private wells.) Note the significant difference that bringing in the rural populations (and making assumptions about their use) makes to the "bottom line" picture of Canadians' everyday dependence on groundwater: 8.9 million people instead of 2.8 million!

TRENDS IN AVERAGE DAILY FLOW – MUNICIPAL USE 1983-1999

Table 3 sets out data for total Canadian average daily municipal water flow of (a) all water systems, (b) groundwater sourced systems and (c) combined groundwater/surface water systems, for the years 1983-1999, at 5 or 6 year intervals. For each average flow figure, the correlating municipal population that relies on the source has been set out below it, where data was available (the 1983 and 1989 MUD data do not provide a breakdown of population by water source). Thus, the first column is the average daily flow from all municipal water systems, and the total population reliant on them; the second column is the average daily flow from groundwater sourced systems, and the population reliant on those systems; and the third column is the average daily flow from combined groundwater/surface water systems, and the population reliant on those systems.

It is difficult to detect any hard and fast trends arising from this data. Between 1989 and 1999 there appears to be somewhat of a positive correlation between increases in municipal population and increases in municipal use of water and groundwater. However, looking at the longer period of 1983 to 1999, despite an overall *increase* of approximately 5 million people in all systems during that period, the use of groundwater *decreased* (the population reliant on groundwater is unavailable for 1983). This negative correlation is also apparent in the period 1989 to 1994, for overall water use.

TABLE 3 MUNICIPAL POPULATION AND AVERAGE DAILY FLOW 1983-1999[28]

Year	ADF (All Sources) (m^3/day) Cdn. Munic. Population	ADF (Groundwater) (m^3/day) Cd. Munic. Population	ADF (Combined) (m^3/day) Cdn. Munic. Population
1983	12 418 647	1 722 728	698 868
	20 486 207	n/a	n/a
1989	13 854 381 (up)	1 804 788 (up)	1 233 471 (up)

[25] Manitoba State of the Environment Report, 1997

[26] Information supplied by Government of Newfoundland and Labrador, Department of Environment and Conservation (Keith Guzzwell).

[27] A Science Council of Canada report estimated overall rural dependence on groundwater sources to be 82%, not 90%. See *Water 2020: sustainable use for water in the 21st century* (Science Council of Canada, 1988) (quoted in Brook Harker, John Lebedin, Michael J. Goss, Chandra Madramootoo, Denise Neilsen, Brent Paterson and Ted van der Gulik, "Land Use Practices and Changes - Agriculture", Chapter 7 (pp. 49-55) in Environment Canada, National Water Research Institute, *Threats to Water Availability in Canada* (Ottawa: Minister of Public Works and Government Services Canada, 2004), at p. 49

[28] Data derived from MUD, 1983-1999.

	22 504 394 (up)	n/a	n/a
1994	13 825 442 (down)	1 098 054 (down)	819 117 (down)
	23 913 874 (up)	2 078 011	1 400 447
1999	14 828 932 (up)	1 480 515 (up)	29 697 (down)
	25 365 259 (up)	2 794 044 (up)	44 579 (down)

Table 4 sets out average daily flow figures for groundwater and combined source systems, for each province over the period 1983-1999, at 5-6 year intervals (measures are m^3/day).

This data reveals that Ontario, Quebec and British Columbia are the biggest users of municipal groundwater, and that municipal groundwater/combined source use peaked in or around 1989, but has been in an overall downward trend since that peak. (However, Alberta and PEI are now both again trending up.) Looking at long-term absolute values, all provinces now use less groundwater/combined sources than they did in 1983, with the exception of Quebec and Newfoundland and Labrador. These trends are interesting when compared to the trend in overall municipal *water* use, which peaked in 1989, declined in 1994 but is once again on the rise and has exceeded the 1989 level (as evident in Table 3).

TABLE 4 TOTAL AVERAGE MUNICIPAL DAILY FLOW, GROUNDWATER/COMBINED SOURCES, IN M^3/DAY[29]

Province	1983	1989	1994	1999	Trend since 1983
BC	309 056	343 745	296 258	274 794	-
AB	127 043	149 476	73 382	78 720	-
SK	272 392	285 626	133 444	47 066	-
MB	38 665	47 833	22 010	21 611	-
ON	1 091 681	1 383 690	658 178	567 013	-
QC	329 901	549 121	543 979	354 732	+
NB	128 880	139 725	101 117	93 994	-
NS	65 348	74 791	29 726	19 308	-
PEI[30]	32 408	35 903	19 281	24 932	-
NL	11 001	27 349	22 298	19 715	+
YK	15 221	1 000	17 498	8 327	-
NWT	0	0	0	0	Same
TOTAL	**2 421 596**	**3 038 259**	**1 917 171**	**1 510 212**	**-**

GROUNDWATER USE – BEYOND MUNICIPAL WATER SYSTEMS

Despite the importance of municipal water systems, they are neither the only users of groundwater, nor necessarily the biggest. Rural populations most often have private wells, which are usually not licensed, and larger industrial and commercial operations tend to drill their own wells. In most but not all jurisdictions, wells (or other operations) that withdraw a high volume of water require a permit.[31]

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[29] Data derived from MUD, 1983 -1999.

[30] The results for Prince Edward Island are somewhat misleading because the number of municipalities participating in the MUD studies varied considerably (e.g. whereas 19 municipalities reported their use in 1983, only 9 participated in the 1999 study). Currently there are 13 municipal water systems in the province, all of which are completely reliant on groundwater.

[31] See discussion of the regulatory system governing bottled water, *infra*.

Table 5 compares volumes and shares of municipal use of groundwater and overall use of groundwater, by province.

Unfortunately, data for non-municipal takings was not available in most jurisdictions, and where it was available, the rates of measure varied. Under such circumstances, it was difficult to draw any useful comparisons or conclusions with respect to the meaning of the data.

TABLE 5 MUNICIPAL AND OTHER GROUNDWATER TAKINGS, BY PROVINCE

Province/ Territory	Total Municipal Withdrawal of GW in m^3/day[32]	% of Total Municipal GW Use in Canada	Total Provincial Withdrawal of GW NB: rate measures vary	% of Total Canadian Withdrawal of GW (All GW Uses)
BC	274 148*	18.52%	n/a	25%[33]
AB	78 720	5.32%	184 303 000 m^3/year (allocated)[34]	n/a
SK	47 066	3.18%	1 542 327 dam^3/year (allocated)[35]	n/a
MB	21 186*	1.43%	80 664 dam^3/year (allocated)[36] ***See note for actual use data.***	n/a
ON	567 013	38.30%	n/a	n/a
QC	326 106*	22.03%	n/a	n/a
NB	93 994	6.35%	322 301.12 m^3/day (allocated) known GW source only[37]	n/a
NS	19 308	1.30%	n/a	n/a
PEI	24 932	1.68%	n/a	n/a
NL	19 715	1.33%	n/a	n/a
YK	8 327	0.56%	n/a	n/a
NWT	0	0%	n/a	n/a
SUM	**1 480 515****	**100%**	n/a	n/a

*** BC municipalities withdraw an additional 646 m^3/day from combined GW/surface sources; Manitoba municipalities an additional 425 m^3/day from combined GW/surface sources; and Quebec municipalities an additional 28,626 m^3/day from combined GW/surface sources.**

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32 Data derived from Municipal Use Database (MUD), 1999.

33 " Ground Water Issues in British Columbia," Min WLAP, Ground Water website http://wlapwww.gov.bc.ca/wat/gws/gissues.html N.B. Data was gathered in 1981.

34 (N.B. 1 cubic metre = 1000 litres = 0.001 cubic decametres (dam^3).) Alberta Environment, "Water Allocation in Alberta." Note that Alberta Environment has also published figures demonstrating the difference between allocated use and actual use. With respect to water use for oil injection, Alberta Environment has published data that show that while 169 million m^3 was *allocated* from surface and groundwater for injection purposes in 2001, the actual volume diverted was 47.5 million m^3. Of this, 37.1 million m^3 was from non-saline (fresh) sources made up of 26.9 million m^3 of surface water, and 10.2 million m^3 of groundwater. Advisory Committee on Water Use Practice and Policy, Preliminary Report (March 2003) at p. 10, and "Water Use for Injection Purposes in Alberta", at http://www.waterforlife.gov.ab.ca/docs/geowa_report.pdf

35 (N.B. 1 dam^3 = 1 cubic decametre = 1 million litres.) Data compiled from a raw data set provided by Don Anderson, A.Sct.T., Senior Technologist, Regulatory Coordination Operations Division, Saskatchewan Watershed Authority, 2004. The data set is based on 3095 active projects in Saskatchewan. Of these, 617 are at the application stage, 151 are approved for construction and 2327 are approved for operation and have been licensed.

36 (N.B. 1 dam^3 = 1 cubic decametre = 1 million litres.) Of the total 80,664 dam^3/year, Manitoba reported the following allocated and actual annual volumes by sector: Irrigation (28848 dam^3 allocated, actual N/A); Industrial (18054 dam^3 allocated; 9130 dam^3 actual); Municipal (13854 dam^3 allocated, 5254 dam^3 actual); Other (13769 dam^3 allocated, actual N/A); Agricultural (5750 dam^3 allocated, 2059 dam^3 actual). While actual use data is incomplete, Manitoba water managers are confident that aggregated licensed amounts for each category exceed the actual amounts used across each sector. Information supplied by Water Licensing Branch, Manitoba Water Stewardship.

37 Estimated volume, compiled from data provided by Nelda Craig, Manager, New Brunswick Water Sciences Section, Science and Reporting Branch, Environment and Local Government.

**** The total average daily flow of ground-sourced municipal water of 1 480 515 m^3/day represents just 9.98% of the total average daily flow of all municipal water of 14 828 932 m^3/day (calculated from MUD, 1999)**

GROUNDWATER USE PATTERNS AND TRENDS

Data that might reveal trends over time in non-municipal use of groundwater is either not available or not readily available. Trend information on water use in Canada that has been published to date relates to trends in water use more generally, and unfortunately, does not usually distinguish or isolate trends in groundwater use.

Groundwater is used in all kind of applications: it runs out of our taps; hotels use it to wash sheets and linens; and it is used in cooling and industrial processes, aquaculture, oil recovery, golf courses and water parks. Industrialization and urbanization have the potential to place heavy demands on groundwater.[38]

Besides the MUD, another important source of information on water use in Canada is the Industrial Water Use Survey, prepared every five years by Environment Canada. This survey data provides information on water use trends in the industrial sector, defined for the purposes of the survey as the manufacturing, mineral extraction and thermal power sectors. The survey is representative rather than comprehensive: out of an estimated total of 35,000 to 40,000 businesses in these sectors, government contacts some 6,000 businesses.[39] In the manufacturing sector, it tries to capture the bigger water users (essentially 14 groups that are the largest water-using two-digit SIC groups), and it tries to capture all significant operating mining establishments and all thermal power establishments.[40] The most recent Industrial Water Use Survey data was collected in 1996.

Unfortunately, much of the survey data is not groundwater-specific, so the survey is not a complete source for finding information about industrial use of groundwater.

Because the Industrial Water Use Survey data did not meet all of our data needs, we obtained additional data and information from provincial and territorial government sources, and from some private sources.[41] It quickly became evident that jurisdictions do not collect and organize their data in a standardized way. One of this project's challenges was to organize all of the different data so that we could make valid comparisons among jurisdictions, and not compare "apples with oranges."

Our findings are set out in Table 6, which organizes the information into five different categories of groundwater use. The organization of the data into five categories was a compromise way of managing the unevenness in the data and finding some common basis for comparison. For BC, establishing five categories was a stretch, since BC's data is normally presented referring to four categories of use. By way of contrast, Saskatchewan's data is normally presented in 14 use categories, so we pooled those as logically as we could into our five established use categories.

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38 Groundwater monitoring in British Columbia has revealed that the aquifers with declining water levels are related to intensive local groundwater pumping for industry, agriculture and municipal water supplies and, in urbanized areas, decreased recharge due to impervious surfaces. BC Ministry of Water, Land and Air Protection, State of Environment Reporting, "Groundwater in British Columbia" (2001 data), online at http://wlapwww.gov.bc.ca/soerpt/7groundwater/wellsglance.html

39 Environment Canada, Industrial Water Use, 1996 (Ottawa: Minister of Public Works and Government Services Canada, 2002), at p. 17.

40 *Ibid.*

41 Gartner Lee consultants and Quebec Water Bottlers Association

We recommend that jurisdictions start to gather their data using a standardized template of use categories, and at a high level of resolution such as Saskatchewan's.

TABLE 6 GROUNDWATER ALLOCATION BY-USE CATEGORY (PERCENTAGES BASED ON PERMIT ALLOCATION UNLESS NOTED AS AN ESTIMATED VALUE). BIGGEST ALLOCATIONS IN <BOLD>. MORE DETAILED BREAKDOWNS ARE IN NOTES.

PROVINCE/ TERRITORY	INDUSTRIAL	AGRICULTURAL	MUNICIPAL	COMMERCIAL & INSTITUTIONAL	OTHER
BC[i] **(Est)**	**55**%	20%	25%		
AB[ii]	**34.5**%	16.9%	26.3%	14.1%	8.24%
SK[iii]	**52.42**%	3.09%	43.01%	0.88%	0.60%
MB[iv]	22%	**44%**	17%		17%
ON[v]	**35.1**%	27.3%	23.9%	5.6%	8.2%
QC[vi]	29.5%	16%	**54**%	0.08%	
NB (Est) [vii]	26.66%		**73.22**%	0.12%	
NS[viii]	n/a	n/a	n/a	n/a	n/a
PEI (Est) [ix]	Some	Some	**#1** use		
NL (Est) [x]			**#1** GW use	#2 GW use	
YK (Est) [xi]	No	No	**#1** and only real use	No	No
NWT	n/a	n/a	n/a	n/a	n/a
NUN	n/a	n/a	n/a	n/a	n/a

Table Notes:

[i] Data source: Ground Water Issues in British Columbia, Ministry of Water, Land and Air Protection, Ground Water website: http://wlapwww.gov.bc.ca/wat/gws/gissues.html (N.B. Data is based on 1981 data.) Also BC State of Environment report (2001). "Industry" here includes BC's categories of Industry, Manufacturing, Mining and Aquaculture (together at 55%); "Agricultural" includes BC's category of Agricultural (20%); "Municipal includes BC's categories of Municipal (18%) and Domestic (7%).

[ii] Data source: Alberta Environment, "Water Allocation in Alberta" (2001). "Industry" here includes Alberta's categories of Industrial (8.0%), Injection (26.4%) and Drilling (developing oil/gas wells) (0.1%); "Agriculture" here includes Alberta's categories of Agriculture (16.5%) and Irrigation (0.4%); "Municipal" includes Alberta's category of Municipal (26.3%); "Commercial and Institutional" includes Alberta's categories of Commercial (12.7%) and Commercial cooling (1.4%); and "Other" includes Alberta's categories of Fish management (5.1%), recreation (2.7%), Other purpose (0.3%), Water management (0.1%) and Wildlife management (0.00%). Note that Alberta's category of "Commercial" includes uses of gardening, golf courses, parks, aggregate washing, construction, bottling (water, etc.), snow/ice making, hauling water, other (abbatoirs, dust control, bridge/vegetable washing, etc.), which might be classed as "municipal" or "industrial" in other jurisdictions.

[iii] Data compiled from a raw data set provided by Don Anderson of the Saskatchewan Watershed Authority, 2004. The data set is based on 3095 active projects in Saskatchewan, 617 of which are at the application stage, 151 approved for construction and 2327 approved for operation and licensed. "Industry" here includes Saskatchewan's categories of Drainage (4.26%), Other - Aquaculture (1.43%), Industrial-Aquaculture (0.20%), Industrial -Cavern Washing (4.61%), Industrial - Cooling water (10.11%), Industrial -Mineral recovery (4.27%), Industrial -Oil recovery (Steam flood) (3.68%), Industrial - Oil recovery (Waterflood) (18.06%) and Industrial - Process water (5.80%); "Agriculture" includes Saskatchewan's categories of Irrigation-agriculture (1.13%) and Industrial - Intensive livestock (1.96%); "Municipal" includes Saskatchewan's categories of Domestic (0.04%), Municipal (0.92%), Municipal – community (0.22%), Municipal – recreational (0.65%), Municipal – rural distribution (0.06%), Municipal – tankload (2.4%), Municipal – urban distribution (38.72%); "Commercial and Institutional" includes Saskatchewan's categories of Irrigation – commercial facility (0.05%), Municipal –institutional (0.21%), Municipal – commercial facility (0.54%) and Industrial – bottled water (0.08%); "Other" includes Saskatchewan's categories of Irrigation – park (0.46%), Multi-purpose – recreation (0.02%), Other – recreation (0.08%) and Other (0.04%)

[iv] Data source: Manitoba Water Stewardship Branch, Water Licensing Section, "Water Allocation in Manitoba". "Industry" here includes Manitoba's category of Industrial (22%); "Agricultural" includes Manitoba's categories of Agricultural (7%) and Irrigation (37%); "Municipal" includes Manitoba's categories of Municipal (17%) and Domestic (0%); and "Other" include Manitoba's category of Other which includes such uses as recreational (water slides), space heating/cooling, firefighting, flood control and habitat.

[v] Data source: Gartner Lee, "Good and Acceptable Practices for Assessing Water Taking Proposals – Ontario Ministry of the Environment and Energy" (Draft for Discussion, July 2002), at p. 10. "Industrial" here includes Ontario's categories of Industrial (11.2%), Dewatering (21.7%) and Construction (2.2%); "Agricultural" includes Ontario's category of Agricultural (27.3%); "Municipal" includes Ontario's category of Water supply (23.9%); "Commercial and Institutional" includes Ontario's categories of Commercial (5.4%) and Institutional (0.2%); and "Other" includes Ontario's categories of Recreation (0.1%), Remediation (1.7%) and Miscellaneous (6.4%)

[vi] Data source: Quebec Water Bottlers' Association, "General Information", found online at http://www.aeeq.org/saviez-vous_en.html. "Industrial" here includes Quebec's categories of Aquaculture (25.3%) and Other industrial (6.5%); "Agricultural" here includes Quebec's category of Livestock and irrigation (16%); "Municipal" includes Quebec's category of Domestic (54%); and "Commercial and Institutional" includes Quebec's category of Commercial (0.08%).

[vii] Estimated information was compiled from raw aggregated water use data provided by Nelda Craig, Manager, New Brunswick Water Sciences Section, Science and Reporting Branch, Environment and Local Government. The estimates are based on known allocations, where groundwater was indicated to be the exclusive source. "Industrial" here includes New Brunswick categories of Aquaculture (23%) and Food processing (1.36%); "Municipal" includes New Brunswick categories of Domestic well (46.23%) and Municipal (26.99%); and "Commercial" includes New Brunswick category of Bottled (0.12%).

[viii] Nova Scotia Environment and Labour advised us that the electronic database normally employed to generate summary data is in the process of being updated. Data should be available upon request in 2005.

[ix] Personal communication with George Somers, Groundwater Section Head, Water Management, PEI Department of Fisheries, Aquaculture and Environment. Groundwater was noted as the sole source of potable water and municipal use was estimated to be the #1 use of groundwater. Food processing was estimated to be the largest industrial user, with aquaculture also using groundwater to a limited extent.

[x] Personal communication with Dr. Abdel-Razek, Government of Newfoundland and Labrador Department of Environment and Conservation, Water Resources Management Division. Dr. Abdel-Razek estimated that municipal use was the #1 use of groundwater, with commercial use being the #2 user (mainly water bottling and aquaculture).

[xi] Data source: Yukon 1999 State of the Environment Report, combined with personal communication with Kevin Rumsey of Yukon Water Resources Branch, Changing Water Resources Department

DISCUSSION: GROUNDWATER USES & IMPACTS

USES THAT ARE COMMON ACROSS CANADA

Reviewing Table 6 and the Table Notes that set out more detailed breakdowns for some of the jurisdictions, the largest volume of water allocated is for industrial purposes; however, the specific industrial application varies significantly from province to province, with some overlaps.

One common industrial use, and a heavy user of groundwater in Canada, is the manufacturing sector.[42] The Industrial Water Use Survey reveals that a huge 177.3 million cubic metres (MCM) of fresh groundwater and 2.3 MCM of brackish groundwater are withdrawn by this sector each year (albeit making up only 2.9% of the

[42] All figures in this paragraph are taken from Table 4 of the Industrial Water Use Survey, 1996, except as noted separately.

sector's total water use of 6037.4 MCM/year). Paper and allied products, food and primary metals manufacturing are the biggest users of fresh groundwater in this sector, with each withdrawing 65.8 MCM/year, 44.6 MCM/year and 22.9 MCM/year respectively. Non-metallic mineral products (9.9 MCM/year), wood products (9.5 MCM/year) and beverage manufacturing (8.1 MCM/year) are next in line. It is also interesting to note that in the manufacturing sector, Ontario accounted for 50% of the total Canadian manufacturing water intake reported, followed by Quebec at 19% of the total and British Columbia at 17%.[43]

According to data available in the Industrial Water Use survey, the thermal power generation industry in Canada is one of the significant industrial users of groundwater, at 137.6 MCM/year of self-supplied freshwater from groundwater sources.[44] Of this, 129.7 MCM/year is used by the electrical power industry and 7.9 MCM/year is used by paper and allied industries.[45]

Another common industrial user of groundwater is the mining sector, where large withdrawals of groundwater take place as mines are dewatered in preparation for mining.[46] In the mining sector in Canada, it is estimated that 97.9% of the mining sector's total water needs of 518.2 MCM/year are self-supplied; and of this, self-supplied groundwater sources make up 40.4 MCM/year or 7.8% of mining's freshwater needs and 4.0 MCM/year or 0.8% of the sector's brackish water needs.[47] Of the self-supplied groundwater that is freshwater, the metal mining sector is the biggest user, at 23.5 MCM/year, coal mines are next at 10.3 MCM/year and non-metal mines use 6.5 MCM/year. Note that of the 518.2 MCM of water used annually by the mining sector, British Columbia withdraws the highest volume of water, at 27.5% of the total, or 142.5 MCM/year.[48]

Another common industrial use[49] of groundwater across Canada is aquaculture. As noted in Table 6, groundwater use for aquaculture is tracked in at least six provinces. It is often used in fish-out ponds, which are gravity-fed, and it is also used to supply hatcheries.[50] Groundwater used in aquaculture operations is typically recycled.[51]

A close second in terms of prominent, common uses of groundwater across Canada is its use in public waterworks or municipal systems. Municipal systems service not only residential users but also many city-dwelling commercial and industrial operations as well. (It has been estimated that only 1% of the municipally supplied treated water in Canada is used for human consumption.[52]) Some of the many uses of water in

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43 Industrial Water Use Survey, 1996, at p. 11.

44 *Ibid*, at Table 28, p. 35. Note that this is only 0.5% of the total water intake by this industry of 28,749.7 million cubic metres (MCM)/year.

45 *Ibid.*

46 Environment Canada, Industrial Water Use survey, 1996 at p. 13.

47 *Ibid*, at Table 18, p. 30.

48 *Ibid*, at Table 26, p. 34.

49 Some jurisdictions, such as the Government of Newfoundland and Labrador, categorize aquaculture as a commercial use rather than as an industrial use.

50 Personal communication with Dr. Abdel-Razek, Government of Newfoundland and Labrador, Department of Environment and Conservation, Water Resources Management Division.

51 *Ibid.*

52 Canadian Bottled Water Association, "CBWA Fact Sheet and Background" found online at http://www.cbwa-bottled-water.org/en/News_Release.htm

municipal systems for industrial, commercial and institutional use include: "…pulp and paper production, industrial processing, heating, ventilation and air conditioning for buildings, restaurants – for cooking and washing, hotels – for washing bedding, flushing toilets, etc, schools universities and hospitals – for cooking, washing and bathroom uses."[53]

Industry sectors that rely on public municipal systems for water tend to be those dominated by smaller establishments, such as the beverage industry which requires potable water, rather than industry sectors dominated by larger establishments, which tend to be self-supplied.[54] However, placing this in context, the bulk of the water used in industry is self-supplied, since the larger businesses use higher volumes: the Industrial Water Use survey reveals that respective reliance of the manufacturing sector, thermal power generation sector and mining sector on public municipal supplies for water is 9.1%, 2.1% and 2.1% respectively.[55]

Groundwater is commonly used in agriculture, especially for crop irrigation and watering of livestock. A recent study noted that groundwater is increasingly being used for irrigation and washing of plant crops that are sent to market with the intention that they be eaten raw, due to the demand that the water used be potable water.[56] Watering livestock is such a common use in Alberta that Schedule 2 to Alberta's guide to submitting an application for a water licence actually provides a "guide" for calculating the quantities of water needed for raising beef, hogs, chickens and turkeys.[57] As noted in Harker et al, "Production of quality livestock requires a stable supply of high-quality water....Groundwater provides nearly all of the water used to produce livestock in Canada."[58]

Another common use of groundwater across the country is water bottling. Saskatchewan, Manitoba, Quebec, New Brunswick and Newfoundland and Labrador all specifically track allocations for bottled water operations. Compared to some other uses, water bottling is not a high volume use, but unlike some other uses, it is 100% consumptive – a factor to be considered when evaluating use and impacts. As noted by Ontario's Environmental Commissioner, Gord Miller:

> …certain commercial operations, especially water bottling plants, consume 100 per cent of the groundwater they extract. When water is used for irrigation, over 70 per cent of the water extracted evaporates or is lost to runoff. Industrial and municipal uses consume approximately 10 per cent of

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53 Alberta Environment, Water Conservation website: http://www3.gov.ab.ca/env/water/Conservation/ici.cfm

54 Small establishments (compared to industries dominated by larger establishments) "tend to draw a much larger proportion of their water supplies from public utilities, largely for two reasons: the fact that public supplies are cheaper than the cost of self-supplied water systems, and the need for potable water for many of the smaller establishments." (Industrial Water Use Survey, at p. 4)

55 See Tables 4, 18 and 28 of the Industrial Water Use Survey, 1996.

56 "In some areas, buyers are starting to require farm audits confirming that potable quality water is being used to irrigate and wash crops that are sent to the fresh market. Many surface water supplies will not meet such requirements without some form of treatment, which may prove difficult to obtain. There is, accordingly, a trend towards the use of groundwater, even though the resource is poorly understood in many parts of the country." Brook Harker, John Lebedin, Michael J. Goss, Chandra Madramootoo, Denise Neilsen, Brent Paterson and Ted van der Gulik, "Land Use Practices and Changes - Agriculture", Chapter 7 (pp. 49-55) in Environment Canada, National Water Research Institute, *Threats to Water Availability in Canada* (Ottawa: Minister of Public Works and Government Services Canada, 2004), at p. 51

57 Alberta Environment, Groundwater Evaluation Guideline, Schedule 2, at p. 27

58 Harker et al, *supra* note 67, at p. 51

the extracted water. At the same time, agricultural land and green space are being transformed into built-up areas. Land that has been paved over or otherwise built up has a reduced capacity to absorb rain water and return it to aquifers, resulting in precipitation running off directly to streams.[59]

Size must also be viewed relative to the size and rechargeability of the aquifer.

USES AND IMPACTS: GROUNDWATER SUSTAINABILITY ISSUES

This section discusses groundwater uses that merit more extensive discussion due to their potential impacts on sustainability.

HEAVY[60] WITHDRAWALS: RECHARGEABILITY, SALINE INTRUSION AND STREAM FLOW EFFECTS

Groundwater withdrawals that are large compared to the available supply, to the point of affecting rechargeability of the aquifer, have been noted as a live issue in a few Canadian jurisdictions. For example, in British Columbia, heavy use of limited island supplies has led to problems being experienced in the Gulf Islands and Saanich Peninsula. Excessive withdrawals in these areas have exposed wells to problems with salt-water intrusion and quality degradation[61] – including increased murkiness (turbidity) and dry wells.[62]

Manitoba's water managers have also been recently challenged by local recharge capacity and sustainability issues arising with the Carbonate aquifer that has been heavily drawn on for ex-urban residential developments north of and beyond Winnipeg's municipal water system.[63] Freshwater resource limits are also being tested in a few areas of southern Manitoba, where irrigation needs required to serve a burgeoning French fried potato farming industry are high.[64] Water managers are reviewing both aquifer capacities and demand-side load, to ensure that freshwater supplies will be able to meet demand.[65]

Prince Edward Island has experienced some saltwater intrusion along its coastline, but to date has been able to manage the problem by rearranging pumping schedules.[66]

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59 Gord Miller, Environmental Commissioner for Ontario, "The Protection of Ontario's Groundwater and Intensive Farming – Special Report to the Legislative Assembly of Ontario" (July 27, 2000) at p. 2.

60 "Heavy" means large compared to the available supply. A withdrawal may not be large, but if an aquifer is small or sensitive, the withdrawal may have a significant impact. BC has 35 aquifers around the province that are considered "heavily used" (where the extraction rate is high relative to the natural recharge rate). *Environmental Trends in British Columbia 2002*, at p. 18; and see BC Ministry of Water, Land and Air Protection, State of Environment Reporting website, at http://wlapwww.gov.bc.ca/soerpt/7groundwater/wells.html.

61 BC Ministry of Water, Land and Air Protection, "Groundwater Issues in British Columbia," website on Ground Water (found online at http://wlapwww.gov.bc.ca/wat/gws/gissues.html)

62 Personal communication with a Gulf Island resident.

63 Personal communication with Rob Matthews, M.Sc., P.Geo., Manager, Water Licensing Branch, Manitoba Water Stewardship.

64 *Ibid.*

65 *Ibid.*

66 Personal communication with George Somers, Groundwater Section Head, Water Management, P.E.I. Department of Fisheries, Aquaculture and Environment.

An Environment Canada study reported that municipalities that depend on groundwater experience more frequent water shortages than those that rely on surface water sources.[67]

In southwestern Ontario, seasonal demands for irrigation cause significant fluctuations in load on the groundwater system. For example, the Grand River Conservation Authority's *Watershed Report*[68] revealed that crop irrigation, which was normally 8th in terms of overall annual consumption of water,[69] leapt up to 2nd place during the month of July – the same time when overall demand for water is at its highest.

In Prince Edward Island, an effect noticed in connection with large groundwater withdrawals has been a reduction in baseflow (the discharge of groundwater to streams) and stream-flow.[70] Managers in PEI are studying that relationship in detail, assessing the impacts on aquatic ecosystems and re-evaluating the groundwater allocation process.[71]

DEWATERING: COALBED METHANE, AGGREGATE MINING AND BIG PIPES

Dewatering refers to the removal of groundwater with pumps or drainage systems in order to gain access to a resource below, or facilitate an activity that requires the ground to be relatively dry. Dewatering is currently associated with coalbed methane production on "wet" coal reserves in Alberta and with coalbed methane development planned in various locations around British Columbia. "Wet" coal reserves are dewatered in order to lower the pressure underground and allow the gas to be extracted.

Concerns associated with dewatering are the potential for negative impacts on freshwater aquifers and their ability to both meet human needs and recharge surface water bodies.[72]

Dewatering is also heavily associated with aggregate operations and quarries in Ontario. Dewatering in this industry raises similar concerns over aquifer levels and rechargeability; however, some related environmental challenges include turbidity and suspended solids in the discharged waters that may result from "gravel washing" - and associated impacts on nearby streams, aquatic life and related ecosystems.[73]

In Ontario, citizens are concerned about massive dewatering associated with the construction of a mega-project, the "Big Pipe", an underground system of pipes intended to transport 740 million litres of sewage per

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67 Environment Canada, "Urban Water Indicators: Municipal Water Use and Wastewater Treatment." Online at http://www.ec.gc.ca/soer-ree/English/Indicators/Issues/Urb_H2O/Bulletin/uw_iss_e.cfm

68 Grand River Conservation Authority, Fall 2003

69 Water, not groundwater. However, agricultural use, primarily crop irrigation, accounted for 12% of all groundwater use in the Grand River watershed.

70 PEI's streams are heavily reliant on discharge: "groundwater discharge accounts for 55 to 65% of mean annual stream flow." (*Canadian Framework for Collaboration on Groundwater* (2003), at p. 49.

71 Personal communication with George Somers, Groundwater Section Head, Water Management, P.E.I. Department of Fisheries, Aquaculture and Environment; also *Canadian Framework for Collaboration on Groundwater* (2003), at p. 50.

72 Mary Griffiths and Chris Severson-Baker, "Unconventional gas: the environmental challenges of coalbed methane development in Alberta" (Calgary, AB: Pembina Institute for Appropriate Development, 2003), Executive summary, at p. 5 (online at http://www.pembina.org/pdf/publications/CBM_Summary.pdf)

73 For a discussion of some of the potential environmental impacts associated with aggregate mining, see e.g., National Marine Fisheries Service, "National Gravel Extraction Policy" at http://swr.ucsd.edu/hcd/gravelsw.htm

day from communities north and east of Toronto to a treatment plant at Pickering, near Lake Ontario.[74] Pipe construction involves the pumping out of up to 66 billion litres of groundwater near the sensitive Oak Ridges Moraine.[75]

Federal fisheries officials and citizens groups worry that the dewatering and associated reduction in base flows to the Humber River will have a "devastating impact" on fish and fish habitat.[76] Aside from base flow reductions, consequent to the construction other streams have suffered from overflow, reductions in temperature and changes in chemical composition, when groundwater aquifers were drained into them.[77]

Other impacts related to the dewatering include impacts on wells, as the water table has dropped (some 100 wells have gone dry); and concerns that groundwater pressure at the pipe depths will cause groundwater to infiltrate the pipe to be as much as 20% of the pipe flow – leading to groundwater losses for the region and its needs.[78]

Groups opposed to the "Big Pipe" favour decentralized wastewater treatment.[79] Groups have also noted somewhat ironically that allowing this mega-project to proceed "makes a mockery of the provincial government's recent commitment to get tough on permits to remove underground water for bottling and other purposes."[80]

WASTE: BLEEDER SYSTEMS

In the Yukon Territory, one of the primary challenges for groundwater is to reduce unnecessary waste of groundwater supplies. Waste is an issue because water is used in "bleeder" systems that keep pipes from freezing. The scale of the problem is illustrated in the average daily consumption in Whitehorse, which at 842 litres per person, more than doubles the national daily average of 326 litres per person.[81]

With great success (an impressive achieved reduction of 98.5%), Yukon water managers are now experimenting with different alternative technologies (e.g. using thermostatically controlled bleeders instead of free flow bleeders) to reduce the use of water in bleeder systems.[82]

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74 Peter Gorrie, "Big pipe hits new snag. Environmental groups launch Fisheries Act prosecution." (July 9, 2004 *Toronto Star*)

75 King Environmental Groups Backgrounder, "King Environmental Groups Oppose Conditional Approval for Sprawl" (July 22, 2004)

76 Karen Gray, Department of Fisheries and Oceans Canada, quoted in King Environmental Groups Backgrounder, "King Environmental Groups Oppose Conditional Approval for Sprawl" (July 22, 2004)

77 Peter Gorrie, "Big pipe hits new snag. Environmental groups launch Fisheries Act prosecution." (July 9, 2004 *Toronto Star*)

78 *Ibid.*

79 King Environmental Groups Backgrounder, "King Environmental Groups Oppose Conditional Approval for Sprawl" (July 22, 2004)

80 Peter Gorrie, "Big pipe hits new snag. Environmental groups launch Fisheries Act prosecution." (July 9, 2004 *Toronto Star*)(quoting Jim Robb, General Manager of the Friends of the Rouge Watershed). Ontario has recently placed a temporary moratorium on new water bottling operations and some other groundwater uses. See discussion *infra*.

81 Yukon State of the Environment Report, at p. 21

82 *Ibid.*

OILFIELD INJECTION

In Alberta and to a lesser extent in Saskatchewan, groundwater is extensively used in oilfield injection activities for enhanced oil recovery: for example, in 2001 the Alberta oil and gas industry diverted 10.2 million m^3 of fresh groundwater for this purpose – some 26.4% of Alberta's licensed groundwater supply.[83] An additional 10.4 million m^3 came from externally sourced saline groundwater, the diversion of which is exempt from licensing requirements.[84] Other uses of water in the oil and gas industry include: water for flood injection, steam assisted gravity drainage, oil sands mining, drilling fluids, pipelines, vessels, tank testing, process, firefighting and associated domestic uses.[85]

The heavy use of groundwater, especially potable groundwater, for oilfield injection has attracted public concern over the potential impact of this use on groundwater supplies, present and future, especially given increased and competing demands on groundwater as a result of economic and population growth, and the potential for fluctuating levels in the water supply due to the hydrologic cycle, droughts, and even climate change.[86]

In 1990, the Government of Alberta instituted the "Groundwater Allocation Policy for Oilfield Injection Purposes," a policy intended to have industry explore alternatives to the use of fresh or potable groundwater. In February 2003, Alberta instituted a more rigorous policy, the Groundwater Evaluation Guideline,[87] detailing the requirement for the industry to identify and assess alternative sources, and mandating industry to "utilize alternative sources rather than potable groundwater whenever alternative sources are available." While these policies have encouraged decreased reliance on fresh groundwater, the shift to "alternative sources" has largely meant a shift to the use of saline groundwater. [88]

Contamination to groundwater, as a result of oil extraction and oil sands production activities (the latter of which are increasing) is also a concern. The regulatory focus here is on ensuring proper treatment of any water that has contacted oil, to prevent it becoming a source of contamination of groundwater.[89]

NO REGULATION OF GROUNDWATER TAKINGS IN BRITISH COLUMBIA

In British Columbia, the most noticeable issue around groundwater use is that its taking is unregulated - which may partly explain why BC's takings are so voluminous, relative to the other provinces. Unlike surface water withdrawals, groundwater withdrawals do not require a licence in British Columbia. Groundwater is only

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83 See Advisory Committee on Water Use Practice and Policy, *Preliminary Report* (March 31, 2004), at p. 10, and Groundwater Evaluation Guideline, at p. 4, and Table 6 *supra* and footnote 43 (data from Alberta Environment).

84 *Ibid.*

85 David Pryce, Canadian Association of Petroleum Producers, "Oil and Gas Industry Water Use: Confronting Water Scarcity Challenges and Choices" (July 15, 2004 presentation at Lethbridge, Alberta conference, Confronting Water Scarcity Challenges and Choices)

86 Advisory Committee on Water Use Practice and Policy, *Preliminary Report* (March 31, 2004), at p. 15.

87 Links to both policies are on the Alberta Environment "Water for Life" website, http://waterforlife.gov.ab.ca/html/technical_reports.html. Apparently in response to the concerns and the policies, the oil and gas industry has over the past 30 years decreased its reliance on freshwater groundwater sources, through the use of alternative sources, such as saline groundwater and through water recycling: see *Ibid*, at p. 4 and Pryce, *supra* note 86.

88 Alberta Environment, Groundwater Evaluation Guideline (February 5, 2003), at p. 1.

89 Alberta Environment, *Focus on Groundwater*, at p. 4.

regulated further to BC's new Ground Water Protection Regulation, which (effective November 1, 2004) requires well drillers to be registered and qualified, and which will (effective November 1, 2005) require compliance with stipulated well construction, maintenance and closure standards.

The lack of regulation of groundwater takings in British Columbia has led to some conflict. For example, it has made it more difficult to identify and manage: well interference by large capacity wells with yields of neighbouring wells; artesian wells (which flow freely, waste water and lower water levels); and groundwater-surface water conflicts (e.g. where groundwater takings deplete a licensed surface water taking).[90]

When the BC government rolled out its new regulation in July 2004 as the first part of a 3-stage initiative to protect BC's groundwater resources, the government announced that future measures will focus on "implementing water management plans in designated areas, drilling authorizations (if necessary) and other measures for aquifer quality and quantity protection and use;"[91] however, details of these measures planned for this third stage have not yet been released.

BACTERIAL CONTAMINATION AND WELL CONSTRUCTION AND MAINTENANCE

Bacterial contamination of groundwater wells arising from poor construction or maintenance practices with wells is an issue that is common to a number of jurisdictions across Canada, including British Columbia and Manitoba. As a Manitoba report on groundwater noted with respect to the presence of coliform bacteria in groundwater aquifers:

> Most of this contamination appears to have resulted from infiltration of bacteria along the ungrouted annulus of well casings, by direct entrance of bacteria into improperly sealed buried wells or wells located in pits or through corrosion holes in the casings.[92]

The same report listed as potential fixes: "proper well construction practices (installation and grouting of adequate lengths of casing, eliminating the use of large diameter well pits), locating wells up-gradient from potential sources of contamination and proper well maintenance."[93]

In response to heightened concerns over water safety in recent years, several provinces including British Columbia (as noted above) and Quebec[94] have recently legislated detailed well standards to try to manage this issue.

IRRIGATION

In Saskatchewan, crop irrigation is a prominent use of groundwater, especially in the southwest of the province, where irrigation is used to boost production. Ontario recently reported that 90% of Ontario farms

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90 BC Ministry of Water, Land and Air Protection, "Ground Water Issues in British Columbia", at http://wlapwww.gov.bc.ca/wat/gws/gissues.html

91 BC Ministry of Water, Land and Air Protection, Ground Water Protection Regulation – Backgrounder", at http://wlapwww.gov.bc.ca/wat/gws/gws_reg_back/back.html

92 *Groundwater in Manitoba: Hydrogeology, Quality Concerns, Management*, at pp. 29-30

93 *Ibid.*

94 Environment Canada, *Canadian Framework for Collaboration on Groundwater*, 2003, at p. 47

rely on groundwater for irrigation of 40 250 hectares of cropland.[95] However, it has been noted that in order for irrigation to be sustainable, irrigators must ensure that the soils to be irrigated and groundwater conditions will permit the safe, long-term application of water.[96]

HEAT PUMPS

An increasingly popular use of groundwater in Canada, but one that most provinces do not specifically track for groundwater use, is its indirect use in ground sourced or "closed loop" heat pump systems, and its direct use in ground and water sourced "open loop"[97] heat pump systems. In the more common "closed loop" systems, the natural heat that exists in the ground and groundwater is used as a "store" of heat for pipes that are laid into the ground, using a heat exchange technology comparable to that used in a refrigerator, for cooling applications in the summer, and heating applications in the winter.[98]

Newfoundland and Labrador's Environment and Conservation Department is notable for having instituted a Policy Directive addressing "Construction of Ground and Water Sourced Heat Pumps," including the related environmental concerns associated with construction of these systems, such as the potential escape of "closed loop" circulating fluids and their migration into the groundwater; improper construction of wells and borings becoming channels of contamination; and interference of "open loop" systems with the groundwater supply of adjacent users.[99] But for the Policy Directive, these concerns would otherwise have "fallen through the cracks" of a regulatory system designed to deal with other issues.[100]

In Ontario, a limited regulation entitled "Ground Source Heat Pumps" is in effect under that province's *Environmental Protection Act*. It generally relieves all ground source heat pumps from the Act's purview, except those that use methanol, which are restricted.

New Brunswick's Wellfield Protected Area Designation Order under the *Clean Air Act* prohibits the installation of a ground source heat pump in any zone established to protect source waters of public waterworks.[101]

WITHDRAWALS TO DECONTAMINATE OR REMEDIATE GROUNDWATER SUPPLIES

It is discouraging to have to note the human legacy that in some jurisdictions, withdrawals made to carry out clean-up on the groundwater itself are significant. For example, in the Grand River Watershed's Fall 2003 report on water use, withdrawals for the purpose of cleaning up contaminated groundwater were the

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95 *Canadian Framework for Collaboration on Groundwater*, 2003, at p. 46

96 Saskatchewan State of the Environment report, 1997, at p. 15.

97 In "open loop" systems (more common in larger projects), a well is dug at either end of the property and the water is made to flow in between the two wells, with the heat being extracted as it passes through the facility.

98 Rather than Freon, brine is usually employed used as the fluid in a "closed loop" heat pump's pipes. However, the rate of flow of any groundwater outside the pipes may affect the design and efficiency of the system.

99 To view the Government of Newfoundland and Labrador's Policy online, see "Construction of Ground and Water Sourced Heat Pumps W.R.98-1" at http://www.gov.nl.ca/env/Env/waterres/Policies/PDWR98-1.asp

100 Construction of Ground and Water Sources Heat Pumps W.R.98-1, at p. 1.

101 Regulation, at Schedule B, section 2(2).

5th largest use of water, at 15.5 million cubic metres per year.[102] Clean-up was also large enough to account for 1.7% of Ontario's overall groundwater use: see Table 6 where "Remediation" is noted in the footnotes as a use under the category "Other."

THE BOTTLED WATER INDUSTRY

GROWTH IN A GROUNDWATER-BASED INDUSTRY

Both production and consumption of bottled water have increased in recent years in Canada. Statistics Canada has reported that net supply of bottled water increased from 527 kilolitres in 1995 to 850 kilolitres in 2000 (a more than 61% increase in production), and apparent consumption per capita increased from 18.0 litres per capita to 27.6 litres per capita.[103] In Ontario, consumption of bottled water rose 45% between 1999 and 2002.[104]

It appears that Ontario, with "ten major water bottling companies and a number of smaller companies…," has the lion's share of bottled water production, reporting production in 2000 of 690 million litres.[105]

While this sounds like a lot of water, it is less than one percent of all permitted water takings in Ontario.[106] This sort of percentage is generally typical amongst the provinces that have water bottling operations, as set out in Table 6 *supra*.[107]

However, while water bottling does not constitute a large percentage of total water withdrawals, it is a 100% consumptive use, meaning that the water is not returned to the aquifer from which it was drawn. The fact that the water is not returned to the local ecosystem via a discharge back to the ground (as occurs with many other types of water withdrawals), raises the prospect that in some cases the impact on the local ecosystem could be significant, if the aquifer were sensitive to a reduction in supply or had difficulty recharging.

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102 Grand River Conservation Authority, *Watershed Report* (Fall 2003)

103 Statistics Canada, "Freshwater Resources", pp 1-32 in *Human Activity and the Environment: Annual Statistics 2003*, at p. 25.

104 Legislative Assembly of Ontario, Hansard, October 17, 2002: presentation by MLA Margaret Marland respecting private member's Bill 183, *An Act to amend the Ontario Water Resources Act*.

105 "Proposed Improvements to Ontario's Water Taking Process", Association of Municipalities of Ontario Water Taking Task Force, December 19, 2002 at p. 10. By way of contrast, Saskatchewan records that 12 water bottling operations are active; New Brunswick has 16; and Newfoundland and Labrador has 10, of which 4-6 are groundwater sourced.

106 *Ibid.*

107 The bottled water industry in Manitoba has allocated to it only 240 cubic decametres/year [= 240 million litres/year] or 0.3% of all licensed groundwater abstractions, made up of 13 operations that have been licensed. Five of the 13 operations represent more than 75% of the total licensed abstractions. (Information from Manitoba Water Stewardship, Water Licensing Branch.) Water extraction data for New Brunswick's 16 bottled water operations is not available, as the province does not regulate water operations if extraction is less than $50m^3$ per day. However, calculating on the basis that water bottling companies generally use between 4 m^3/day for a small plant to 40 m^3/day for a large plant, New Brunswick officials estimate that the plants operating in the province, which are considered to be medium in size, could possibly average 25-30m^3/day each. (Information provided from Daniel Boudreau, Canadian Food Inspection Agency, via personal communication from Nelda Craig, Manager, Water Sciences Section, Sciences and Reporting Branch, New Brunswick Environment and Local Government.)

Related to this, it has been noted that in Ontario at least, water bottling operations have tended to become concentrated in areas where spring water sources are plentiful.[108] Additionally, these areas tend to be rural and serviced by unpaved roads.[109] As a result of the increased traffic and wear and tear on the roads from industry truck traffic, some municipalities have expressed a concern not only for the roads, but also for the character of rural communities impacted by water bottling operations.[110] As a result, municipalities have expressed interest in further groundwater studies, well protection zones and water protection initiatives.[111]

REGULATION OF BOTTLED WATER OPERATIONS

Bottled water operations are regulated at both the federal and provincial levels. At the federal level, bottled water is regulated as a food product. At the provincial level, regulation potentially entails purview and licensing of water withdrawals, protections against pollution and contamination, and the establishment of drinking water standards. The discussion below focuses on identifying laws that address sustainability considerations – especially any laws that specifically address the sustainability of withdrawals for the purpose of bottled water operations. Note we have not included any discussion or review of federal or provincial laws restricting bulk water exports, which is a related issue, but which is a discussion beyond the scope of this paper.

FEDERAL LEGISLATION

At the federal level, regulation of bottled water falls under the Food and Drugs Act, administered by the Canadian Food Inspection Agency. The *Food and Drugs Act* sets national standards for safety, quality, labelling, selling and advertising of food products, including bottled water. Division 12 of the Food and Drug Regulations sets specific standards for prepackaged water and ice.

Since 1968, Health Canada has published Guidelines for Canadian Drinking Water Quality. Revisions to the Guide are published annually. Since water is a provincial responsibility, however, the Guidelines do not on their own have the force of law. It is up to each province to pass a law requiring compliance with the Guidelines.

Apart from the Food and Drugs Act, the *Canada Water Act* contains provisions for formal consultation and agreements with the provinces on matters relating to water resource management and water quality management. Our research did not discover any federal-provincial agreements relating to management of groundwater resources vis-à-vis takings for bottled water operations.

PROVINCIAL/TERRITORIAL LEGISLATION

This section reviews the regulatory scheme established for bottled water operations, as they affect sustainability of the resource only.

British Columbia does not have any regulation of groundwater takings, and has no legislation that specifically targets the bottled water industry. In fact, the Drinking Water Protection Regulation under the *Drinking*

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108 Association of Municipalities of Ontario Water Taking Task Force, "Proposed Improvements to Ontario's Water Taking Process" (December 19, 2002), at p. 11

109 *Ibid.*

110 *Ibid.*

111 *Ibid.*

Water Protection Act specifically excludes "equipment for dispensing bottled water" from the definition of "domestic water system."[112] Note, however, that commercial takings of spring water for bottling are considered surface water and do fall under BC's surface water licensing provisions.

Alberta follows a groundwater withdrawals licensing regime under its *Water Act*. All diversions of water require a licensed allocation. Approvals are initially given by issuance of an interim licence only.[113] Alberta does not have any specific legislative provisions to address the bottled water industry, but it does have a "Policy on Water Diversions from Sand and Gravels Adjacent to a Water Body and from Springs,"[114] which stipulates that where a diversion of a spring will increase the groundwater flow rate, the application for a water diversion will be evaluated in accordance with the Groundwater Evaluation Guide.

Alberta has also legislated provisions regarding the protection of "wells" from sources of contamination, e.g. in the Water (Ministerial) Regulation under the Alberta *Water Act*, but there is no specific mention of bottled water wells or operations. The Potable Water Regulation applies only to waterworks systems. The Activities Designation Regulation under the Environmental Protection and Enhancement Act, which lists activities and works that require approvals or registration for the purposes of environmental assessment, lists the construction of waterworks systems that use groundwater, but "waterworks systems" do not include wells used for the purposes of a commercial bottled water operation. One can conclude then that any environmental or public health protections that might flow from the environmental assessment process do not apply to bottled water operations.

In Saskatchewan, all groundwater uses except for domestic purposes are required to obtain a permit. The approval process entails ensuring that proposed projects are "sustainable and do not cause adverse impacts to the environment or other users."[115] As for specific contemplation of bottled water operations, Saskatchewan only contemplates bottled water insofar as to stipulate in its *Public Health Act* that Cabinet is authorized to make regulations prescribing standards for ice, bottled water and dispensed water; however, to date, Cabinet has not done so.

In Manitoba, the *Water Rights Act* stipulates that a licence is required for agricultural and irrigation water withdrawals greater than 25,000 litres per day. For industrial, municipal and "other" uses (including water bottling operations), any amount of withdrawal requires a licence. Applicants must identify their intended use and flow rates, and increasingly, are required to submit a project assessment report from a qualified professional.[116] Periodic metering and annual reporting of water consumption are stated conditions of all water licences issued by Manitoba.[117] Manitoba does not, however, have any specific regulations targeting bottled water operations.

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112 Drinking Water Protection Regulation, B.C. Reg. 200/2003, at s. 3(c).

113 Alberta Environment, *Focus on Groundwater*, at p. 5

114 Appendix "C" in the Groundwater Evaluation Guide.

115 Saskatchewan Watershed Authority, "Groundwater" website, at http://www.swa.sk.ca/WaterManagement/Groundwater.asp?type=Regulatory

116 Manitoba Water Stewardship Branch, Water Licensing Section, "Water Allocation in Manitoba."

117 *Ibid.*

Ontario regulates water takings greater than 50,000 litres per day through issuance of "Permits to Take Water" further to the Ontario Water Resources Act, s. 34(3) and considerations stipulated under the Water Taking and Transfer Regulation, which include sustainability considerations.[118]

While Permits to Take Water are available for two, five and ten year terms, permits for water bottling operations have typically been granted for 2-year terms only, in recognition that the impact of taking water without replacing it is largely unknown.[119]

In 2003, rising public concern over increasing water takings and the prospect that demands might exceed supplies, inspired the Ontario government to pass "The taking and use of water" regulation, which places a temporary moratorium for Southern Ontario and parts of Northern Ontario on the issuance of new Permits to Take Water for the purposes of: manufacturing or producing bottled water; fruit or vegetable canning; ready-mix concrete manufacturing; aggregate processing; and product manufacturing.

This rather controversial moratorium runs until December 31, 2004. Takings for agricultural purposes, including aquaculture, nurseries, tree farms and sod farms, are excluded from the temporary ban on new permits. The purpose of the moratorium is to ensure new permits will not be issued for new and expanding water bottling operations and the other listed operations until new rules are developed for water takings.[120]

Quebec's laws specifically refer to bottled water operations and considerations of groundwater sustainability. The relatively new (2002) Groundwater Catchment Regulation, under the Environmental Quality Act, specifically stipulates that "[p]rojects intended to be distributed or sold as spring water or mineral water or to be an ingredient in spring water" require the authorization of the Minister[121]

Applicants must provide information about the intended use of the water, the total flow each month and ownership of the site and of adjacent lots within a 30m radius of any catchment work intended for human consumption.[122] Applicants must also furnish an attestation of the Minister of Natural Resources related to the mining rights likely to be granted.[123]

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118 Before a permit is issued, prescribed is *mandatory* consideration of "the protection of the natural functions of the ecosystem", "groundwater that may affect or be affected by a surface water taking" and "surface water that may affect or be affected by ground water taking" and *discretionary* consideration of "existing and planned uses for water, including livestock uses, municipal water supply, agricultural uses, private domestic uses, other uses, and whether it is in the public interest to grant a permit." Note also that all Permits to Take Water are posted to the Environmental Bill of Rights Registry for public comment.

119 Ontario Agricultural Value-Added Innovation Network, "Bottled Water" (July 2003), at p. 2 (prepared in cooperation with the Ontario Ministry of Agriculture and Food, with funding from Human Resources Development Canada and found online at http://www.aginnovation.ca/resources/bottledwater.pdf). Note also that the CBWA has lobbied against the 2-year limit, calling it "unfair", without a scientific basis, and unnecessary, given other measures available to the ministry to restrict a taking, should conditions change or an adverse effect be proven: see CBWA, "Comments on the Proposed Amendments to Ontario Regulation 285/99…" (May 21, 2003), (online at http://www.cbwa-bottledwater.org/en/news.html)

120 Ontario Ministry of the Environment, White Paper on Watershed-based Source Water Protection Planning (February 2004), accessed October 25, 2004 at http://www.ene.gov.on.ca/programs/3585e01.htm

121 Groundwater Catchment Regulation, Chapter IV. "Projects having a capacity less than 75 m^3 per day intended to supply more than 20 persons" and "Projects having a capacity of 75 m^3 or more per day or that will bring the capacity to more than 75 m^3 per day" also require ministerial authorization.

122 Groundwater Catchment Regulation, Chapter IV.

123 *Ibid.*

Where a project involves water that will be sold as mineral or spring water, the application must also include a hydrogeological study establishing the impact of the project on the environment, other users and its food safety.[124]

Authorizations last for 10 years. Applications for renewal must submit a statement of a professional engineer or geologist stating that the impact of the groundwater catchment on the environment or other users, or for spring or mineral water catchments, on food safety, remains unchanged. If there has been a change of impact, the application for renewal must include a hydrogeological study specifying the nature and causes of the changes.

Quebec has additional regulations that protect wells from sources of contamination, and these regulations also specifically refer to bottled water operations. For example, the "Regulation respecting the reduction of pollution from agricultural sources" under the *Environment Quality Act* has numerous provisions regarding the protection of wells and springs from livestock facilities, livestock waste, farm compost and mineral fertilizers. It establishes a 300m "protected zone" around, amongst other things, "a water intake used to produce spring water or mineral water…"[125] and prohibits certain works or activities from taking place within the zone.[126]

Additionally, the "Regulation respecting the burial of contaminated soils" prohibits the "laying out [of] a contaminated soil burial site on a land within the supply area of… a waterworks system…used for the production of spring water or mineral water…"[127] Finally, the "Regulation respecting the prevention of water pollution in livestock operations" prohibits the establishment of liquid manure livestock operations within a 300m of a well or spring used to supply a waterworks system or a water bottling plant, and prohibits the spreading of manure in water or on ground within 30 m of a water bottling plant.

New Brunswick requires an environmental impact assessment screening and approval process for any waterworks, public, private or commercial, that involve takings of more than $50m^3$ (=50,000 litres) per day. The screening entails a water supply source assessment process assessing sustainable yields, aquifer type, potential pollution sources, etc.[128] New Brunswick does not have any regulations that specifically target bottled water operations.

Nova Scotia requires water withdrawals greater than 23,000 litres per day to obtain a withdrawal approval, pursuant to the Environment Act's Activities Designation Regulations (Division I). Applications for approvals must be submitted to Nova Scotia Environment and Labour in accordance with relatively detailed requirements stipulated in the Guide to Groundwater Approvals, which include a Qualified Persons

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124 Where the project has a capacity of less than 75 m^3 per day intended to supply more than 20 persons, or 75 m^3 or more per day or will bring the capacity to more than 75 m^3 per day, and the project is intended for supplying drinking water, the application must include a hydrogeological study establishing the impact of the project on the environment, other users and public health. All hydrogeological studies must be signed by a professional engineer or geologist. (Groundwater Catchment Regulation, Chapter IV)

125 Section 27.

126 Section 29.

127 Section 8.

128 Personal communication with Nelda Craig, Manager, New Brunswick Water Sciences Section, Science and Reporting Branch, Environment and Local Government. Note that municipal waterworks must additionally undergo a designation process further to the Wellfield Protected Area Designation Order under the New Brunswick *Clean Water Act*.

Assessment Report and hydrogeological study which evaluates the effects of the proposed withdrawal on existing groundwaters and the environment.[129] Nova Scotia does not have any regulations specifically targeting bottled water operations.

Prince Edward Island requires all wells that have a capacity greater than 50 Imperial gallons per minute to go through a Groundwater Exploration Permit procedure. (PEI is unique in its choice to regulate takings by pump rate as opposed to volume of taking.) Applicants must identify their proposed location, the expected pumping rate, the pumping schedule and other users in the area.[130] The approval process considers whether the groundwater extraction will have a significant impact on other groundwater users or the environment.[131] Prince Edward Island does not have any regulations specifically targeting bottled water operations.

Newfoundland and Labrador requires a water use licence for any water withdrawals (no minimum) that are not for domestic purposes.[132] The application process for a licence entails an assessment of potential adverse effects of the withdrawal.[133] The municipal authority in which the undertaking is proposed to be located must also be notified, as must other government departments that may be affected.[134]

Like Quebec, Newfoundland and Labrador has specifically contemplated bottled water operations in its regulatory system. Required relevant information needed from bottled water applicants is set out in a tailored application form entitled "Application for Water Licence for Water Bottling and Other Finished Water Based Products from Any Water Source." Requirements of applicants include: detailed plans addressing the availability of water, a business plan and the need for infrastructure and storage and processing facilities; and water quality analysis reports. Applicants must specify their daily, weekly and annual water withdrawals from the proposed source and answer whether the supply will be sufficient to support present and future demands. Additionally, applicants must provide names of all users who may be affected by the applicant's use of the resource and a plan for accommodating them, as well as a "no objection letter" from the municipal authority, "if required."[135]

Newfoundland and Labrador grants 10-year licences for water rights and approves applications, subject to availability and hydrogeological information.[136]

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129 Guiding principles that are used for allocating withdrawals include that "Withdrawals from the aquifer must be sustainable (i.e., can be maintained indefinitely without causing unacceptable environmental, economic or social consequences)" and "New groundwater withdrawals should not cause any significant adverse effects to existing groundwater users or the environment. Note that existing users are not required to modify operations if their water withdrawals interfere with water levels in newly installed wells."

130 InfoPEI, "Groundwater Exploration Permit" and "Groundwater Exploration", found at http://www.gov.pe.ca/infopei/onelisting.php3?number =20112 [and 20113].

131 *Ibid.*

132 Government of Newfoundland and Labrador, *Water Resources Act*, ss. 4 and 14.

133 *Ibid,* at s. 14(1).

134 *Ibid*, at s. 14(3).

135 Application form, "Water Bottling and Other Finished Water Based Products from Any Water Source."

136 Personal communication with Dr. Abdel-Razek, Government of Newfoundland and Labrador, Department of Environment and Conservation, Water Resources Management Division.

Groundwater takings (except for municipal use in the Yukon) are not significant in either the Yukon, Northwest Territories or Nunavut. None of these jurisdictions has any regulations specifically targeting bottled water operations and related sustainability considerations for this groundwater use.

SUMMARY REGULATORY SCHEMES FOR THE BOTTLED WATER INDUSTRY

The establishment of a bottled water operation creates the possibility of a variety of sustainability and environmental impacts: impacts on rechargeability (especially given that the use is 100% consumptive); the potential for contamination; cumulative impacts on a limited mineral water source; impacts on neighbouring wells, municipalities, local roads and the local neighbourhood character; and the list goes on.

The regulatory response to this use, like other groundwater uses, has not been uniform across Canada. While in this case a few jurisdictions (Ontario, Quebec and Newfoundland and Labrador) have instituted some specific regulations or policy to address some of the impacts they believe to be specific to a bottled water operation, other jurisdictions have simply not tailored their schemes at all.

THE CANADIAN BOTTLED WATER ASSOCIATION'S MODEL BOTTLED WATER CODE

Some 85% of the bottled water sold in Canada is produced by members of the Canadian Bottled Water Association (CBWA).[137] Members of the CBWA adhere to a voluntary CBWA Model Code (Model Code). Because this voluntary self-regulation by the industry supplements and enhances the federal and provincial schemes of regulation for such a significant proportion of producers, the Model Code merited review. We reviewed the September 2002 revision.

As might be expected, the Code is primarily focused on ensuring that safe, potable water is delivered to consumers. The Code is broken down into six Rules[138] and three appendices.[139]

The Code of Ethics set out as Appendix C can be applauded for listing as its first code item,

> 1. CBWA bottler members will respect the sustainability and durability of the aquifer from which they take water.

However, the Model Code is silent on the issue of *how* to protect source sustainability and durability, except on the issue of source contamination.[140] The Model Code does require bottlers in certain cases to determine

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137 Canadian Bottled Water Association, at http://www.cbwa-bottledwater.org/en/cbwa.htm

138 The six rules are: Definitions and Product Designations, Product Quality, Good Manufacturing Practices and Operational, Requirements, Source Water Monitoring, Finished Product Monitoring and Labeling Requirements.

139 Appendix A sets out a "Monitoring Matrix," Appendix B a "Total Coliform Standard and Policy," and Appendix C a "Code of Ethics."

140 Rule 3.3 requires the bottler to submit a "basic hydro geological survey of the source and a sanitary survey", to demonstrate the "integrity of the source." The sanitary survey is stipulated to require "Watershed surveillance consisting of an inspection of portions of the drainage area necessary to identify and evaluate actual and probable sources of contamination." (Item 3.3.1), "Evaluation of source construction and protection, and where appropriate, intake structures, and transmission facilities." (Item 3.3.2), and "Evaluation of finished water storage facilities." (Item 3.3.3). Rule 3.12 sets out standards respecting identifying circumstances that could lead to an adverse effect on the safety of bottled water, including "source contamination, spills, accidents, natural disasters or breakdowns in treatment."

the recharge area of the source and the zone of influence,[141] however the driving force behind this requirement appears to be to establish whether there are any contaminants within the area that might affect the source. The Model Code does not explicitly require members to use their findings on the recharge area and zone of influence to consider the impacts of the demands on the aquifer on the sustainability and durability of the aquifer.

CONCLUSION

Groundwater use in Canada is significant and extensive in both its scope and its complexity. Across the country, we rely on clean, fresh, groundwater in the most essential way – for drinking water and other daily needs - and we have also extensively incorporated this resource into our industrial, agricultural and commercial endeavours. In some industries, such as the oil injection industry, we rely further on non-fresh or saline aquifers to meet our needs for water.

The impacts, potential and real, from our use of groundwater are many and varied. Our uses have the potential to deplete groundwater supplies; to contaminate them (sometimes to the point of requiring extensive remediation); to mix saline into fresh supplies; and to impact on other related ecological or human systems, such as nearby streams and fish habitat or other human users of the resource. Given these hazards, we need to plan and manage groundwater use carefully, carry out other related research such as mapping, and learn more about the resource's interactions with other elements of the water cycle.

Yet we still lack knowledge about our use of groundwater. As we have identified, the data is not complete, and the gaps in the data interfere with our ability to get a "full picture" of what is going on across the country, and sometimes even to interpret what is happening with groundwater use within the various jurisdictions. Canadians need to devote more resources to data collection, and we need to standardize the ways that we collect data, so that it can become more accessible and useful to all interested parties.

Moreover, as was demonstrated with the bottled water industry (and to a limited extent, in our shorter discussion of other uses, such as oilfield injection and ground sourced heat pumps), while some jurisdictions have made an effort to respond to, and manage, the specific challenges posed by particular groundwater uses, other jurisdictions have not. Because groundwater data and information are essential prerequisites to regulation of the resource for sustainability, efforts to increase the data set on groundwater use in Canada will support regulatory efforts vis-à-vis sustainability.

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[141] Rule 4 sets out standards on Source Water Monitoring, and while these standards could be bolstered to address sustainability, at the moment the Rule does not carry the requirement for analysis that far. For example, the Rule stipulates that where a source does not comply with the Guidelines for Canadian Drinking Water Quality, the bottler must show by analysis that its treatment reduces the contaminant levels below the federal legal requirements. Additionally, the Rule requires that "a field inspection of the source" be carried out by a "professionally qualified hydro geologist" that "shall demonstrate the integrity of the source and safety of the catchment operations," and that shall include several listed items, including: "A report on the regional geology surrounding the site and the specific site geology. A description of the vertical and horizontal extent of the source aquifer using existing data. The information will be used to define the recharge area of the aquifer, or in the case of regional aquifers, the zone of influence of the subject source." (Item 4.1.2); "A watershed survey of the recharge area or zone of influence of subject source that identifies and evaluates actual and potential sources of contamination, and which shall be updated every three years, including any reported discharge that may affect the source." (Item 4.1.4) "Based on the findings in item 4.1.4, a plan for special monitoring of any significant contaminant source and for taking restrictive preventive or corrective measures as appropriate to protect the source water." (Item 4.1.5).