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RAINWATER AVAILABILITY AND HOUSEHOLD WATER CONSUMPTION FOR MAYNE ISLAND

for:

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1.0 INTRODUCTION

Water supply on the Gulf Islands is an increasingly scarce resource. Accelerating growth and development, depletion of aquifers, and change in precipitation regimes with climate change contribute to an uncertainty in the viability of the Islands' future water supply. The Islands Trust retained Madrone Environmental Services Ltd. (Madrone) to conduct this case study into rainwater availability and patterns of household consumption on Mayne Island. The information from this study will assist in formulating planning policies that to encourage or regulate the adoption of water conservation (demand management), rainwater augmentation, or other water supply measures for different islands and regions.

The purpose of the study is to examine both the potential amount of rainwater available for collection on Mayne Island, and the amounts of water being consumed by typical residential households. More specifically, the objectives are:

- To collect rainfall data for Mayne Island from the past 25 years.
- To determine a monthly rainfall average for the Island.
- To prepare projections about the rainfall potential for Mayne Island for the next 25 years.
- To estimate the amount of water a typical Mayne Island residential household is using now.

- To provide assumptions about how much of total household water consumption is being used for non-potable uses such as gardening water.
- To examine factors that influence water consumption of single family residential households now and in the future, and based on these variables
- provide opinions about how residential household water use may change in the future.

A team consisting of Madrone Environmental Services Ltd. and the Gulf Islands Rainwater Connection Ltd. collaborated to undertake this project. Madrone took overall responsibility for coordinating the work, and prepared the material on rainwater availability. Bob Burgess and Dick Stubbs of the Rainwater Connection undertook the work pertaining to household water demand, and organized the two public meetings.

2.0 RAINWATER AVAILABILITY

2.1 Methodology

Several aspects of precipitation are important in considering the feasibility of using rainwater as a water supply on Mayne Island. They include the average annual amount of precipitation, its distribution throughout the year, and its reliability. As well, spatial variations may be important.

To characterize precipitation we obtained records for all weather stations in the vicinity of Mayne Island. We reviewed the data to determine which stations were most representative of current conditions based on the location of the stations and the period of records. We then analysed the data to determine the mean annual precipitation and mean monthly precipitation. ClimateBC[1] software was used to model regional-scale variations in mean annual precipitation.

[1] ClimateBC v2.03 is software developed by the UBC Department of Forest Science. It provides downscaled spatial interpolation of climatic data from PRISM (Parameter-elevation Regressions on Independent Slopes Model). The PRISM model was developed by Dr. Christopher Daly of Oregon State University. PRISM uses a digital elevation model and a coordinated set of rules, decisions and calculations to interpolate climatic parameters from regional climate station observations to a grid of 2.5 x 2.5 arcmin cells.

Starting from available climate station data, the PRISM system interpolates the value of the climate element in question (like precipitation) to a particular grid cell by calculating linear relationships between the climate element and elevation. Each climate element value at a grid cell is estimated by determining a separate regression function using data from many nearby climate stations. Each station in the multiple regression is weighted based on five factors: Distance, elevation, vertical layer, topographic facet, and coastal proximity. In short, the closer a given station is to a target grid cell in distance and elevation, and the more similar that station is in its climatology to the cell (given by the other three factors), the higher the weight the station will have on the final, predicted value for that cell. PRISM typically is configured to predict values approximately every 4 km horizontally.

We characterized the reliability of precipitation by performing a statistical analysis of 30 years of data using the Environment Canada's Consolidated Frequency Analysis[2] program to fit annual precipitation values to the Generalized Extreme Value distribution. From this, we projected the return period of various levels of drought (years with low annual rainfall).

The analyses described above were performed for climate data from recent years. To estimate the potential future conditions we used a series of modeled scenarios of greenhouse-gas-driven climate change that are incorporated into ClimateBC. The scenarios originate with four different climate models, under three separate projections of emissions. From these we determined the projected change in mean annual precipitation and in dry season precipitation over a range of possible future conditions.

2.2 Recent Climatic Conditions

There are records for seven Environment Canada weather stations near Mayne Island (Table 1). Most of the stations suffer from significant data gaps or from short record duration. Three of the stations are, or were, located on Mayne Island itself. Co-incidentally (or perhaps not), two of those stations had the longest and most complete record sets. The records for one of those two ended over sixty years ago. Consequently, we concluded that the best available representation of Mayne Island conditions would be obtained by using records from only the remaining station, Station 1014931 (Mayne Island). This station is located near the ferry terminal on the southwest corner of the island.

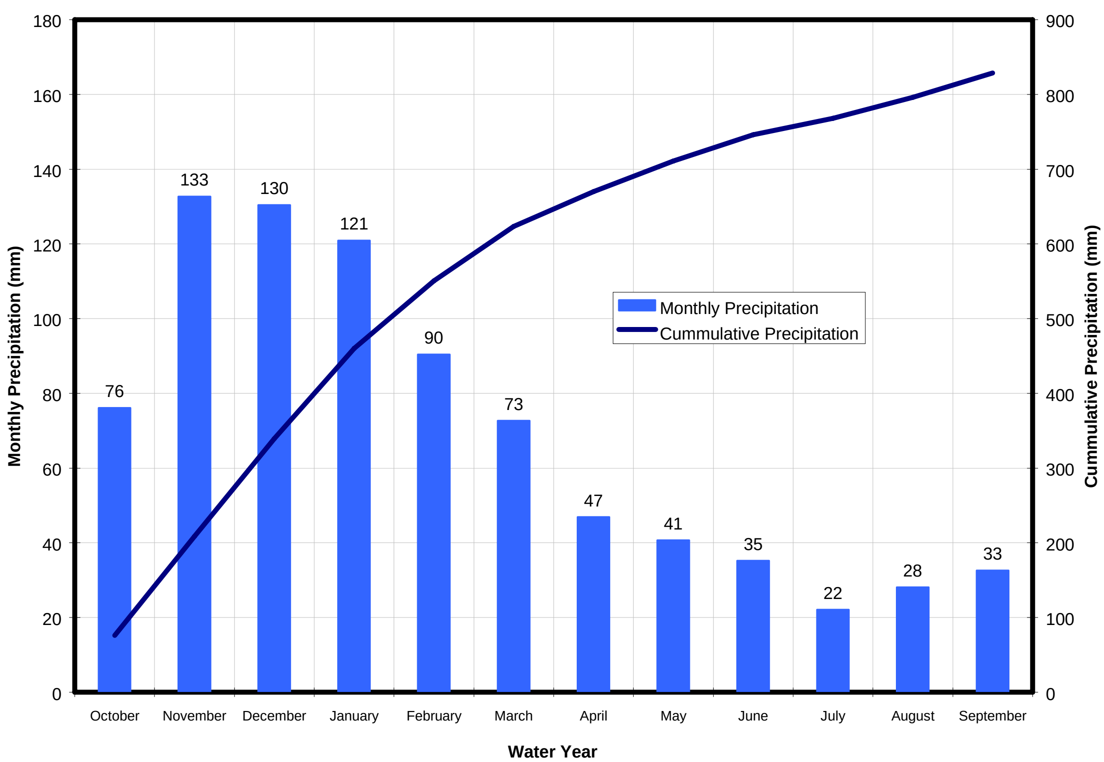
[2] The Consolidated Frequency Analysis(CFA) program is software developed by Developed by the Surveys and Information Systems Branch, Environment Canada. CFA is primarily intended for analyzing hydrometric data, but can be used for the analysis and graphing of any extreme data. The program performs both parametric and non-parametric analysis.

Table 1. Weather stations near Mayne Island

	Records Starting	Records Ending	Total Years	Complete Years	Mean Precipitation for Complete Years (mm)
Mayne Island, Stn. 1014930	1921	1942	22	19	687
Mayne Island, Stn. 1014931	**1970**	**2002**	**33**	**29**	**829**
Active Pass,	1984	1996	13	3	881
Galiano Island GCC	1956	1977	22	14	880
Galiano South 2	1979	1984	6	3	986
North Pender	1972	2004	27	15	809
Saturna Capmon	1989	2004	16	14	819

Records from this station indicate mean annual precipitation during the period 1970 to 2002 was 829 mm. Monthly means show the characteristic pattern for coastal British Columbia, with the bulk of precipitation occurring from October through March, followed by a much drier spring and summer.

Figure 1. Mean Monthly Precipitation - Mayne Island Weather Station



2.2.1 Spatial Trends in Precipitation

While the available data is insufficient to ascertain fine-scale spatial variations in precipitation, regional trends can be discerned. The ClimateBC model indicates that there is a gradient of precipitation increasing from southeast to northwest. The model predicts that the St. John Point at the southeasterly corner of the island receives 800 mm of annual precipitation, while the Helen Point at the west end of the island receives 850 mm (see Figure 1). Overlain on the regional trend, there are almost certain to be finer-scale variations driven by orographic effects on the prevailing southeasterly storm winds. The higher elevations on the south side of the ridge running along the southern coast are likely to receive considerably greater precipitation. A rain-shadow effect may exist on the northern, leeward side of this ridge, and may extend to Miners Bay.

- Regional Distribution of Mean Annual Precipitation -
- Mayne Island, BC -

FIGURE 2

NOTE: This map shows regional trends in mean annual precipitation based on interpolation from weather station data. It does not capture variations due to local topograpghy

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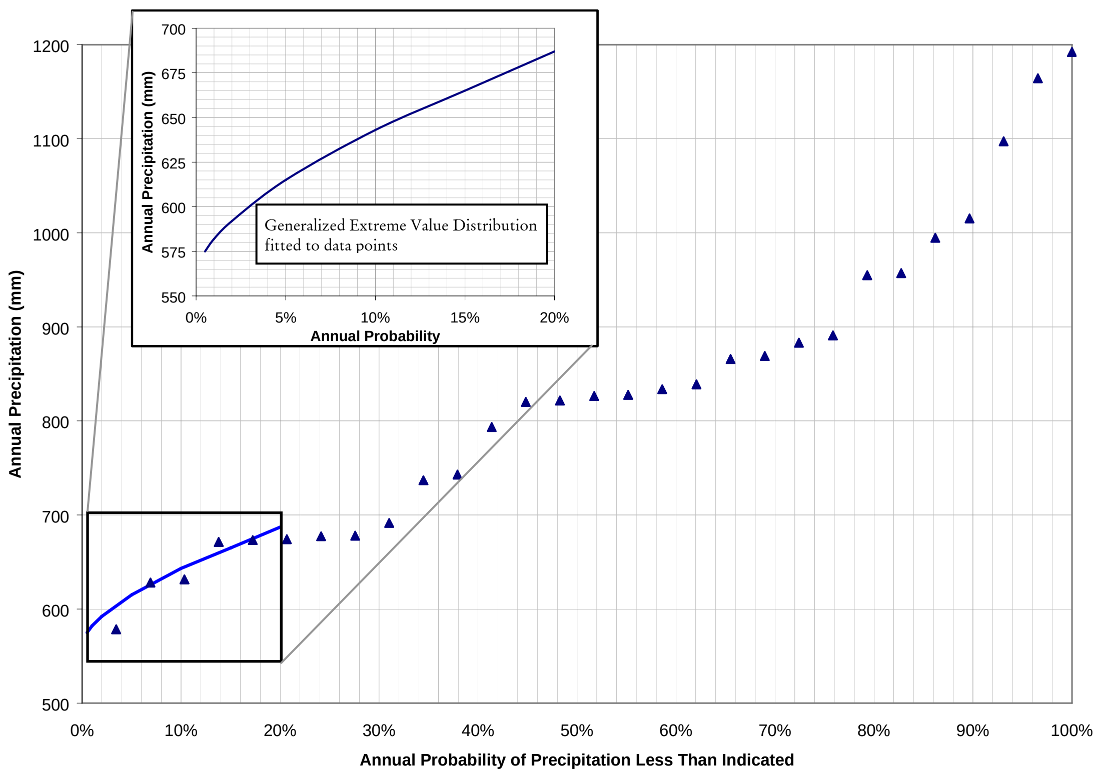
2.2.2 Extreme Dry Conditions

Depending on the purposes for which collected rainwater is used, the reliability of the supply may be a significant consideration and may influence the design of collection and storage systems, or in some case render rainwater use impractical. Annual averages of precipitation tell us little about the year-to-year reliability of the rainwater supply. To characterize reliability of we plotted the annual precipitation against the frequency of occurrence for 29 years of data at the Mayne Island Station (Figure 2), and then fitted the Generalized Extreme Value Distribution to the points.

Figure 3. Annual Precipitation Probabilities – Mayne Island Weather Station



For some types of rainwater harvest systems, the design criteria will be based on ensuring that there is a reasonable probability that the system will perform its intended function every year for its entire design life – even during drought years.

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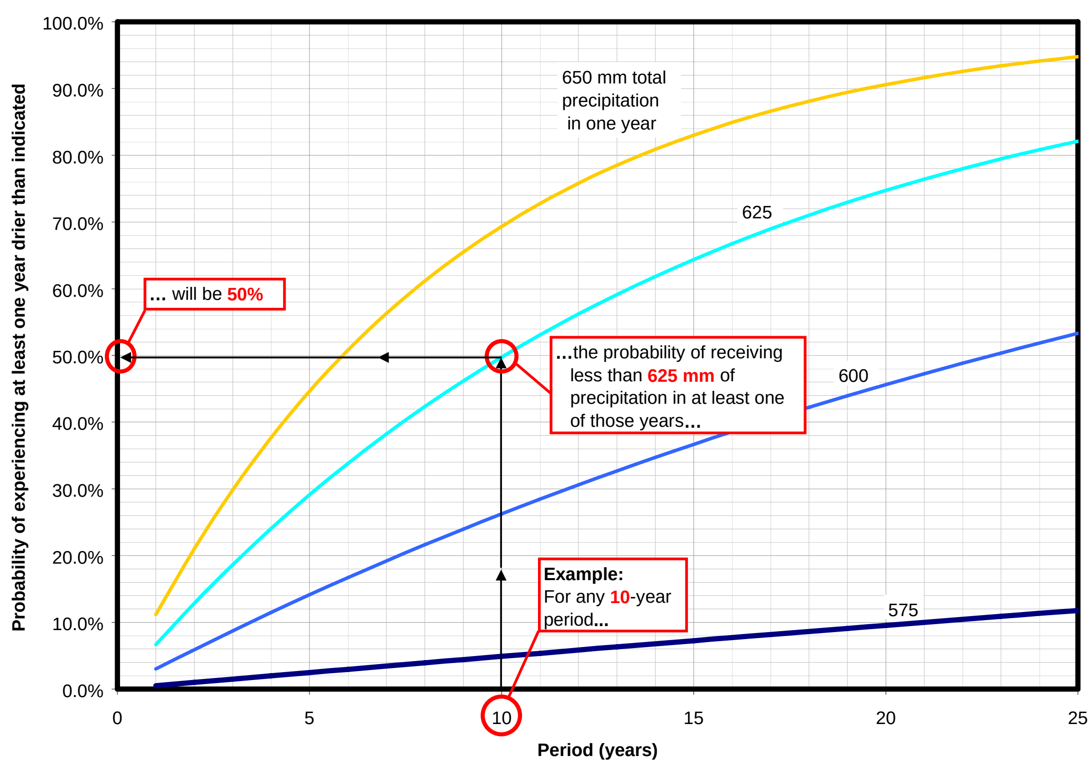
To establish design criteria it is necessary to know the likelihood of various levels of drought during the design life. We calculated the likelihood of four levels of drought (annual precipitation less than 650 mm, 625 mm, 600 mm, and 575 mm) for various design life durations, using the projections shown in Figure 3. The results are shown in Figure 4.

Figure 4. Probability of Drought on Mayne Island



2.3 Future Climatic Conditions

The precipitation statistics described above are based on recent 30 year averages. However, climatic conditions are not static but instead are perpetually changing (for example, the mean annual rainfall recorded on Mayne Island was 687 mm for the period from 1920 to 1942, but was 829 mm for the period from 1970 to 2002 – though part of that difference may be attributed to slightly different locations of the respective weather stations). Climatic changes appear to have been particularly rapid in the past few decades.

Computer models that approximate the complex, interrelated processes in the atmosphere, the oceans, and on land, indicate that the recent changes have been driven, at least partly, by human-influenced emissions of greenhouse gases and other substances. Most models indicated that global climate will continue to change over the next century at historically rapid rates.

The degree of predicted change depends on the model used and the assumptions made about future emissions (which in turn depends on assumptions about economic activity and government intervention to control emissions). To illustrate the potential changes in rainwater availability we have compiled results of climate change predictions for Gulf Islands area from four different models. Two of the models were developed by the Canadian Center for Climatic Modeling; the first generation Coupled Global Climate Model (CGCM1) and the second generation CGCM2. The other two models were developed by the Hadley Center for Climatic Prediction and Research, UK Meteorological Office: the second and third generation Hadley Circulation Model (HADCM2 and HADCM3). Three future emissions scenarios, all generated by the United Nations Intergovernmental Panel on Climate Change (IPCC), were considered (see Table 2 footnotes).

The models indicate that mean temperatures during the period from 2010 to 2039 will rise significantly; by 1 to 2 C. However all but one model predict that total annual precipitation will increase only a modest 3% to 7%, and that summer precipitation will change less than 3% (Table 2). The lone exception is the HADM3 model using the A2x emissions scenario, which predicts an increase of 11% in total annual precipitation, accompanied by an increase of 6% in summer precipitation. Because the models deal with time-averaged parameters, they do not directly predict the probability of extreme conditions.

Because the results indicate increases in both total annual precipitation and in summer precipitation, rainwater harvesting systems that are designed for recent climatic conditions are likely to provide at least as much water supply through the next 25 years. However, the increase in mean temperatures, particularly during the summer months may increase water consumption. An analysis of this effect was beyond the scope of this study.

Table 2. Predicted Precipitation for Mayne Island Means for 2010 to 2039

Emmisions Scenario[3]	Climate Model	Mean Annual Precipitation	Mean Summer Precipitation[4]
—	Observed 1960-1999 mean	829 mm	159 mm
gax	CGCM1	884 mm (+7%)	154 mm (-3%)
	HADCM2	872 mm (+5%)	164 mm (+3%)
A2x	CGCM2	854 mm (+3%)	160 mm (+1%)
	HADCM3	920 mm (+11%)	169 mm (+6%)
B2x	CGCM2	864 mm (+4%)	159 mm (0%)

[3] The three emission scenarios are derived from the IPCC. All are ensemble averages of variations of scenarios within a "family" of scenarios having the same basic assumptions:

gax – this scenario is based the IPCC IS92a scenarios, approved in 1996, which assume no government intervention to control greenhouse gas emissions. Population is projected to rise to 11.3 billion by 2100 and average economic growth is projected at 2.3%.

A2x – this scenario is based on the IPCC "Special Report on Emissions Scenarios" (March 2000) and assumes little government intervention to control greenhouse gases. It assumes significant increases in fossil fuel use and especially nuclear energy. Differences in culture, technology use, and economic growth persist between global regions. Global population increases to 15 billion by 2100 (as opposed to the A1 scenarios, where regional cultures, technology, and economic growth converge, resulting in a decrease in birthrates with increasing affluence, and a global population that peaks at 9 billion in 2050 and declines to 7 billion by 2100).

B2x – this scenario is based on the IPCC "Special Report on Emissions Scenarios" (March 2000) and assumes that addressing economic, social and environmental problems is the baseline of public policies and that policies regarding climate change are similar to today's policies. Nonetheless, fossil fuel use is predicted to increase as is nuclear energy. The global economy is dominated by services and information technologies. Differences in culture, technology use, and economic growth persist between global regions. Global population increases to 11 billion by 2100.

[4] For the five-month period from May through September

3.0 HOUSEHOLD WATER CONSUMPTION

3.1 Methodology

To address the questions of household water use, two household water use questionnaires were developed – one for Water Districts and one for individual householders. The purpose of the questionnaires was to collect both hard data and informed opinions on past and present water use by typical residential households as well as estimates of how water use may change over the next 25 years for both potable and non-potable use.

In early May, the questionnaires were pre-tested with individuals and representatives of Water Districts and then used for interviews with the Capital Regional District Water Services Dept. (CRD); the North Salt Spring Water District (NSSWD), and the Maracaibo Water District on Salt Spring Island.

These results were summarized and presented to a public meeting on Mayne Island May 13, 2006, and meeting participants were asked their opinions on many of the questions. Copies of both questionnaires were handed out at the May 13 meeting and Water District representatives and individuals from private households were asked to respond.

Questionnaires were returned in early June, and the results were summarized and presented to a second public meeting at the Agricultural Hall on Mayne Island on June 24, 2006. Preliminary analysis about the amount of non-potable water use and possible total future household water use were also presented at this meeting. Approximately 12 people attended this meeting – all of whom were members of one of the Water Districts. Some corrections/additions to survey data were suggested, and opinions were expressed about future potable and non potable household water use in households within their Water Districts. Two additional Water Districts expressed an interest in providing water use data.

In total information was collected from 9 Water Districts before the data cut off of June 30, 2006. This is considered too small a sample to provide definitive data on household water use, but it provides a good cross section of household water use and water conservation measures within both large and small Water Districts on several Southern Gulf Islands and the Capital Region District.

No questionnaires were completed by individual householders but a variety of comments were collected at the May 13 and June 24 meetings. To supplement information on non-potable water use a separate key informant telephone survey was conducted in late June and early July. These findings must be considered anecdotal, but the information received provided valuable insights into the amounts of water being used for garden watering in single-family homes.

3.2 Estimated 2005 Residential Household Water Use

Information collected from the Water District survey was combined with the key informant survey to produce a record of reported annual water consumption in 2004 or 2005 for different types of single-family residential households on Mayne Island. The Survey results from the Water Districts are described in Appendix A, and the results of the Key Informant Survey are reported in Appendix B. This information is summarized in Table 3 below.

Table 3. Annual Household Water Consumption (2004-05) For Different Types of Households

Location/Description of Household	Annual HouseHOLD Water Consumption
Average Household in CRD and NSSWD (mostly full-time occupants)	273,000 L (60,000 imp gal)
"Water-Rich" Gulf Island Residential Households i.e. households on healthy wells or piped water (mostly full-time occupants)	180,000 L (40,000 imp gal)
"Water-Poor" Gulf Island Residential Households i.e. households on poor wells and/or rainwater (mostly full-time occupants)	132,000 L (29,000 imp gal)
Rainwater Dependent Full-time Households with water saving fixtures [Indoor Water Use Only]	116,000L (25,500 imp gal)
Average Household (water connection) in "Water Rich" Small Water Districts on SSI and Galiano (mix of full and part-time residents)	149,000 L (32,800 imp gal)
Average Household (water connection) in "Water Poor" Small Conserver-Oriented Water Districts on Mayne Island and Pender Island (mix of full and part-time residents)	71,000 L (15,600 imp gal)

The high variation in the water use figures in Table 3 reflects three major variables affecting water consumption of residential households.

- **Urban vs. rural island locations:** The survey findings indicate a significant difference between more urban areas and more rural island households. Water - rich island households are estimated to use one third less water annually than an average household in the CRD. Most of this difference is attributable to the amount of non-potable water used in the summer months.

- **The amount of water available:** The study results indicate that island based water-rich households with their own water supply used 27% more water than the water-poor households on their own wells or rainwater systems. As well, households in Water Districts where water is relatively abundant with few outdoor watering restrictions use 50% more water than households in the Mayne Island Water Districts with limited water supplies and tight outdoor watering restrictions. Once again, the major difference between higher and lower water consumers is the amount of water used during the summer months.

- **The proportion of full-time vs. part-time residents:** Lower annual household water use in the smaller Water Districts also reflects the fact that many of the homes are not occupied full-time. Based on the estimates of Water District representatives, it is assumed that 1/3 of these Water District households are full-time occupants; 1/3 are weekend/seasonal residents (50%occupancy), and 1/3 are summer season residents (35% occupancy). A simple calculation shows that an "average" household under this definition will occupy the home 61% of the time and it is assumed that it will use 61% of the water used by a full-time household.

It is clear that there is no "typical" Mayne Island household for calculating estimated annual water consumption. It is possible however to identify a number of factors affecting water demand, and to make an estimate of "average" annual household water demand for single family dwellings on Mayne Island based on assumed combinations of these factors.

- **Assumption 1:** As indicated in the survey, 10% of summer use in the water poor Mayne Island Water Districts is presently supplied by non-piped water sources such as rainwater or grey water. It is estimated that this increases the actual average annual household water consumption within these smaller Water Districts to 75,000 litres (16,500 imperial gal) per year.

- **Assumption 2:** The water use figures for the water rich Water Districts reflect actual use for their mix of full and part-time residents i.e. 149,000 litres (32,800 imp gal) per household.

- **Assumption 3:** It is assumed that the "private" households on Mayne Island (those not served by Water Districts) have the same occupancy pattern of full-time to part-time residents as the households in Water Districts. Consequently it is assumed that their annual water use will be 61% of a full-time household which reduces the estimated annual water use for water poor private households to 80,500 litres (17,700 imperial gallons) and to 110,000 litres (24,200 imp gal) for water rich private households.

- **Assumption 4:** It is assumed that Mayne Island households are evenly distributed among the four categories of households described above. This means that:
  - 25 % of total households are located in water poor Water Districts using an average of 75,000 litres per year.
  - 25% are water poor "private" households using 80,500 litres.
  - 25% are located in water rich Water districts and use 149,000 litres.
  - 25% are water rich "private" households using 110,000 litres annually.

Combining these assumptions suggests that the current average annual household water use for a single-family household on Mayne Island is 104,000 litres or 22,900 imperial gallons.

3.3 Seasonal Variations in Residential Water Use

The study findings demonstrate what Gulf Island residents are already experiencing. There isn't a shortage of water in the Gulf Islands, *but* there is a shortage of water in the summer when rain is scarce and demand is at its highest.

As described in Appendix A, summer water use for the 5 months May-Sept is significantly higher in all the reporting Water Districts. Summer use levels range from 145 -215% of the winter monthly averages (Oct-April). Peak summer month use (July and August) in some cases tripled the wintertime average.

The two biggest reported contributors to increased summer demand are an increase in summer residents (higher occupancy rates) and outdoor or non-potable water use.

The increase in summer population is attributed to 5 factors:

- the number of part-time, summertime households
- the fact that some of these summertime households have children, or for other reasons, are larger than an average Island household
- an increased number of visitors to all households during the summer months
- the presence of high use “vacation” rentals” (mentioned by several respondents)
- increased demand from B&B’s and small farms (mentioned by the North Salt Spring Water District)

3.4 Non-potable Water Use

This study concludes that non-potable water use (defined as water used outside the house for gardening, cleaning and filling of hot tubs and pools) is a major contributor to increased summer water demand and accounts for a significant proportion of total annual water consumption.

As summarized in Appendix A, the CRD Water District estimates that 38% of total average summer water use is non-potable use, and they attribute virtually all of that to irrigation water rather than outdoor cleaning and hot tubs, etc.

Estimates developed from the Gulf Islands Water Districts survey information suggested substantially lower proportions of total summer water demand for non-potable water uses. Several representatives believed their watering controls were so effective that no water was used outdoors in their Water Districts while most of the others, despite strongly enforced restrictions on garden watering, agreed that outdoor use could account for 8-25% of total summer use. On the other hand, one Water District on Galiano Island that sets no restrictions on outdoor watering reported data suggesting non-potable water use of 35% of total summer demand – almost as high a proportion as the CRD.

A separate analysis of non-potable water use (see Appendix B) concludes that different types of households on the island will use very different amounts of water for outdoor use. By combining assumptions about each type of household it is possible to estimate the amount of water an "average" Mayne island will consume for non-potable uses. These assumptions are summarized below:

- single detached houses with gardens and abundant water supplies (either wells or unrestricted piped water supplies) will use an average of 10,000 litres (2,200 gal) per month during summer peak times, and many will use double this amount - more than an average household in the CRD. Non-potable water use in peak months will constitute 50%-70% of total summer water use for these households.

- where water supplies are limited either by strong Water District restrictions or low volume private wells, non-potable, peak month, water use of households with gardens will be less than the urban average of CRD households, but is still estimated to average 6,000 litres (1,300 gal) per month during the peak summer months. This figure recognizes that small scale conserver-oriented gardens can require less than 2,000 litres (450 gal) per month, while serious gardeners willing to invest in alternative water supplies will use 10,000 litres (2,200 gal) or more in peak months.

- based on the assumption that one third of the Island's households have no gardens (or gardens that use less than 2,000 litres in a peak month), **it is estimated that non-potable water use for all households on Mayne Island averages 5,000 litres (1,100 imp gal) per month during the peak months of July and August. This represents 25-45% of total household water use for those peak summer months.**

- using the generally accepted standard that peak monthly use is twice that of the other three summer months (May, June and Sept), **it is estimated that total household demand for non-potable water averages 19,000 litres (4,200 imp gal) for the 5 summer months May through September. This represents 20-35% of total summer water consumption and 18% of total estimated annual household water demand.**

3.5 Factors Influencing Future Water Consumption

A major focus of this study has been to identify factors that could increase or decrease household water consumption over the next 25 years. This includes demographic changes that may affect household size or the amount of time a home is occupied. It also includes changes in water conservation attitudes and practices.

3.5.1 Population Growth

The following summary of available population/household growth statistics is included here for general information. An increased number of houses will of course increase the overall demand for water on the Island. Although the focus of this study is to provide estimates of existing and possible future water consumption of individual households, this information could be applied to the study findings to estimate overall Island water demand.

The CRD Regional Planning Services Dept. compiles census data on population and has produced a long-term population growth forecast. Their information shows that the full-time resident population (census data) on Mayne Island increased 20.3% between 1991 and 1996 (from 739 to 889 persons), but that it declined by about 1%, to 880 people, in the 5 years from 1996 to 2001. This growth pattern is more volatile than the growth of the overall Southern Gulf Islands enumeration area which grew at 15.4% from 1991-96, and 3.6% from 1996-2001. The population growth on Mayne Island over the 10 years 1991-2001 was approx. 19.5%, which was very similar to that of the larger Southern Gulf Islands enumeration area which includes most of the southern islands including Salt Spring Island.

The CRD long term forecast for the Southern Gulf Islands is for 43% population growth for the 30 years 1996 to 2026. On an annual basis this is a slightly slower growth rate than experienced on Mayne Island from 1991-2001.

The number of existing lots on Mayne Island is reported to be 1,550, and the Islands Trust estimates that there is potential, under existing plans, for an additional 170. This suggests a total potential for 1,720 homes on the island at sometime in the future. At the present time, it is estimated that there are 1,170 occupied lots on the island. This leaves a growth potential of 550 new homes if every potential lot is built upon.

The demographic data is not sufficiently detailed to develop an accurate forecast of the number of new homes that will be built over the next 30 years, but the following estimate can be extrapolated from existing information.

Assuming that the present population is similar to the census population from 2001, the ratio of homes to census population is 0.75 or 1.33 homes for every person counted in the census. This of course reflects the number of homes that are not occupied full-time, and their occupants are not included in the census.

The CRD 30 year forecasted growth rate of 43% in census population would translate into a total increase of 378 people. If the current house to population ratio is used it suggests that 504 new homes would be built on currently vacant lots over the next 30 years. That would constitute 92% build-out of the currently defined total growth potential for development of new lots.

It should be noted that this estimate of newly developing lots is significantly higher than recent Building Permit figures for the Island that suggest an average of 10 new lots are being built upon each year. Extending this rate of development suggests a total of 300 new homes being built on vacant lots over the next 30 years.

3.5.2 Changes in Household Occupancy (full vs. part-time)

The currently available population and other data does not support a definitive calculation of the proportion of homes occupied full-time as compared to those occupied on a weekend or summer seasonal basis. It was not possible within the study parameters to examine this type of data for other BC or Canadian retirement centers.

The 2001 census data and the estimates of local Island representatives do however indicate that approximately one third of Mayne Island homes are occupied full-time (or at least 10-12 months per year). The general consensus among Mayne Island Water District representatives is that the remaining two thirds of homes are split evenly between regular weekend residents who also spend at least a month during the summer (approx. 50% occupancy), and houses that are occupied almost solely during the summer – but often for 3-4 months (counted as 35% occupancy). When these occupancy rates are combined, they equal an average annual occupancy of 61%.

Two contrasting trends have been reported over the past 5 years as real estate activity has increased. Some of the older residences (often occupied by full-time residents) are being bought and the original house replaced with a retirement home for a new Island resident. Many of the vacant lots are also being developed with future retirement homes. This is resulting in a short-term increase in the proportion of weekend or seasonally occupied homes, but many of the new owners have the intent of retiring full-time to their new homes within the next 3-5 years, and this could increase the proportion of full-time residents in the future. On the other hand, there is also a trend (especially in the higher priced waterfront areas) towards the construction of new seasonal homes for persons who plan to keep both a city and an island recreational home.

Overall, there is a consensus that the proportion of full-time households on Mayne Island will increase, and these will be predominantly 2 person retirement couples. The amount of the increase is unclear, but none of the local sources believed the proportion of full-time households will increase beyond 50%.

The conclusion of this study is that it is unlikely that the proportion of full-time occupants will increase by more than 10-15% over the next 30 years, and the proportion of full-time occupants is unlikely to exceed 45% of total Mayne Island households.

Representatives of the Water Districts expressed the view that an increased proportion of full-time households will create little or no increase in average summer water consumption. Survey respondents suggested that many of the new homes are introducing water conserving fixtures and appliances, which will minimize summer and winter increases in demand. Some respondents even suggested that a two-person full-time household with normal numbers of summer guests might use less water during the summer months than a family or group using a seasonal home – and certainly less than a seasonal home used for vacation rentals. They believe the biggest determinant of future summer demand will be the type of households that will occupy the remaining homes during the summer.

3.5.3 Changes in Household Size and Composition

School District and other local data sources show a steady decline in the number of families with children on the Island, and local opinion is that this decline will continue as house prices increase – especially for the more remote Islands like Mayne Island that have no middle or high schools.

Regional and national demographics suggest that household sizes will decline generally, and there is no reason to believe that this trend won't apply to Mayne Island. It is the conclusion of this study that household size of full-time residents will not be a significant factor affecting the amount of water used in an average Mayne Island single family home.

This study does conclude however, that increased numbers of people in the part-time residences will increase average household water use in the future. This increase will result from an increased number of larger seasonal homes that are used by more people for longer periods of time, as well as an increased number of vacation rental properties. **Overall, it is estimated that annual water consumption of part-time occupied homes will increase by 20%, which will increase average household water use on the Island, by 13%.**

3.5.4 Water Conservation Attitudes and Practices

This study concludes that changes in household attitudes towards water use; development of new technologies, and government and local Water District incentives and regulations have the potential to significantly impact future single family household water consumption on Mayne Island – to both increase and decrease use.

Non-Potable Outdoor Use

There is a general consensus that the most likely source of increased household water use will be water consumed for outdoor non-potable water uses. There are a number of factors that could increase this demand for non-potable water. These include:

- larger new homes with larger gardens.
- increased number of hot tubs, and some swimming pools.
- a growing number of retired residents (even in seasonal homes) with a greater interest in gardening.
- increased use of automatic irrigation systems that are not properly adjusted or monitored.
- a reduction in the number of community based Water Districts with their strong neighbour to neighbour peer pressure to conserve outdoor water use.
- hotter summers – and hotter Septembers.

On the other hand, several factors were identified which could decrease the amount of outdoor water, which is ultimately supplied from the Island,'s ground water supply:

- increased education about water conservation
- increased restrictions on outdoor water use and tighter enforcement by Water Districts (i.e. restrictions on use of piped water)
- increased acceptance and use of drought-tolerant planting
- further acceptance of water saving watering systems such as underground micro irrigation or drip watering
- increased use of on-site water cisterns filled by rooftop rainwater rather than ground water
- improvements in grey water processing technology that makes recycling of bath and washing machine water a more practical alternative for residential households
- further development, and cost reductions, for salt removing technologies for those with salty wells or proximity to the ocean.

The very low summer outdoor water use demand on the piped water in the locally managed water Districts is an indicator of how little outdoor water from ground water sources might be achievable in the longer term if support for water conserving practices increase and alternative water sources such as rooftop rainwater are more commonly used. Overall; however, this study concludes (see Appendix B) that influences increasing outdoor water use will outweigh the factors reducing demand.

It is estimated that average residential household demand of non-potable water will increase (above currently estimated volumes) by 20-25% over the next 30 years. It is the opinion of the authors that strong government regulations and accompanying incentives will be the only factor that will prevent this level of increased outdoor water use.

Indoor Potable Water Use

There is a growing opinion that British Columbians have turned the corner on their recent past patterns of high water use – and residents of the Gulf islands are at the forefront of this change in consciousness. Survey respondents were generally of the opinion that indoor water use will stabilize or decline on Mayne Island as it has already done in other water conscious jurisdictions.

Survey respondents suggested a substantial list of programs and practices that could reduce individual and household water demand in the future. Many of these water conservation measures are already being used by the Water Districts surveyed, although some may not have been in place long enough to show the conclusive results identified by the CRD. (see Appendix A). These actions include the following.

- demand management programs (fixture & appliance rebates, public education and awareness programs, local newsletters)
- free consultations to high water users to identify possible leaks or other cost effective reductions in use
- increased use of low water use fixtures such as toilets, clothes and dish washers
- requirements for each house water connection to be turned off when the house is vacant (leak and fixture failure protection)
- restrictions or prohibitions of outdoor water use of well-fed piped water (only possible in Water Districts that vote to do it)
- greater proportion of clustered or multiple housing
- increased cost of water – especially for high volume users. It should be noted that several Water Districts reported that some high volume users are completely unaffected by price, but that most retired people remain cost conscious.
- increased use of alternative water sources such as rainwater or grey water
- supportive government legislation and financial incentives to water conservation programs or alternative water supply systems.

It is the conclusion of this study that there are more factors influencing reductions in indoor water use than reasons for predicting increased use. Overall, it is estimated that indoor water consumption in residential households on Mayne Island will decline by as much as 20% on a per capita basis in full-time residential households. However, it is likely that the relatively large number of seasonal homes or cabins may be slower to introduce water saving fixtures and practices. **Overall, it is estimated that average annual indoor (potable) water demand for Mayne Island households will decline by 10%.**

3.6 Preliminary Estimates of Future Water Consumption

The Water Districts in the Gulf Islands that responded to the water use survey estimate that per capita and average household water use will stay the same or decline over the next 25 years. Six Districts believe their household use will remain at present levels with a possibility for small decreases. Two Districts forecast declines in average household water use. Individuals contacted as part of this study were uniformly of the opinion that their water use would decrease in the future, but there was no consensus about the amount of the reduction.

Although it is beyond the study terms of reference to estimate future household water consumption, this section provides a preliminary estimate of annual household water use in the year 2030 based on the data and assumptions in the preceding sections of the report.

The following table combines the study findings for each of the elements which were identified as factors that could affect future household water consumption in single family households on Mayne Island. The assumptions used to make each estimate are summarized in the table as a review of the report findings.

The resulting average household water use estimate for the year 2030 must be considered tentative and preliminary at best. Table 4 is presented as one possible framework that may prove useful for making future projections when more population and water use data is available

Table 4. Preliminary Estimate - Average Household Annual Water Use in 2030

Assumptions	Estimated Change	Estimated Annual Household Water Use in 2030
Start from base of 2005 average household water use for single family dwellings on Mayne Island (See Table X-1 in section 4). Assumes an equal mix of four "typical" households including water rich households in water districts and on private wells, and "water poor" households in water Districts and on private wells.	2005 base year	2005 average **104,000 L** **(22,900 imp gal)**
It is assumed that the mix of "typical" water use households will not change significantly as the Island develops.	none	Same average household water use
Household size of full-time occupied households will not change significantly.	none	Same water use

Table 4. Preliminary Estimate - Average Household Annual Water Use in 2030 *(con't)*

Assumptions	Estimated Change	Estimated Annual Household Water Use in 2030
The proportion of full-time occupied households will increase by 12% to 45% of total households. Assuming that the part-time households remain evenly split between weekenders @ 50% occupancy, and summer residents @ 35% occupancy, the average household occupancy rate will increase from 61% in 2005 to 68% in 2030. (see section 7 B)	A 7% increase in occupancy increases average household water consumption by 9%	Add 9,000 L (2,000 imp gal)
Annual water use of part-time occupied homes will increase by 20%. (see section 7 C). This assumes that seasonal homes will be used 20% more often during the winter, and that the number of persons per household during the summer (May-Sept) will increase by 20%.	This will increase average annual household water use by 13%	Add 13,700 L (3,000 gal)
Non-potable water use (mostly for irrigation) will increase by 20%. (see section 7 D). This assumes that a potentially large increase due to larger homes and gardens, older garden-oriented residents, a more urban aesthetic, a decreased number of locally managed water districts, and hotter drier summers will be offset by such factors as increased low water landscaping practices and continued restrictions in Water Districts. The increase is calculated from this study's estimate that an average Mayne Island household is currently using 19,000 L (4,200 imp gal) over the 5 months of summer (May – Sept.) This amounts to 18% of total annual use. (see Section 6).	20% increase in non potable use will increase total annual use by 4%	Add 3,800 L (840 imp gal)
Indoor (potable) year round household water use will decrease by 10% due to low water use fixtures and appliances and an increasing water conservation awareness.	10% decrease in indoor water use will decrease average annual household water use by 8%	Deduct 8,500 L (1,900 imp gal)
Estimated Annual Water Use for Average Mayne Island Household in 2030		**122,000 L (26,800 gal)**

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APPENDIX A

HOUSEHOLD WATER USE SURVEY

SURVEY RESULTS

Number of responses

Data was collected from 9 Water Districts located on southern Vancouver Island and 4 southern gulf islands:

- 1 from the Capital Regional District (CRD)
- 1 from Pender Island (Trincomali)
- 2 from Salt Spring Island (North Salt Spring Water District – NSSWD and Maracaibo))
- 2 from Galiano Island (Spanish Hills and Galiano Estates), and
- 3 from Mayne Island (Bennett Bay, Mount Parke and Laura Point.

Size of Water Districts and Growth

The majority of survey responses were from small to medium sized independent, volunteer managed, Water districts. Two large districts were included – the Capital Regional District (CRD) with over 84,000 connections and the North Salt Spring Water District (NSSWD) with 1,710 connections. Four of the districts were in the mid size range of 70-130 connections (Maracaibo, Mount Park, Trincomali and Bennett Bay), and three were small districts with 16-25 connections (Laura Point, Galiano Estates and Spanish Hills).

Most of the Water Districts surveyed are in established subdivisions and are growing slowly as more of the lots in their areas are developed and connected to their system. Growth in the number of connections over the past 10 years generally has ranged from 5 to 15%.

Most expect generally similar growth rates over the next 25 years as the remainder of the vacant lots in their districts are occupied.

The two exceptions are on Salt Spring Island. Maracaibo is a medium sized district that has grown by over 40% during the last 10 years and anticipates a further 35% growth over the next 25 years as the remainder of their lots are developed. NSSWD has added 212 connections over the past 10 years (an increase of 14%), but anticipate over 800 new connections over the next 25 years – an increase of 48%.

Table A-1. Water Connections

Water Districts Surveyed	Number. of Connections in 2005	New Connections in Past 10 Years	New Connections Anticipated in Next 25 Yrs.	Reasons for Increased Connections
Capital Regional District (CRD)	84,000	6.6%	13-27%	Regional pop growth More retirement households and smaller households.
North Salt Spring Water District	1710	212 (14%)	800 (47%)	Development of vacant lots and new lots being developed.
Maracaibo (Salt Spring Island)	70	20 (40%)	25 (36%)	Expect 100%build-out of vacant lots.
Trincomali (Pender Island)	85	12 (15%)	15 (18%)	100% development of vacant lots.
Galiano Estates	22	1 (5%)	3 or 4 (18%)	100% development of vacant lots.
Spanish Hills (Galiano Isl.)	25	none	none	No vacant lots and won't add more users.
Bennett Bay (Mayne Isl.)	130	5 (4%)	21 (16%)	100% development of vacant lots.
Mount Park (Mayne Isl.)	63	2 (3%)	7 (8%)	100% development of vacant lots.
Laura Point (Mayne Isl.)	16	1 (7%)	1 (6%)	Develop all vacant lots.

Current Household Water Use

Annual household (or system connection) water consumption in the smaller Water Districts varied from 170,000 litres (37,000 imperial gallons) to as low as 58,700 litres (12,900 gal). The three locally managed and conservation-oriented Districts (Trincomali, Mount Parke and Bennett Bay Districts) were in the lower range of 58,700 to 70,000 litres (12,900-15,400 gal), while the other three (Maracaibo, Galiano Estates and Spanish Hills) reported annual household consumption of between 127,000 and 170,000 litres (28,000-37,000 gal).

The two larger Water Districts with mostly full time residential households reported annual household use of about double these figures - 270,000 litres (60,000 gal) per year. Some of the lower usage in the smaller Water Districts can be attributed to a higher proportion of weekend and summer part time residents, but water conservation attitudes and the amount of outdoor water used in the summer are also important contributors. For example, the CRD estimated that their average 2004 winter usage (which they consider to be mostly indoor use) was 16,600 litres (3,600 gal) per month for an average household of 2.2 persons (7,545 litres per capita per month). This rate of use over 12 months would result in average household water use of 200,000 litres (43,800 gal) per year – only slightly higher than water use in Galiano Estates.

Total annual household water use for households on private wells in the gulf islands is difficult to determine because most well-supplied private systems have not installed water meters. Discussion with several individuals indicated that their use is more related to the perceived quantity of water their well produces than anything else. Those with marginally producing wells have become water conservers and report household water use (for full time 2 person use) similar to the higher end figures from the smaller water districts – i.e. in the 130-140,000 litres (29-31,000 gal) per year range. No one we talked to believed they used water at the levels reported for urban areas.

For comparison, several households that are solely dependent on stored rooftop rainwater, and that have installed water conserving fixtures and appliances, reported per capita indoor water use at, or below, 160 litres per capita per day (lpcd) or 35 imp gal per person per day (G/P/D). At this rate of consumption a full time, 2 person household would use less than 10,000 litres (2,200 gal) per month or 118,000 litres (26,000 gallons) per year.

The CRD per capita indoor water use rate (247 litres or 54 gal per day) was about 50% higher than this "typical" rainwater dependent household.

Seasonal Variations in Household Water Use

Summer water use (5 months May-Sept) is significantly higher in all the reporting Water Districts. Summer use levels range from 145 -215% of the winter monthly averages (Oct-April). Peak summer month use (July and August) in some cases tripled the wintertime average.

The two biggest reported contributors to increased summer demand are an increase in summer residents and outdoor water use.

The increase in summer population is attributed to the number of part time summertime households; the fact that some of these part time households have children, and the increased number of visitors during the summer months. The presence of high use "vacation" rentals" was mentioned by several respondents, and increased demand from B&B's and small farms was mentioned by NSSWD.

Outdoor Non-Potable Water Use

The questionnaire responses indicate that outdoor (non-potable) water use is potentially a major contributor to increased summer water demand. The CRD reported that virtually all of the 50-70% increased use in the summer is attributable to irrigation, with only a small proportion used for other outdoor uses like car washing and power washing. They don't believe hobby farm or B&B use is a significant overall contributor. Their figures indicate that about 37% of total summer demand is going to non-potable outdoor use.

The other water districts were less certain about what proportion of their increased summer water use was attributable to irrigation use as compared to added population or more indoor water use per capita among the summer residents. Respondents were asked their opinion on the proportion being used outdoors, and based on this estimate, the proportion of total summer water use for irrigation or other outdoor uses was calculated.

Only one very closely managed Water District (Trincomali) attributed none of their summer increase to irrigation use. They reported that approx. 25% of their residences have set up rainwater cisterns and summer irrigation systems. Despite an actively enforced anti watering campaign, the Bennett Bay Water District estimates that "stealing" the Water District piped water for the garden use could amount to as much as 18% of peak month summer use. Other Districts with less active outdoor watering restrictions estimate that non-potable outdoor water use comprises 25-35% of total summer water use.

A more detailed examination of outdoor water use based on other information collected as part of the study is reported in Appendix B.

Past Changes in Household Water Use

Average annual household water use per Water District connection has been quite stable over the past 10 years with annual increases of less than 1% per year. The Districts with larger declines in use attributed it to a decline in full time family households, and a reduction in system leaks, as well as improved monitoring and education.

The CRD estimate that winter (indoor) per capita demand has decreased by about 0.4% per year due primarily to toilet and washing machine replacement, and an active "Demand Management" program. Bennett Bay attributes a zero growth in total annual water use (despite a 4% increase in connections) to more part time households and their toilet rebate program, as well as a reduction in water system and individual property pipe and fixture leaks. Bennett Bay has reduced leaks on individual properties by requiring members to shut off their water supply at the street service valve when they are away for extended periods.

Table A-2. Water Use and Seasonal Variations

Water Districts Surveyed	Recent Annual Household Water Use	Summer vs. Winter Household. Water Use[1]	Reasons for Seasonal Increase	Estimated Non-Potable Water Use in Summer
Capital Regional District	1995: 250,000 L 2000: 260,000 L 2005: 269,000 L	150 -170 %	Irrigation. Higher increase in dry summers. Bigger increase for detached housing.	Virtually all of summer increase 38% of total summer water use.
North Salt Spring Water District	1995:261,000 L 2000:217,000 L 2005: 277,000 L	140%	Added Occupants Added Irrigation B&B, small farms	Most of summer increase 25% of total summer water use.
Maracaibo (Salt Spring Island)	1995: 193,000 L 2000: 161,000 L 2005: 153.400 L	205%	Pop. Doubles in peak months. Some large Irrigation users.	Possibly ½ of summer increase 25% of total summer water use.
Trincomali (Pender Island)	2005: 70,000 L	145%	Population doubles in summer - some vacation rentals. No outdoor use allowed.	Report that there is NO outdoor use. 25% of homes have rainwater cisterns.
Galiano Estates	2005: 170,500 L	140%	Irrigation Summer residents.	Estimated ½ of summer increase. 15% of total summer water use.
Spanish Hills (Galiano Island)	2005: 127,000 L	215%	Lots of water for gardens Visitors and weekenders.	Estimated 2/3 of summer increase 35% of total summer water use.
Bennett Bay (Mayne Island)	2005: 83,000 L	215% in peak months	Part time owners, guests, and some "illegal". outdoor use	18% of peak summer month water use.
Mount Park (Mayne Island)	1995: 80,000 L 2000: 70,200 L 2005: 58,700 L	147%	Mostly summer and weekend residents and some "illegal" outdoor use.	Perhaps 25% of summer increase 8% of summer water use.
Laura Point (Mayne Island)	No data submitted	Summer increase	6 full time owners, but increased guests in summer.	outdoor use banned June – Oct.

[1] Percentage increase of average summer monthly use (May-Sept) compared to average winter monthly use.

Estimated Changes in Future Household Water Use

The CRD estimates that demand management initiatives will reduce per capita demand by between 12 and 17% over the next 25 years. Their objective is to defer expansion of the water supply reservoirs beyond 2050 by limiting overall growth in water demand to 10% over 25 years – despite population growth estimated at 0.5 and 0.9% per year. Their rebate programs and public education demand management programs have achieved significant reductions over the past ten years. Their surveys show "that public awareness of the need to conserve, and means to conserve water, have substantially increased."

The surveyed Water Districts in the Gulf Islands estimate that per capita and average household water use will stay the same or decline over the next 25 years. Five of the Districts believe their household use will remain at present levels with a possibility for small decreases. Three Districts forecast declines in average household water use. Discussions with the Water District representatives revealed a general consensus that per capita indoor water use was expected to decline. However an increased proportion of full time residents and increases in outdoor use could add to their average annual household use.

Individuals contacted as part of this study were uniformly of the opinion that their water use would decrease in the future, but there was no consensus about the amount of the reduction.

A number of factors that could either increase or decrease household water use were identified by survey respondents and other individuals contacted as part of the study.

Factors That Could Reduce Future Household Water Use:

1. Conservation-oriented administrative practices of Water Districts. Survey respondents suggested a substantial list of actions that could reduce individual and household water demand in the future. Many of these water use reduction measures are already being used by these Water Districts, although some may not have been in place long enough to show the conclusive results identified by the CRD. These included:
   - Demand management programs (fixture & appliance rebates, public education and awareness programs, local newsletters.
   - Metering of all users and regular reading and monitoring of the information.

- Free consultations to high water users to identify possible leaks or other cost effective reductions in use.
- Requirements for each house water connection to be turned off when the house is vacant (leak and fixture failure protection.)
- Restrictions or prohibitions of outdoor water use.
- Local peer pressure to enforce compliance with the community decision.
- Increased cost of water – especially for high volume users Although several Water Districts reported that some high volume users are completely unaffected by price, most retired people remain cost conscious.
- Supportive legislation and government financial incentives to water conservation programs or rainwater harvesting systems.

2. Public education programs to increase conservation practices of households using well water.

3. Increased public acceptance and use of low water use fixtures such as toilets, clothes and dish washers, and drought tolerant landscaping.

4. Financial incentives to private households for water conservation (e.g. the rebate program of the CRD).

5. Increased support for the use of alternative water sources such as rainwater.

6. A greater proportion of clustered or multiple housing where outdoor watering use is reduced.

Factors That Could Increase Future Household Demand:

1. Demise of Small Water Districts
   Volunteer burnout may contribute to more of the local Water Districts deciding to have the CRD manage their water services. Several of the respondents expressed the opinion that the reduction in locally managed systems with their neighbors to neighbors relationships and peer pressure could lead to increased water use.

2. More Full Time Retired Residents
   An increased proportion of full time residents will increase total annual water demand in Water Districts like those surveyed, but it is questionable if they will increase summer demand. Some respondents indicated that they expected that a two person full time household with normal numbers of summer guests might use less water during the summer months than a family or group using a seasonal home. For example, Trincomali District expressed a concern that a possible trend from their existing retired resident base to more seasonal and vacation homes could present an increased challenge to their objective of maintaining current per household use levels.

3. Increased Wealth and/or City Attitudes?
   There is no consensus that the increased number of larger retirement homes being built will correlate to higher per capita and household water use levels associated with urban areas. Many of the longer-term residents representing the local Water Districts have observed that many of the new residents are bringing a strong "green" philosophy with them, and implementing more water conserving measures than existing longer-term residents. Despite the larger homes and larger garden areas, many are using less rather than more water.

4. Increased Outdoor Water Use
   The biggest likely contributor to increased household water use, and increased summer demand, is an increase in the amount of non-potable water used for outdoor use. Respondents to the survey identified larger homes with larger landscaped areas, a more urban aesthetic, more hot tubs, and an increased number of gardening oriented retirement residents as possible contributors to increased use. At the same time they identified increased use of drip irrigation, rainwater cisterns, "zero landscaping" and strongly enforced local restrictions as factors that could offset an increase.

Table A-3. Forecast Changes in Water Use

Water Districts Surveyed	Changes In Household Water Use Past 5-10 years	Reasons for Past Changes in Household Water Use	Estimated Changes in Household Water Use in Next 25 years	Reasons for Estimated Future Changes in Hshld. Water Use
Capital Regional District	Decreased by approx 0.4% per year	Toilet and wash machine replacement. Active "Demand Management Program".	Forecast 12-17% decrease in per capita water use over next 25 years	Fixture and appliance rebates; Demand mgm't programs and summer use restrictions.
North Salt Spring Water District	6% increase over past 10 years	More "city" homes. Higher outdoor use despite restrictions and stepped rates.	About the same	Summer use restrictions and stepped water rates.
Maracaibo (Salt Spring Island)	20% decrease over past 10 years	Improved infrastructure, stepped rates; more organized; improved attitudes.	Continued decrease	Growing conservation ethic; water efficient gardening, rainwater use.
Trincomali (Pender Island)	Slight decrease	Smaller households. Better awareness. Tight restrictions and monitoring.	Slight decrease	Growing awareness; more rainwater use. Metering is crucial.
Galiano Estates	Stable	Stable population, good awareness but no restrictions.	About the same	Continued self imposed conservation practices.
Spanish Hills (Galiano Island)	Stable	Stable population that just don't use too much water. Fixed some system leaks. No restrictions.	About the same	Lots of water, no restrictions, but conservative water users.
Bennett Bay (Mayne Island)	Stable	Toilet replacement. More part time residents; summer use restrictions.	About the same	Fewer full time residents but more connections.
Mount Park (Mayne Island)	36% decrease over past 10 years	More part time residents; infrastructure improvements, newsletter; monitoring use, summer restrictions.	Some decrease	Continued education, monitoring and restrictions on outdoor use.
Laura Point (Mayne Island)	Decreased	Toilet rebate, education, and monitoring.	About the same.	Possibly lower per capita use, but offset by more full time residents.

Table A-4. Water Conservation Practices

Water Districts Surveyed	Current Water Conserving Policies	Public.Acceptance of Water Conservation	Proposed Future Water Conservation Actions
Capital Regional District	Meters; restrictions; fixture & Appliance rebates; education, contact with high users.	Overall acceptance Some resistance to restrictions	More education and incentives; added restrictions, rainwater.
North Salt Spring Water District	Meters, variable water rates, education, letters to high users, some restrictions.	Overall acceptance but some resistance	More restrictions and bylaw enforcement.
Maracaibo (Salt Spring Island)	Meters, variable water rates, education, published list and letters to high users.	Overall acceptance but high users will pay higher price	More education.
Trincomali (Pender Island)	Meters; ban on outdoor use; publish individual useage; education, mandatory curb shut off when away 48 hours.	Good from owners Renters less accepting	Active Board role in education. Stay small and active.
Galiano Estates	No restrictions. Monthly newsletter.	General acceptance if no restrictions	No perceived need to further manage water use.
Spanish Hills (Galiano Island)	Informal policy, meters, variable rates, and suggested curb shut off when away.	General acceptance. No need for restrictions	None planned. Volunteers getting tired. Switch to CRD?
Bennett Bay (Mayne Island)	Meters, household use only, education, peer pressure, toilet rebates, newsletter, letters to high users; shut off when away.	Increasing awareness and acceptance by most	More rebates. Need gov't support. e.g. rebates for rainwater equipment. More volunteers to run the District or switch to CRD?
Mount Park (Mayne Island)	Meters; education; restrictions; posting and letters.	Good	None planned.
Laura Point (Mayne Island)	Shut off when away; Summer outdoor restrictions; education; peer pressure "small system easy to police" and "free" toilets.	Good	More education Promote rainwater use. Discourage lawns.

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APPENDIX B

NON-POTABLE HOUSEHOLD WATER USE

Definition of Non-Potable Water Use

The study Terms of Reference asked for an estimate of the amount of household water that is used for non-potable uses.

For the purposes of this study, a non-potable use has been defined as water used outside the house that would probably not need to be disinfected. The major outdoor, non-potable uses identified are outdoor washing of the house, car, decks and pathways, and irrigation water for the garden. Water to replenish hot tubs and pools might also be included. This definition of non-potable water excludes indoor uses such as toilets or laundry room/shop cleaning sinks. It also excludes outdoor water sources that might be used recreationally for children's play.

Methodology

This study used three data sources to provide information on non-potable water use:

- estimates of the proportion of total water used for non-potable uses in the 9 Water Districts surveyed.
- Telephone interviews with a small sample of private households that have kept records or estimates of their outdoor water use, and
- An analysis of irrigation water demand for different types of gardens based on standard garden watering formulas.

This data was compared, and assumptions made to develop an estimate for current outdoor, non-potable residential household water use. In addition the factors that could affect future non-potable water demand are summarized, and used to develop a forecast for household non-potable water use in the year 2030.

Estimates of Water District Household Outdoor Water Use

The changes in seasonal water use of 9 Water Districts were analyzed to produce an estimate of summer non-potable water use. No estimates of winter non-potable use were done due to lack of data, and because the major non-potable residential water use occurs during the summer months. For example, the Capital Regional District (CRD) water district, which keeps quite accurate records based on meter readings, assumes that all of their average winter monthly demand is for indoor use.

As reported in Appendix A, the CRD estimated that 38% of total summer water use is non-potable use, and they attribute virtually all of that to irrigation water rather than outdoor washing and hot tubs, etc. Estimates developed from the Gulf Islands Water Districts survey information suggested substantially lower proportions of total summer water demand for non-potable water uses. Several representatives believed their watering controls were so effective that no water was used outdoors in their Water Districts while most of the others agreed that outdoor use could account for 8-25% of total summer use. One Water District on Galiano Island that sets no restrictions on outdoor watering reported data suggesting non-potable water use of 35% of total summer demand – almost as high as the CRD, but their monthly total volumes were far less than the CRD. In some cases sufficient data was collected to translate these proportional amounts into volume use per household per month. Examples are listed below:

CRD peak months (July and August)	15,780 lphpm* (3,450 G/H/M**)
CRD summer average (for 6 month irrigation season April-Sept)	10,700 lphpm (2,350 G/H/M)
Spanish Hills peak months	7,000 lphpm (1,540 G/H/M)
Galiano Estates peak months	2,850 lphpm (625 G/H/M)
Bennett bay peak months	2,000 lphpm (440 G/H/M)

*litres/household/month

** imperial gallons/household/month

The Island based Water District household use figures are extremely low compared to the urban levels of the CRD. It must be noted however, that the lowest figures (2-3,000 lphpm) represent the estimated amount of non-potable water used from the piped water supply. Actual outdoor water use on these properties is estimated to be as much as twice this amount because many of these households are using rainwater cisterns or grey water to supplement their outdoor watering requirements.

Representatives of these Water Districts believe that outdoor household (or connection) water useage from their piped water supply would be considerably lower than similar homes on their own wells or on larger scale water systems. Their reasons included the tight watering restrictions enforced with peer pressure, older long-term residents with a low water use mentality, and a high proportion (20-50%) of households already using rainwater cisterns to water the gardens. The other approaches used in this study to estimate outdoor water use (see below) substantiate this belief.

Information from Individual Households

The second source of information was telephone interviews with 6 key informants chosen by convenience; i.e. persons known by the researchers. Although this information is almost anecdotal in nature, the results provide a useful comparison to the other data sources. This information is summarized in Table B-1.

Table B-1. Summary of Private Household Outdoor Water Use Survey

Household	Garden Description	Watering Method	Peak Monthly Water Use	May, June & Sept. Use
Salt Spring Island 1 acre lot Piped water	Moderate size front of house garden and shrub beds. Some native plants.	Hose hand watered and soaker hose.	9,100 L (2,000 gal)	3,650 L (800 gal)
Salt Spring Island 3 acre lot Piped water	Japanese style garden all sides of house plus large vegetable garden with several fruit trees.	Automatic micro irrigation system.	22,700 L (5,000 gal)	4,500 L (1000 gal)
Salt Spring Island 3 acre lot 100% rainwater	Extensive flower and shrub house beds, 1 formal garden with mix of native plants. Vegetable garden.	Automatic micro irrigation system.	10,900 L (2,400 gal)	4,100 L (900 gal)
Thetis Island 1 acre lot Grey water with rainwater backup	Garden beds along 3 sides of house plus 500 sq ft rock garden and 15 pots. High proportion of drought tolerant plants.	Some drip watering and hose hand watering.	7,300 L (1,700 gal)	3,600 L (800 gal)
Pender Island 5 acre lot 100% rainwater	Baskets, pots and native plants.	Watering can by hand.	1,800 L (400 gal)	680 L (150 gal)
Thetis Island 3 acre lot Well with rain barrels	40 deck pots (1 to 15 gallon size).	Automatic micro irrigation system.	900 L (200 gal)	450 L (100 gal)

The results of the key informant survey demonstrate the variety of outdoor water uses depending on the size and type of the garden, the type of watering technique and the water source. The examples selected suggest that those on a secure piped water supply with few watering restrictions use the most water while those with limited supplies used less. Rainwater dependent households that are paying between $1.00 and $2.00 per gallon for their summer storage are using as little as 1,800 L or 400 gallons in the peak summer months. The survey responses also suggest that the watering method affects outdoor water consumption. For example normal hose watering of even a fairly small planted area (example #1) resulted in water use levels similar to the extensive garden in example #3 which used a very sophisticated controlled rate drip watering system on a timer. The high water use in example 2 demonstrates that a large vegetable garden can use twice as much water as the calculated hypothetical amounts in the small garden scenarios described below. Example 2 also demonstrates that an Island single-family house – even with micro irrigation- can use more garden water than an average household in the CRD.

Irrigation Water Demand for "Typical" Gardens

The third approach used in this study to estimate outdoor irrigation water use was to develop a series of scenarios for water use in different types of gardens. A standard industry water application rate of 25 mm (1 inch) of water per week to size fruit and maximize flower blooming during the peak dry summer months was used in the calculations. This results in 100 mm (0.1 m) of water application per month. The shoulder months (May, June and Sept) require one-half of this amount. The monthly volume of water use (in cubic metres) is calculated by multiplying the area of the garden (in square metres) by the monthly water application. The resulting monthly volume is multiplied by 1000 to obtain monthly volume in litres. This volume can be converted to imperial gallons by multiplying by 0.22.

Four scenarios were developed (below), and the water requirements of typical gardens combining these components were calculated (see Table B-2).

Scenario A: 30 glazed deck pots hand or drip watered. Assumes 6.8 litres (1.5 gal) per week	820 L/month (180 gal/month)
Scenario B: Flower planting bed around patio or front entry Assumes 15 lineal metres (~50′) by average 1 metre wide (~3′)= 15 m^2	1,500 L/month (330 gal/month)
Scenario C: Small Vegetable Garden - 4 raised beds Assumes 4 beds each 1 m (~3′) by 2.5 m (~8′)= 10 m^2	1,000 L/month 220 gal/month
Scenario D: Small Orchard - Assumes 4 semi-mature trees spaced 15 feet apart. Watering area 10 m (~33′) x 10 m (~33′) = 100 m^2	10000 L/month (2,200 gal/month)

Table B-2. Monthly Irrigation Water Use for Typical Small Gardens

Scenario	May	June	July	Aug	Sept	TOTAL Summer
Scenarios A + C deck pots & vegetable garden	910 (200)	910 (200)	1,820 (400)	1,820 (400)	910 (200)	6,370 L (1,400 gal)
Scenarios A + B deck pots and flower bed	1,160 (255)	1,160 (255)	2,320 (510)	2,320 (510)	1,160 (255)	8120 (1785)
Scenarios A + B + C deck pots, flower bed and vegetable garden	1,660 (365)	1,660 (365)	3,320 (730)	3,320 (730)	1,660 (365)	11,620 (2,555)
Scenarios A + B + C +D Pots, flower bed, vegetables and orchard	6,660 (1,465)	6,660 (1,465)	13,320 (2,930)	13,320 (2,930)	6,660 (1,465)	46,620 (10,255)
Spanish Hills Gardener using 35% of summer water use for irrigation	4,340 (955)	4,340 (955)	7,000 (1,540)	7,000 (1,540)	4,340 (955)	27,000 (5,950)

Volumes in litres, bracketed volume in imperial gallons

These figures demonstrate that even small gardens can create a significant demand for outdoor water – especially during the peak use summer months. They also identify the impact that vegetable gardens and fruit trees can have in areas where there is no natural ground water to provide moisture. Comparison of the figures in Table B-2 with the other information sources suggests that gardens can be maintained on less water than this “industry standard”. For example the rainwater dependent gardens in Table B-1 are larger in size than these scenarios, but use less water in peak months.

Estimates of Current Non-Potable Household Water Use

The following Table B-3 summarizes the study findings related to residential household non-potable water use.

Table B-3. Summary of Peak Month Non-Potable Water use

Location/Type of Household Water Use	Monthly Household Non-Potable Water Use	Summer Water Use*
Capital Regional District Peak Monthly Use	15,800 L (3,500 gal)	38%
Capital Regional District Average Summer Use	10,700 L (2,350 gal)	35%
Spanish Hills Water District Peak month piped water	7,000 L (1,550 gal)	35%
Galiano Estates Water District Peak month piped water	2,850 L (600 gal)	15%
Bennett Bay Water District Peak month piped water	2,000 L (450 gal)	18%
Individual household on piped water supply Peak month	9,000 – 22,700 L (2-5,000 gal)	50-75%
Individual water poor household (slow or no well) Peak month	1,000 – 10,000 L (200-2,200 gal)	2-50%
Typical Scenarios using peak month "industry standard" water use	1,700 – 11,000 L (400-2,200 gal)	

*as a fraction of total annual household use

The wide range of the water use figures in Table B-3 makes it difficult to determine the outdoor, non-potable water use for a "typical" residential household. It is possible however to identify some of the factors affecting demand, and to make an estimate of "average" household non-potable water use based on assumed combinations of these factors:

- The major demand for non-potable water will be during the mid summer months of July and August. Generally, demand during the other summer months (May, June and September) will be 50% of this amount.

- The type of watering system will affect the amount of water used, but this is a minor factor compared to water availability.

- The availability of a secure, inexpensive supply of water significantly increases demand. It is assumed that single detached houses with gardens and abundant water supplies (either wells or unrestricted piped water supplies) use an average of 10,000 litres (2,200 gal) per month during summer peak times, and many will use double this amount - more than an average household in the CRD. Non-potable water use in peak months will constitute over 50% of total summer water use for these households.

- Where water supplies are limited either by strong Water District restrictions or low volume wells, non-potable, peak month, water use of households with gardens will be less than the urban averages of CRD households, but is still estimated to average 6,000 litres (1,300 gal) per month during the peak summer months. This figure recognizes that small scale conserver-oriented gardens can require less than 2,000 litres (450 gal) per month, while serious gardeners willing to invest in alternative water supplies will use 10,000 litres (2,200 gal) or more in peak months.

- Clearly the size of the garden, the type of plants and the size of higher water demand vegetable gardens and orchards is a major factor in the demand for non-potable water. At the present time it was observed that many households have very limited garden areas which reduce the overall estimated non-potable water use for the Island as a whole. In addition, some of the new larger gardens are using a higher proportion of drought tolerant plants.

- Based on the assumption that one third of the Island's households have no gardens, or gardens that use less than 2,000 litres in a peak month, it is estimated that average non-potable water use for households on Mayne Island is 5,000 litres (1,100 imp gal) per month during the peak months of July and August. This would represent 25-30% of total household water use for those peak summer months.

- If it is further assumed that peak month demand is double that of the other 3 summer months, the average non-potable residential household water use during the 5 summer months (May-Sept.) would be 19,000 litres (4,200 imp gal).

Forecasted Changes in Residential Household, Non-Potable, Water Use

Overall, there is a consensus that outdoor or non-potable water use will increase over the next 25 years because there are more factors likely to increase demand than influences to reduce it.

Survey respondents identified 5 factors that could contribute to increased non-potable water use:

- larger new homes with larger gardens
- increased number of hot tubs, and some swimming pools
- a growing number of retired residents (even in seasonal homes) with a greater interest in gardening
- increased use of automatic irrigation systems that are left unattended
- a reduction in the number of community based, volunteer run, Water Districts with their strong neighbour to neighbour peer pressure to conserve outdoor water use
- hotter summers – and hotter Septembers.

On the other hand several factors were identified which could decrease the amount of outdoor water used by a household which is ultimately supplied from the Island's ground water supply:

- increased education about water conservation
- increased restrictions on outdoor water use and tighter enforcement by Water Districts (i.e. restrictions on use of piped water)
- increased acceptance and use of drought tolerant planting
- further acceptance of water saving watering systems such as underground micro irrigation or drip watering
- increased use of on-site water cisterns filled by rooftop water rather than ground water.

There were a variety of opinions on the likely magnitude of the increased use of ground water for outdoor non-potable purposes, and the examination of precedents from other parts of the world was beyond the scope of this study. The conclusion of this study is that increases of 20 to 40% are possible over the next 10 years, but that the rate of increase will diminish in the longer term as the severity of the ground water problem becomes more apparent.

Overall it is estimated that average residential household use of ground water for outdoor non-potable use will have increased by 20-25% by the year 2030.