Chapter 8 GROUNDWATER ASSESSMENT NORTH AND SOUTH PENDER ISLANDS: EXISTING LEGAL AND INSTITUTIONAL FRAMEWORKS

8.1 Introduction

This chapter reviews the legal and institutional frameworks that influence current water management practices. The existing water supply systems on North and South Pender Islands are discussed in detail. The context for the current water supply systems is that they provide an overview of the challenges facing water resource management on North and South Pender Islands. The implications of the legal and institutional framework on water resource management are discussed.

8.2 Legal and Institutional Frameworks

The issues confronting water resource planners and managers are many and made more difficult by the fact that they have strongly interrelated social and technical dimensions (Viesmann, 1988). As stated by Beck (1988), water resource management is accomplished within some form of legal or institutional framework that must be known, understood and used. The pitfalls of the legal and institutional systems should be avoided to the fullest extent possible.

The regulations governing water resources in the Gulf Islands of British Columbia can be sub-divided into federal, provincial and local. This is a not an ideal scenario for management and has been referred to by Cohen (2007) as a patchwork framework for groundwater governance. As Cleaver and Franks (2000) point out, the increasingly complex scenarios regarding water management have placed ever greater demands on planners. The increased water management complexity relates back to the basic research goal of developing a cost-effective approach to estimate the physical groundwater resources available while providing useful information to assist planners in developing community plans.

8.2.1 Federal

Under The Constitution Act (Department of Justice Canada, 1867), the federal responsibilities for water are limited, since the provinces have been given the prime responsibility for water resource management. The federal government does have jurisdiction over conservation, protection of oceans, fisheries, navigation, and international relations (Government of Canada, 2003). The federal government also has responsibilities for water on federal lands, including national parks and First Nations lands (Government of Canada, 2003). There are, however, areas of shared federal-provincial jurisdiction (Environment Canada, 2003), which include:

- Interprovincial water issues
- Agriculture
- Significant national water issues
- Health
- Navigation
- International water issues
- Fisheries and oceans

There are a number of federal laws impacting water; the most relevant are the Fisheries Act, the Canadian Environmental Protection Act (1999), Federal Water Policy (1987), and the Health Act. The Federal Water Policy has made little progress in achieving the goals set forth in 1987 (Cote, 2006):

- Develop, with provincial governments and other interested parties, appropriate strategies, national guidelines and activities for groundwater assessment and protection;
- Conduct research and undertake technological development and demonstration projects in response to groundwater problems;
- Develop exemplary groundwater management practices involving federal lands, responsibilities, facilities and federally funded projects;

- Provide information and advice on groundwater issues of federal and national interest.

Health Canada has prepared a set of Guidelines for Canadian Drinking Water Quality (Health Canada, 2006). Significantly, guidelines are voluntary and unenforceable, while standards are legally binding and enforceable (Boyd, 2003). As a result, no jurisdiction within Canada is compelled to adhere to the Canadian Drinking Water Quality guidelines.

For North and South Pender Islands, there are no interprovincial water issues, since both are located entirely within the Province of British Columbia. The islands are, however, surrounded by federal territory over which there is intergovernmental jurisdiction. Both North and South Pender Islands are close to the San Juan Islands of the United States, so they must rely on the federal government to deal with any international water concerns that may arise.

There are federal lands on North and South Pender Islands, including:

- Pender Island Indian Reserve, South Pender Island
- Greenburn Park, South Pender Island
- Roesland, North Pender Island

These lands are administered by Indian and Northern Affairs in the first case, and Parks Canada in the other two cases.

8.2.2 Provincial

The Province of British Columbia has stated emphatically that all groundwater resources are the sole property of the province (B.C. Environment, 1993a). Unfortunately, despite claiming ownership of the resource, the Province of British Columbia had no groundwater legislation to manage the resource until 2005, when Groundwater Protection Regulations were included as part of the Water Act (B.C. Government, 2005). Fragmentation of groundwater governance is not restricted to different levels of government but Provincial legislation is widely distributed throughout a number of departments and agencies (Henderson, 1998; B.C. Auditor General, 1999), including:

- Ministry of Land, Water and Air Protection
- Ministry of Health
- Ministry of Forests
- Ministry of Transportation and Highways
- Ministry of Municipal Affairs
- Ministry of Small Business, Tourism and Culture
- Ministry of Community Services
- Ministry Responsible for Housing, Office of Housing and Construction Standards
- Ministry of Agriculture, Fisheries and Food
- Environmental Assessment Office
- Land Use Coordination Office
- Capital Regional District Office

The existing provincial legislation controlling land use and impacting water management includes the following statutes:

- Water Act
- Drinking Water Protection Act
- Water Utility Act
- Groundwater Protection Regulation
- Environmental Assessment Act
- Health Act

- Islands Trust Act
- Local Services Act
- Highways Act
- Controlled Access Highways Act
- Municipal Act
- Local Government Act
- Agricultural Land Commission Act
- Agricultural Waste Control Regulation
- Farm Practices Protection Act
- Energy Act
- Water Utilities Act
- Parks Act
- Building Code
- Regional Parks Act
- Land Registry Act
- Land Titles Act
- Pollution Control Act
- Waste Management Act
- Heritage Conservation Act

The fragmentation in groundwater resource management is accompanied by inadequate legislation, policy and planning, as well as lack of enforcement of existing legislation. Cohen (2007) noted that, on the Gulf Islands, it is common for there to be a lack of enforcement of the above-listed statutes. These deficiencies combine to exacerbate the lack of reasoning often associated with community planning. The B. C. Auditor General (1999) recommended that a single agency be assigned the role of protecting drinking-water sources. To date, that recommendation has not been acted upon.

During the early 1990s, the province considered legislation to designate Groundwater Management Areas (GMAs) and the Gulf Islands were identified as possible GMAs due to their heavy reliance on groundwater (B.C. Environment, 1993b). The legislation was not passed and, to date, no areas in British Columbia have been designated as GMAs.

The B. C. Auditor General's Report (1999) noted that there is a lack of an integrated approach encompassing land and water management. The report highlighted issues of lack of control over septic tank systems, well interference, and aquifer depletion, as well as lack of management tools to deal with single family water wells. All these issues are of concern for residents of North and South Pender Islands.

A study undertaken by Henderson (2006) on Bowen Island, British Columbia, identified four categories of barriers to effective groundwater governance: 1) governance including fragmented management, reliance on volunteers, lack of municipal leadership; 2) financial; 3) attitudinal, including water as a proxy for development, resistance to water conservation measures; and 4) scientific, related to the lack of knowledge of supply capacity. Not all of these barriers are directly related to the legal and institutional frameworks currently in place, but there is certainly an inference that an indirect relationship exists.

8.2.3 Local Water Policies

The North Pender Island Official Community Plan (Islands Trust, 2003) lists a set of local regulatory bylaws including the following:

- A bylaw regulating the use of land, buildings and structures including density, siting, size, and dimensions;
- A bylaw regulating the shape, dimensions and area of parcels of land that may be created by subdivision;

- A bylaw regulating the establishment of different density regulations for a zone;
- A bylaw regulating drainage.

However, a caveat in the Official Community Plan states that nothing put forward in the plan need be undertaken. One wonders why the community went to the trouble to establish the by-laws and develop a community plan if the bylaws can simply be ignored without consequences.

The North Pender Island Local Trustees (Islands Trust, 2003) have included in the Official Community Plan a section pertaining to water systems. The policies suggested include the following:

- The Trust Committee shall
  - a) support a combination of local water supply systems;
  - b) support water conservation and education;
    - Sources of drinking water shall be protected through regulation;
    - Use and setbacks of buildings and other improvements shall be regulated to protect wells;
    - The quality of domestic water supplies and community water systems should be monitored regularly. Use of water saving devices is encouraged;
- The Ministry of Environment, Lands and Parks shall be encouraged to:
  - a) monitor the quantity and quality of water supplied from the groundwater systems;
  - b) administer well drilling activities and the tapping of watershed and aquifer resources;
  - c) establish limits on the number of wells authorized in relation to known water supply volumes;

- Not less than 2045 litres/day/lot, shall be proven available prior to subdivision approval or the issuance of building permits;
- Storage of rainwater to supplement water supply for household use, fire protection and irrigation is encouraged;
- To reduce the risk of flood damage, all buildings shall be situated in accordance with provincial standards.

The major difficulty with the Water System Policies section of the Official Community Plan is the lack of any definition outlining the procedures in place to carry out the policies listed. The document does not state how the Trust Committee will support water supply systems, water conservation, and education. It does not provide any references to the regulations that may protect drinking water sources. The establishment of limits on the number of wells would be impossible to regulate, since there has never been an assessment of the water supply volumes on the island. Limiting the number of wells does not take into account the location and depth of wells or pumping rates, which may be more significant than the number of wells. In addition, the policies use phrases such as “shall be encouraged” and “should be”. An example of the use of these phrases from the North Pender Island Official Community Plan is “The quality of domestic water supplies and community water systems ‘should be’ monitored regularly. Use of water saving devises is ‘encouraged.’”. These phrases indicate that all policies are voluntary and there are no penalties for not voluntarily abiding by the policies. In addition, proven water well production of 2045 litres/day/lot is less than the median water well production for the islands. Thus, without a grandfathering clause, approximately 10% of the current lots would have insufficient water resources for development approval or the issuance of a building permit.

The local Health Officer is generally responsible for ensuring adequate water supply, sewage disposal and other items listed in the Official Community Plan. Unfortunately, the local Health Officer is generally not familiar with hydrogeology; the absence of expertise in that field can lead to the approval of sewage disposal facilities in less than optimum geologic conditions.

The North Pender Island Official Community Plan (Islands Trust, 2003) suggests that consultation with other government agencies will occur, but offers no specifics as to how this may be achieved. The Community Plan should include a clear and concise approach to inter-agency requirements for consultation

8.2.4 Local Water Systems

On North and South Pender Islands, the management of water can be divided into several sub-sections (Figure 8.1). Magic Lake Estates has a water distribution system that is managed by the Capital Regional District based in Victoria. Razor Point Road Development and Trincomali are designated as Improvement Districts with the sole purpose of managing water resources for each community. Poets Cove and Otter Bay Marina have (or are planning to have) high population densities and will require a water management system; the remainder of the islands consists of unregulated, individual water well users. The following sections describe each of the water management systems listed above.

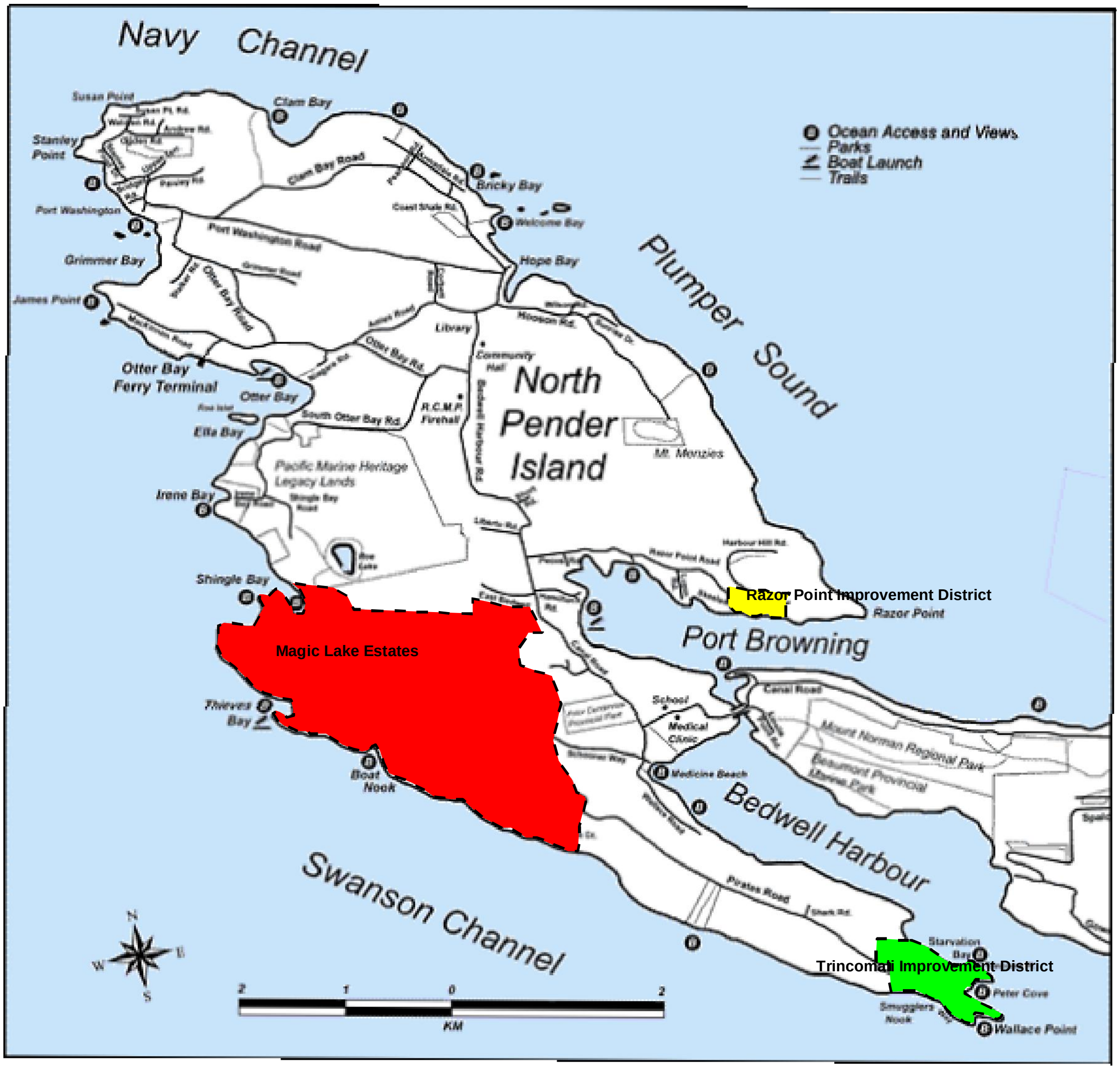

Figure 8.1: Water supply systems, North and South Pender Islands

8.2.4.1 Magic Lake Estates

Magic Lake Estates currently has the highest population density on the Outer Gulf Islands. The subdivision was established in the early 1960s and consists of 1243 lots, ranging in size from one-third to one-half acre. The initial water supply system was installed and operated by Gulf Industries. The water for the system was sourced from Magic Lake, a man-made reservoir constructed in 1964. Gulf Industries was licensed to withdraw either 456,600 litres/day (120,635 gal/day) or 166 million litres/year (42.3 million gal/year) from Magic Lake. There were no meters to monitor withdrawal rates. Due to contamination from septic fields located adjacent to the lake and the subsequent increased algal content, Magic Lake ceased to be the water supply source for the community in the late 1970s.

In 1980, the operation of the water supply system was transferred to the Capital Regional District (CRD). A committee of local residents was established to provide recommendations to the CRD. Any capital expenditures made for the water supply system must be approved by the CRD Environmental Committee and the CRD Board of Directors.

The current water supply for Magic Lake Estates is Buck Lake, a man-made reservoir constructed in 1967. The withdrawals are licensed at either 1.73 million litres/day (0.46 million gal/day) or 630 million litres/year (167 million gal/year). Signage at the firehall, located at the entrance to Magic Lake Estates, informs residents of the water supply status of Buck Lake.

To ensure security of supply for the community, a reserve was placed on Roe Lake in 1978 by Order in Council (Mordaunt, 1981). Presently both Roe Lake and Magic Lake are viewed as additional sources of supply. It is anticipated that once all lots have been developed, Buck Lake will not have sufficient water to meet the needs of the community, and additional supply will be provided from both Roe Lake and Magic Lake (North Pender Local Trust Council, 1993). Magic Lake is currently used as a supplemental water source for Buck Lake. There are concerns related to the water quality of Magic Lake that may impact its usefulness as a supplemental water supply source in the future (Island Tides, 2005a). A water review conducted in 2005 (Island Tides, 2005a) indicated that there are currently 894 residential lots on the water system and another 317 lots still to be developed. There are also concerns related to the sales listing of a large parcel of land encompassing most of the Buck Lake watershed. This parcel has significant subdivision potential and therefore may impact both future water quality and surface run-off to Buck Lake (North Pender Island Trust Committee, 2006).

In the mid-1990s, it was estimated that the water supply system was losing up to 45% of capacity due to leaks (Islands Tides, 1996). A large portion of the pipeline distribution system was replaced during the summer of 2002, but it is estimated that the system currently loses 190 to 225 litres/min. (50 to 60 gal/min.) due to leakage (Island Tides, 2005a). The losses are equivalent to 16.5% of daily licensed withdrawals. The estimated costs of repair to the water system were $825,000 or approximately $920 per developed residential lot. Additionally, the community has not approved the use of water meters. There is significant opposition to the installation of water meters. Residents are concerned that the water meters will be used to monitor consumption rates rather than to detect leaks in the system (Magic Lake Estates Water and Sewer Committee, 2004). Leak detection has appeared on the agenda of all of the Magic Lake Estates Water and Sewer Committee meetings (Magic Lake Estates Water and Sewer Committee, 2003 and 2004) during 2003 and 2004.

No documentation of measurements of the storage capacity of Buck Lake, Magic Lake or Roe Lake was uncovered during the research. A bathymetry survey to map the bottom topography would provide the information required to calculate the volume of water available to the residents of Magic Lake Estates. In addition to individual water meters, it would be useful to meter the extractions from the lake to enable a full system accounting.

In addition to assisting in leak detection, water meters have been proven to reduce water use (Tate, 1990, Chaplin, 1998). A block pricing scheme with higher rates during the summer months when reserves are typically declining would serve the community well. The lack of a block pricing scheme represents almost a tragedy of the commons scenario, in which the self-interest of individuals overrides the interests of the community as a whole. The lack of a mechanism to control water demand through water pricing in Magic

Lake Estates enables water to be treated as a free good, so that the user has no incentive to place a value on water (Agth and Billings, 2002).

The rates charged for the water supply system are parcel taxes of $129/year and user fees of $60/year (Table 8.1). The water consumption in Magic Lake Estates has been estimated at approximately 820 litres/lot/day (216 gal/lot/day), including losses in the system. This rate of water consumption would translate to about 450 litres/person/day (119 gal/person/day), which is excessive, even for most urban environments. The City of Edmonton has mandatory water meters, with an average domestic daily water demand of 225 litres/person (www.epcor.ca/Water/WaterUtilitiesStats2005.htm). As a comparison, Calgary, Alberta is not fully metered and uses an average of 340 litres/person/day (90 gal/person/day) for residential use (City of Calgary, 2005). Magic Lake has almost twice the water consumption of the City of Edmonton and uses one and a half times the water per capita than the City of Calgary. The City of Calgary requires that all homes have water meters by 2014 although there is no measure of how many homes currently possess water meters. The cost of water supply in Magic Lake is, however, substantially lower than in any of the larger western Canadian urban centres. The rate is similar to the rates in both Razor Point Road and Trincomali Improvement Districts. There are no consumption charges levied in any of the Pender Islands water systems.

Table 8.1: Comparison of household water system costs in western Canada (adapted from City of Calgary, 2005).

Location	Fixed Charge	Consumption Charge	Average Annual Cost
Magic Lake Estates	$189.00	Nil	$189.00
Razor Point Road	$200.00	Nil	$200.00
Trincomali	190.00	Nil	$190.00
Greater Victoria	$94.45	$0.7048	$314.60
Vancouver	Flat annual rate per single family residence	Nil	$271.00
Calgary (metered) (unmetered)	$119.04 $540.00	$0.9015/m^3 Nil	$389.49 $540.00

The community has not prepared any educational information that would provide new residents with a means of understanding the water issues and offering measures to augment water supply. During 2003, the water levels in Buck Lake were extremely low, with stage three water restrictions in effect. A brochure entitled "WaterInfo", produced by the CRD, was distributed to all residents and property owners (Magic Lake Estates Water and Sewer Committee, 2003b).

The initial sewer system in Magic Lake Estates was installed and managed by Pender Holdings. In 1980, the operation of the sewer system was also transferred to the CRD. There are currently two sewage treatment facilities in the community and they provide only secondary treatment (aeration). The system was operating at close to its capacity of 172,748 litres (45,640 gallons) in 1996. The rates for the sewer system have been established as a parcel tax of $295/year and a user fee of $101/year. Problems have also been reported with leaks from the sewer pipeline (Islands Tides, 1996). The location of leaks in a sewage pipeline can impact water quality in surface water supplies if they are recharged by contaminated groundwater/surface runoff. Groundwater contamination in aquifers for adjacent individual water well users could occur if leakage from the sewage pipeline reaches zones of high secondary porosity and permeability.

8.2.4.2 Razor Point Road Improvement District

The Razor Point Road Development dates back to the 1960s. It consists of 31 properties, of which 27 have been developed. Of these, there are between 12 and 14 properties with year-round residents. The greatest demand for water is during the dry summer months, when the majority of the developed properties are occupied. The water supply for the development consists of a well located in an adjacent development (Harbour Hills). The water well was drilled to a depth of 125 metres, with the groundwater table occurring at a depth of about 33 metres. The well produced water at a rate of 378.5 litres/min. (100 gal/min.) after completion but has been pumped at a much lower rate of 3.8 litres/min.

(10 gal/min.). The well is likely located along the Allison Fault, which may account for the high production rate, sulphur odour, and colouration.

Water pumped from the well is stored in a 4,540 litre (1,200 gallon) storage tank and services the community through a gravity fed system of water lines. From conception until 1992, the water system was managed by developer WO-KANDA Enterprises. In 1992, an Improvement District was established by the residents with the sole purpose of managing the water system. A Board of Directors elected by the community oversees the operation of the water system. The Board of Directors consists of three individuals from the community. One of the Board members is elected on an annual basis.

A metering system has been established and is used primarily for leak detection. The metering system also plays a role in the overall accounting system. The volume of water that is pumped to the storage tank is recorded and compared to the volume of water consumed by residents. The comparison of these figures provides information on leaks in the system that may not be readily evident through the monitoring of individual water meters.

The residential meters also play a role in monitoring excessive consumption of water. If a meter reading indicates that there has been a substantial increase in water consumption by a particular resident, the Board of Directors will meet with the resident to discuss reducing water use.

The property owners are currently charged a flat fee of $200/year for a lot with a residence and $68/year for a lot without a residence. There are no hook-up fees or plans for any charges based on consumption rates. The income from annual fees is used to cover the operating costs of the system. Any surplus funds are set aside to cover any capital purchases required. In 2003, an automated chlorination system was installed to improve the taste and colour of the water in the system.

Water quality is checked by the Vancouver Island Health Authority every two months. Table 8.2 indicates typical water testing results. There has been little variation in water quality since testing commenced in 1981.

Table 8.2: Water quality testing, Razor Point Improvement District.

Elements	Sample (1999)	Units	Sample (1981)	Maximum Limits Permissible in Drinking Water
Aluminum	O.105	mg/L	n/a	No limit listed
Antimony	0.098	mg/L	n/a	No limit listed
Arsenic	<0.500	mg/L	n/a	25.0
Barium	<0.009	mg/L	n/a	1.00
Beryllium	<0.003	mg/L	n/a	No limit listed
Boron	0.653	mg/L	n/a	5.00
Cadmium	<0.001	mg/L	0.004	0.005
Calcium	62.1	mg/L	58.7	200
Chromium	0.020	mg/L	n/a	0.050
Cobalt	0.025	mg/L	n/a	No limit listed
Copper	0.032	mg/L	<0.001	1.00
Gold	<0.040	mg/L	n/a	No limit listed
Iron	0.051	mg/L	<0.030	0.300
Lanthanum	<0.020	mg/L	n/a	No limit listed
Lead	<0.500	mg/L	n/a	10.0
Magnesium	15.8	mg/L	15.1	50.0
Manganese	0.158	mg/L	0.41	0.050
Molybdenum	<0.020	mg/L	n/a	No limit listed
Nickel	<0.050	mg/L	n/a	No limit listed
Phosphorus	0.118	mg/L	n/a	No limit listed
Potassium	0.486	mg/L	0.44	No limit listed
Scandium	<0.050	mg/L	n/a	No limit listed

Elements	Sample (1999)	Units	Sample (1981)	Maximum Limits Permissible in Drinking Water
Silicon	8.51	mg/L	21.7	No limit listed
Silver	<0.010	mg/L	n/a	0.050
Sodium	12.1	mg/L	12.1	200
Strontium	0.261	mg/L	n/a	No limit listed
Titanium	<0.010	mg/L	n/a	No limit listed
Tungsten	<0.050	mg/L	n/a	No limit listed
Vanadium	<0.010	mg/L	n/a	No limit listed
Zinc	0.009	mg/L	0.026	5.00
Hardness	220	mg/L	209	150-300 mg/L = hard
PH	7.45		7.80	6.5 to 8.5
Total Suspended Solids	n/a	mg/L	<0.5	
Total Dissolved Solids	n/a	mg/L	410	
Turbidity	n/a	JTU	0.35	
Conductivity	n/a	micromhos/cm	495	

Notable by its absence from Table 8.2 are data on total and fecal coliforms. Because leakage from septic tanks and fields has such a large potential to impact water quality, it would be important to include both total and fecal coliforms in any future testing. There is also a legal requirement to test for total coliform, fecal coliform, and *E. coli*. (B.C. Government, 2003). The land use adjacent to the water well has changed significantly since 1981 when the area was predominantly tree-covered, with little human habitation. Currently, the land surrounding the water well is part of Harbour Hills development and most of the lots have been developed with the associated septic tanks and/or septic fields.

One shortcoming of the Razor Point Road Development water system is the reliance on a single well. There is no security of supply if something happens to this particular well. Well-head protection measures should be implemented to protect the water well and reduce risk of contamination. The community should also pay close attention to land use on the lots adjacent to and particularly upslope of the water well. It would be wise to develop an emergency response plan to ensure security of supply.

8.2.4.3 Municipal Improvement District of Trincomali

The Trincomali subdivision was established in 1968 and consists of 104 lots. As of 1996, 79 of these lots had been developed. The initial water system was installed and operated by Pender Utilities. The supply system comprises six wells. The water from these wells is pumped to two 45,450 litre (10,000 gallon) storage tanks located up slope from the subdivision to allow for gravity feed. Two of the wells had to be replaced early in the history of the development due to contamination from diesel fuel used in the initial water pumps. The contaminated wells were replaced by alternate wells and the diesel pumps were replaced by electric pumps to reduce the potential for contamination.

In 1983, the residents of the subdivision voted to form an Improvement District with the sole purpose of managing the water supply system. A Board of Directors consisting of five elected representatives from the community was established. The Board established fees for water supply, which included the following:

- $190 flat fee
- $500 connection fee
- $25 turn-off fee
- $25 turn-on fee

In 1993, water meters were installed in all residences at a cost of $150/meter. The costs were kept low through the use of volunteer labour from the community to install the meters. The water meters have been used for several purposes, including identification of leaks and recording daily consumption patterns. The recording of daily consumption patterns plays a significant role in the water management practices of the Improvement

District. During the dry summer months, daily consumption records of all residents are posted on a bi-weekly basis on a community bulletin board and peer pressure is used as a means of maintaining low levels of consumption. Any consumption deemed to be excessive results in members of the Board of Directors visiting the resident. If excessive consumption continues, access to the water system is denied. Excessive water consumption would be deemed to be water use above recommend levels established by the district, as outlined in Table 8.3.

Table 8.3: Recommended reasonable water use for essential domestic purposes

270 to 320 litres (60 to 70 gallons)/day for a 2 person household

410 to 500 litres (90 to 110 gallons)/day for a 4 person household

635 to 725 litres (140 to 160 gallons)/day for a 6 person household

In 1988, the Improvement District increased storage capacity by constructing a reservoir with a capacity of 1.36 million litres (360 thousand gallons). Community residents paid for the capital expenditure, receiving matching funds from the provincial government. The residents had the option of paying a lump sum of $1,550 or $188/year for a 20-year period.

The Improvement District has prepared an information package on its water system with suggestions for reducing water consumption and augmenting supply, that is distributed to new residents. By recording the volume of water pumped into their storage facilities and comparing it to the metered water consumed, they have established an accounting system to identify leaks and monitor usage of the community (Table 8.4). Sudden increases in unaccounted water in the system in early 2000 led to the search for and discovery of a break in a pipe connecting two of the district's water wells. The variations in unaccounted water have declined since 1993, as leaks in the main system have been found and repaired (J. Roberts, personal communication, 2003). The storage facilities and number of water wells indicate that significant thought and money have been expended to ensure security of supply for the residents of the community.

Table 8.4 shows that the greatest consumption of water takes place during June, July and August when rainfall is typically at its lowest. The lowest consumption occurs during the winter months when aquifers are replenished by winter rains. The District of Trincomali consumed 5.0 million litres (1.1 million gallons) of water in 2002 or an average of 421,568 litres (92,734 gallons) per month. If June, July and August are taken out of the year total, the average monthly water consumption decreases to 379,390 litres (83, 456 gallons). For the three summer months, the average consumption is 44% higher, at 548,102 litres (120,568 gallons).

Water quality tests are conducted for fecal coliforms on a regular basis by the Vancouver Island Health Authority. In contrast to the Razor Point Road Municipal District, no other tests are conducted on the water samples. The greatest potential threat to the water quality is fecal coliforms, so the regular tests represent a logical, cost- effective approach to monitoring water quality for the community.

Table 8.4 contains information that can be used to calculate a water balance for Trincomali. Tables 8.5a and b present the water balance for 2002, 1943, an average period of annual rainfall, and 1996 using several assumptions:

- 1 inch of rainfall equals 17.4 million gallons of water per square mile (Solley *et al*., 1998)
- Groundwater recharge varies between 0.5 and 2.0% of precipitation
- An average daily per capita water consumption rate of 50 gallons

Table 8.4: Water use balance, Municipal District of Trincomali (J. Roberts, 2003)

Date	**Reservoir Meter**	**Gallons In**	**Storage Tanks**	**Storage Difference**	**Gallons Used**	**Gallons Used/Day**	**Gallons Metered**	**Unaccounted Gallons/Day**
01/31/02	14,558,570	79,390	16,947	6,692	72,698	2,345	68,120	148
02/29/02	14,626,406	67,836	13,273	(3,674)	71,510	2,554	63,709	279
04/01/02	14,723,820	97,414	13,273	0	97,414	3,044	91,046	199
04/30/02	14,813,760	89,940	17,354	4,081	85,859	2,961	80,456	186
05/31/02	14,917,090	103,330	17,552	198	103,132	3,327	97,901	169
06/30/02	15,011,140	94,050	13,026	(4,526)	98,576	3,286	94,843	124
07/31/02	15,131,535	120,395	13,518	492	119,903	3,868	114,498	174
08/31/02	15,274,267	142,732	13,026	(492)	143,224	4,620	139,711	113
10/01/02	15,369,720	95,453	13,762	736	94,717	3,055	91,890	91
10/31/02	15,455,653	85,933	18,119	4,357	81,576	2,719	75,278	210
11/30/02	15,525,107	69,454	18,119	0	69,454	2,315	66,923	84
12/31/02	15,595,494	70,387	13,762	(4,357)	74,744	2,411	70,381	141

The years 1943 and 1996 represent the minimum and maximum rainfall years on record. The calculations indicate that under the current level of development and assuming that 0.5 % of precipitation recharges groundwater, there is a deficit for all years that have average annual precipitation or lower. For 1996, there was a surplus of 2.12 million litres (467,113 gallons). If the percentage of precipitation recharging groundwater increases to 2% which is the figure used by the Wilder *et al.* (1978), there is a surplus recharge for even the lowest annual precipitation on record. It should be noted that the percentage used by the North Carolina Geological Survey (Wilder *et al*. 1978) may not be applicable to Trincomali. Trincomali has a different climate and physiography. Portions of Trincomali are extremely narrow and would not be suitable for the location of water wells. This indicates that the area used for the calculations of recharge may be overestimated. Trincomali also has a very limited soil cover which would tend to enhance surface runoff, thereby decreasing the volume of water available for groundwater recharge. A more realistic figure for the water balance of Trincomali may be 1% of precipitation which would still leave the district in a deficit position for years when there is less than average rainfall once all 104 lots have been developed.

Table 8.5a: Water balance for Municipal District of Trincomali on current 79 developed lots

Year	Precipitation	Assumed Consumption (gallons)	Assumed Recharge 0.5% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 1.0% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 2.0% (gallons)	Surplus/ Deficit (gallons)
2002	20.1” (511mm)	1,112,807	696,000	(416,807)	1,392,000	279,193	2,784,000	1,671,193
1943	15.7” (400 mm)	1,112,807	547,752	(565,055)	1,097,720	(15,087)	2,185,440	1,072,633
Average	31.6” (802 mm)	1,112,807	1,099,680	(13,127)	2,199,360	1,086,553	4,398,720	3,285,913
1996	45.4” (1152 mm)	1,112, 807	1.579,920	467,113	3,159,840	2,047,033	6,319,680	5,206,873

Table 8.5b: Water balance for Trincomali assuming full build out of 104 lots

Year	Precipitation	Assumed Consumption (gallons)	Assumed Recharge 0.5% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 1.0% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 2.0% (gallons)	Surplus/ Deficit (gallons)
2002	20.1” (511mm)	1,465,000	696,000	(769,000)	1,392,000	(73,000)	2,784,000	1,319,000
1943	15.7” (400 mm)	1,465,000	547,752	(917,248)	1,097,720	(367,280)	2,185,440	720,440
Average	31.6” (802 mm)	1,465,000	1,099,680	(365,320)	2,199,360	734,360	4,398,720	2,933,720
1996	45.4” (1152 mm)	1,465,000	1.579,920	114,920	3,159,840	1,694,840	6,319,680	4,854,680

8.2.4.4 Poets Cove

Poets Cove is located on South Pender Island and occupies the site of the former Bedwell Harbour marina. The current development was completed in 2004 (VIHA, 2004) and consists of a restaurant, marina, general store, and a lodge with 22 rooms, 15 cottages and nine villas (Poets Cove, 2004a). In its first summer of operation, it managed to maintain an occupancy rate of approximately 70%. The development has a licence to withdraw up to 50,000 litres (11,000 gallons) of water/day from Greenburn Lake. This translates to approximately 1,000 litres per room, cottage and villa, potentially withdrawn from Greenburn Lake on a daily basis.

The lake is located upslope from the development and the water supply system for the development relies on gravity feed. The development maintains two 30,000 litre (6,600 gallon) storage tanks on the upslope portion of the property. For fire safety, there must be a tank with 20,000 litres (4,400 gallons) of water available at all times.

Water plays a significant role in advertising for the development. A website describes the facilities as including washer and dryer, dishwasher, deep soaker tubs, showers, hot tubs and two swimming pools (Poets Cove, 2004b). The website makes no mention of the water shortages that are often encountered during summer months in the Gulf Islands, nor does it provide any educational information regarding water usage.

Greenburn Lake is managed by Parks Canada and at present there is no means of monitoring water withdrawals from the lake. In addition, there is no metering of the individual units within the development. No attempt has been made to store precipitation for use in maintaining lawns and gardens within the development. The concept of utilizing a dual piping system to fully use gray water has been considered but not implemented.

From a security of supply perspective, there is no backup plan if the water quantity or quality from Greenburn Lake should diminish to the point at which it is no longer an acceptable source. In view of the social and economic ramifications, it would simply be prudent business practice to have an alternative water source. It would also make sense to have a means of monitoring water consumption of residents, along with a user pay policy.

No water quality testing information was made available at the time of preparation of this dissertation. In addition, no attempts are made to educate residents and visitors as to the need to conserve the limited water resources of South Pender Island. There are currently a number of islands experiencing perceived problems with renters and visitors not respecting the limited nature of the water supplies (Island Tides, 2005b).

8.2.5 Individual Water Wells

Residents of North and South Pender Islands who are not part of a water system rely on individual water wells for water supply. On North Pender Island, there are approximately 900 water wells, although only 526 can be found in the water well data base (Islands Trust, 2005). The average rate of production from these wells is skewed by a few excellent producers. The median rate of production (at 5.7 litres/min. (1.25 gal/min)) has been used as being more representative of well yield. The median rate translates to 8,175 litres/day (1,800 gal/day), which is more than sufficient to meet the requirements of a single family dwelling. Figures for water well production presented in the Official Community Plan (North Pender Island Local Trust Committee, 1993) severely underestimate the average production rates (1.3 litres/min (0.29 gal/min)). The numbers can be somewhat misleading. A survey conducted by the North Pender Islands Trustees in 1991 (Henderson, 1998) found that 22% of respondents who relied upon water wells had experienced water supply problems. The prevalence of water supply problems in the questionnaire raises the issue of security of supply, and as with the other water supply systems, points to the need for an emergency response plan to deal with water scarcity issues.

Guidelines have been recommended for drilling and completion of water wells (B.C. Environment, 1993a), but a voluntary system is not necessarily going to be successful in ensuring well-head protection. The voluntary system relates back to the lack of groundwater legislation in the Province of British Columbia. There are no regulations regarding metering or water quality sampling of private wells. The risk of groundwater contamination for individual well users is relatively high. The Ministry of Health controls the siting of septic tanks and fields, but there is no follow-up to ensure proper maintenance or potential for leakage and ultimately, contamination of the water source. There are a number of means of augmenting water supply for individual well users including cisterns, holding ponds, re-use of gray water, use of water saving devices, and small desalination systems. (SOPAC, 1998) (see Section 3.4).

The quality and quantity of groundwater available for consumption by an individual well are functions of the land use on an individual's property and on adjacent properties. It is imperative that individuals be involved in the Community Planning Process, so that they will be aware of land-use changes and the impact these changes may have on their water supply and quality.

Table 8.6a: Water balance for North Pender Island on the 2001 census population of 1,776

Year	Precipitation	Assumed Consumption (gallons)	Assumed Recharge 0.5% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 1.0% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 2.0% (gallons)	Surplus/ Deficit (gallons)
2002	20.1” (511mm)	32,412,000	18,361,350	(14,050,650)	36,722,700	4,310,700	73,445,400	41,033,400
1943	15.7” (400 mm)	32,412,000	13,793,850	(18,618,150)	27,587,700	(4,824,300)	55,175,400	22,763,400
Average	31.6” (802 mm)	32,412,000	28,866,600	(3,545,400)	57,733,200	25,321,200	115,466,400	83,054,400
1996	45.4” (1152 mm)	32,412,000	41,472,900	9,060,900	82,945,800	50,533,800	165,891,600	133,479,600

Table 8.6b: Water balance for North Pender Island assuming full build out population of 4,200

Year	Precipitation	Assumed Consumption (gallons)	Assumed Recharge 0.5% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 1.0% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 2.0% (gallons)	Surplus/ Deficit (gallons)
2002	20.1” (511mm)	76,650,000	18,361,350	(58,288,650)	36,722,700	(39,927,300)	73,445,400	(3,204,600)
1943	15.7” (400 mm)	76,650,000	13,793,850	(62,856,150)	27,587,700	(49,062,300)	55,175,400	(21,474,600)
Average	31.6” (802 mm)	76,650,000	28,866,600	(47,783,400)	57,733,200	(18,916,800)	115,466,400	38,816,400
1996	45.4” (1152 mm)	76,650,000	41,472,900	(35,177,100)	82,945,800	6,295,800	165,891,600	89,241,600

*****assume daily per capita water consumption of 50 gallons

Table 8.7a: Water balance for South Pender Island on the 2001 census population of 159

Year	Precipitation	Assumed Consumption (gallons)	Assumed Recharge 0.5% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 1.0% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 2.0% (gallons)	Surplus/ Deficit (gallons)
2002	20.1” (511mm)	2,901,750	6,192,000	3,290,250	12,384,000	9,482,250	24,768,000	21,866,250
1943	15.7” (400 mm)	2,901,750	4,860,720	1,958,970	9,721,440	6,819,690	19,442,880	16,541,130
Average	31.6” (802 mm)	2,901,750	9,783,360	6,881,610	19,566,720	16,664,970	39,133,440	36,231,690
1996	45.4” (1152 mm)	2,901,750	14,055,840	11,154,090	28,111,680	25,209,930	56,223,360	53,321,610

Table 8.7b: Water balance for South Pender Island assuming full build out population of 990

Year	Precipitation	Assumed Consumption (gallons)	Assumed Recharge 0.5% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 1.0% (gallons)	Surplus/ Deficit (gallons)	Assumed Recharge 2.0% (gallons)	Surplus/ Deficit (gallons)
2002	20.1” (511mm)	18,067,500	6,192,000	(11,875,500)	12,384,000	(5,683,500)	24,768,000	6,700,500
1943	15.7” (400 mm)	18,067,500	4,860,720	(13,206,780)	9,721,440	(8,346,060)	19,442,880	1,375,380
Average	31.6” (802 mm)	18,067,500	9,783,360	(8,284,140)	19,566,720	1,499,220	39,133,440	21,065,940
1996	45.4” (1152 mm)	18,067,500	14,055,840	(4,011,660)	28,111,680	10,044,180	56,223,360	38,155,860

*****assume daily per capita water consumption of 50 gallons

8.3 Discussion

Tables 8.6a, 8.6b, 8.7a, and 8.7b present estimated water balances for North and South Pender Islands. Table 8.6a presents the estimated water balance for North Pender Island using the population from the 2001 census. In a similar fashion to the water balance calculated for the Trincomali Improvement District, estimates have been made for the years 2002, 1943, and 1996 and for a year of average annual precipitation. The estimated deficit/surplus for each year shows a great dependence on the percentage of precipitation that actually recharges the groundwater. For years with precipitation levels similar to or less than 2002, there is at best a small surplus when groundwater recharge is 1% of the annual precipitation. In Table 8.6b, which represents the estimated full build out population for North Pender Island, the calculations suggest that with the exception of the years receiving maximum annual precipitation, deficits will occur or in other words there will be the potential for groundwater mining. The tables are based on the assumption that water consumption on a daily per capita basis is 227 litres (50 gallons). Obviously if water consumption is lower there will be increased supplies or conversely if consumption is higher there will be a greater deficit. The water balance calculations do not include any visitors to the islands thus actual consumption will be greater.

The same relationships hold true for South Pender Island, with the exception being that with the low current population there are no deficits. Once full estimated build out occurs, deficits will occur for most years of lower than average annual precipitation.

There is a concept referred to as the “Water-Budget Myth” that assumes there is a means of calculating a safe yield for an aquifer system (Bredehoeft, 2002). Bredehoeft (2002) has noted that given the climatic variations and changes caused by human activities, water budgets are an oversimplification required to understand groundwater development and management.

Many reports have been prepared discussing water issues in both Canada and British Columbia (Hare, 1984; Crippen Consultants, 1990; Tate, 1991; Dovetail Consulting, 1992; B.C. Environment, 1993a, 1993b, 1993c, 1993d, 1994a, 1994b; B.C. Auditor General, 1999; Mitchell, 1999; Government of Canada, 2003). None of the reports has investigated water issues from a water balance perspective. Many of the reports provide insight into the issues by discussing concepts such as integrated water resource management, groundwater contamination, lack of legislation, well-head protection, and increased demands on limited supplies. The reports appear to be conceptually sound, but unfortunately from a historical perspective, they simply provide rhetoric and very little change to the existing legal and institutional framework. The recommendations of both the Auditor General (B.C. Auditor General, 1999) and B.C. Environment (1993a, 1993b, 1993c, 1993d, 1994a and 1994b) have not yet been addressed. Granted, government moves slowly, but it has been up to 14 years since some of these reports were published. During that time, the populations of the islands has grown substantially as have the population in the surrounding urban centres of Seattle, Vancouver, and Victoria. Increasing demands have been placed on limited groundwater resources.

The existing framework for water resource management is reactive in nature and poorly suited to island environments, which are heavily reliant on groundwater. As Templer (1988) pointed out, water availability is strongly influenced by the institutional framework controlling the allocation of existing supplies. The existing institutional framework for water governance on the Gulf Islands is a complicated interaction between many government agencies, with no one agency able to take control. In view of their lack of understanding of the groundwater resources, it is difficult for this multitude of agencies to devise an overall groundwater management scheme that could be easily utilized in community planning on North and South Pender Islands.

Additionally, because of the wide range of water systems on North and South Pender Islands, there is an added degree of complexity. That complexity combines with three levels of government and many government agencies to create an unwieldy situation. Simplification is required as part of a reasonable approach to groundwater management design.