An Exploration of Rain Harvesting Systems for the Sunshine Coast

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January 2009

Sunshine Coast
Conservation Association

Cover photo:

Rain harvesting storage tanks, Hornby Island, January 2009. These tanks store 6,000 gallons of rain water harvested from a 1600 square foot roof. The system provides a home with water for all indoor and outdoor non-potable uses year round. Following the snow storms of December 2008 and January 2009, this system was able to harvest approximately 200 gallons of melt water per day. King Anderson photo.

PREFACE

In the experience of the Sunshine Coast Conservation Association over many years, drinking water protection and security issues have produced more demand for leadership and services than any other issue. Consequently, water-related issues have always ranked as the Association's first priority. As readers of the soon-to-be published book *The People's Water: The Fight for the Sunshine Coast's Drinking Watersheds* will appreciate, the involvement of the public in drinking water issues has been consistent, effective and sometimes highly dramatic.

New challenges related to drinking water are now emerging; we are experiencing the effects of global climate change, population growth and rising levels of per-capita use. The implications for public finance and services are not ignorable. Changes are needed and this is always difficult; large numbers of people must be convinced that such is necessary. Our Association seeks to be involved in positive change and so we asked ourselves what sorts of measures could provide positive remedies that communities and their local governments could accept?

Use of traditional rain harvesting technology to provide sources for both potable and non-potable water supply has been experiencing a revival in North America for some time now. In 2007, our Association began to consider the potential of rain harvesting to alleviate peak demand low flow periods in Chapman Creek. We put our intentions to the Sunshine Coast Community Foundation and they generously responded with a grant to enable us to more thoroughly study rain harvesting. This report is the result of our studies under this grant.

Every reasonable effort has been made to ensure the integrity of the report and the accuracy and completeness of the information contained herein. Please note that all volume is given in litres or cubic metres (1000 L) unless it was originally described in gallons. The approximate metric equivalent is then given in brackets. Gallons are presumed to be Imperial units which are 20% larger than US gallons. 4.54 L = 1 Imperial gallon

We hope the Sunshine Coast public and their elected decision makers will consider the potential of rain harvesting technologies to produce a positive new direction for water conservation. Enjoy!

Daniel Bouman
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EXECUTIVE SUMMARY

The Sunshine Coast's water supply infrastructure is now showing signs of distress; our water treatment plant is operating at full capacity year round and water use conflicts are emerging during the low-flow times of the year. As well, our population is growing and this also strongly suggests that new water sources are required.

While our local situation has some unique aspects, the basic problems of rising use and numbers of users are common almost everywhere in British Columbia. This has prompted the Province to develop a water master plan which will make an increasing number of water conservation measures mandatory for municipalities and regional districts within the next four years. Clearly, new water conservation initiatives are warranted now for the Sunshine Coast Regional District.

Rain harvesting systems are a traditional approach to dealing with water scarcity and are widely used across the southwestern American states and also right here in coastal British Columbia; on the Gulf Islands for example. The idea is fairly simple; rainwater from a roof is directed into a storage tank (or cistern) and is then available for a variety of uses. Our abundant annual rainfall virtually guarantees that these systems will function well if properly designed, built and maintained.

Compared to the cost of developing infrastructure for a new water source area, rain harvesting is remarkably cost effective. For example, a rain harvesting system involving a gravity fed 9.1 m3 (2000 gal.) storage tank and a small pump to deliver water for irrigation could cost as little as $2,500 installed. If 6,000 of these systems were established in single family dwellings in rural areas, the total dispersed storage would be 54,500 m3 (12 million gal.) at a cost to the home owners of ~$15 million. This volume of water is the equivalent of a 12 day supply of water for all the Chapman/Gray system users. Also note that this water would be available during the lowest flow time of the year which also coincides with the peak demand time for irrigation purposes.

There are a number of incentives that could provide motivation for development of rain harvesting systems. Given the benefit to the regional system, a subsidy or a tax incentive may be appropriate. Regional government could also provide technical support in the form of generic plans and home owner consultation. It will be important to continue with water conservation education. Negative incentives are also an option. Studies show that major changes in water use policy are more likely to be successful if they are preceded by effective ongoing public education and consultation.

AN EXPLORATION OF RAIN HARVESTING SYSTEMS FOR THE SUNSHINE COAST

PURPOSE OF THE STUDY

The purpose of this paper is to develop our understanding of rain harvesting systems and their potential and practicality to conserve water and to alleviate demand on public water distribution systems of the Sunshine Coast Regional District. In addition, this paper will review which rain harvesting products and services are currently available. A cost/benefit analysis of a variety of rain harvesting systems and sizes will determine whether or not water conservation gains from the use of these systems is potentially sufficient to justify a public subsidy of materials or installation costs. This discussion paper describes the potential of rainwater harvesting systems applied particularly to single family homes in the rural areas currently serviced by the Sunshine Coast Regional District.

WHY DO WE NEED MORE WATER?

There is no doubt that our quickly growing population (2002-2006 saw an 8.4% population increase) is placing a great demand on our current public water sources, treatment and distribution systems. However, the hot temperatures during the July 1 long weekend in 2008 created a situation of unprecedented water usage far exceeding what the population increase could account for.[1] Without any additional population growth the increasing per capita water consumption will demand that the Regional District develop new sources of domestic water supply and increase the infrastructures for treatment and distribution sooner rather than later. The effects of climate change also need to be considered. Preliminary studies based on the Roberts Creek hydrograph data from 1959-2004 predict that in the future there will be lower stream flows during the summer and that they may extend further into the fall.[2] The proximity of Roberts Creek to Chapman Creek suggests that this kind of scenario will exacerbate the water situation with a potential decrease in stream recharge occurring just as seasonal human demand increases.

The majority of the SCRD's water consumers are already facing a seasonal water issue on Chapman Creek. Not as well publicized but of ongoing concern are the minimum water flows required to sustain a rearing salmonid population in the lower reaches of the creek. Chapman Creek had in the past one of the largest populations of salmon on the Sunshine

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[1]Over 27 million litres per day was the single highest day. "Hot Weather A Risk for Water System", *The Local*, Thursday, July 10, 2008. Linda White France, p. 2.

[2] Paul Whitfield (Meteorological Service of Canada), presentation at the Sunshine Coast Water Summit, March 23, 2006.

Coast. Not only did it provide habitat for rearing juvenile salmon year round through to the smolt stage but also hosted spawning habitat for Steelhead, Chum, Coho and Pink salmon, and Cutthroat trout. A water licence that allows the SCRD to withdraw more water than appears at times to be available and a dramatically increasing water demand has caused the total Chapman Creek flow below the intake pipe to drop on occasions in recent years to 0.125 m3/s during late summer – the equivalent of one garbage can of water being emptied per second.[3] Aside from greatly reducing available habitat, the lack of water creates stress on the over-summering fry and makes it impossible for the Pink Salmon returning in late August, for example, to enter the Creek to spawn. A low flow agreement that provides certainty for the survival of a certain population size will have to be reached almost immediately. It seems likely that this will reduce the amount of water that can be withdrawn during the already occurring low flow conditions.

Within the provincial context, the SCRD may in fact find it difficult in the near future, even without a low flow agreement, to withdraw the maximum allowable water permitted under its licence. The Honourable Minister of the Environment, Barry Penner, released the province's new water policy: Living Water Smart: British Columbia's Water Plan on June 03, 2008. This plan recognizes that our water use must not only be more efficient but that the management of it must be watershed based. The provincial government's position "…will require all users to cut back their water use in times of drought or where stream health is threatened."[4]

THE CASE FOR RAIN WATER HARVESTING

To develop a new source, whether surface or ground, and to expand the infrastructure will be costly to the local taxpayer. As an example, to construct a reservoir that would hold enough water for 20 hours of consumption for the relatively small population of the Town of Gibsons is estimated to cost $1.3 million. It has been estimated that storage for one week's worth would cost $30 million to construct.[5]

Currently 80% of provincial funding to local governments is for water-related infrastructure.[6] If the SCRD were to move forward to develop a new source, it is now the provincial government's position that conditions to receiving infrastructure funding include showing adaptation to climate change and reduction of the impact on the environment. In addition, it is the provincial vision that 50% of new municipal water

[3].McBain, G., Fisheries & Oceans Community Advisor, pers. comm., 28.09.2008

[4]Available on line at www.livingwatersmart.ca, page 47.

[5] Sunshine Coast Citizens Concerned with Responsible Development on line at www.scccrd.ca; confirmed with Town of Gibsons staff, October 28, 2008

[6] www.livingwatersmart.ca, page 63.

needs will be acquired through conservation by the year 2020[7]. Not only will this help to reduce the impact on watersheds, for example, but it will reduce costs for municipal (and provincial) governments as it is cheaper, per unit of water, for the water purveyor to acquire additional water by conservation than it is to develop new water sources.[8]

Prior to the release of the province's plan, rainwater harvesting may have been viewed as a method of collecting water that allowed a few dedicated do-it-yourself homeowners to live in very dry areas not serviced by municipal water and areas where the ground water was of questionable quality. The most immediate examples of such homeowners are residents on some of the Gulf Islands. With the introduction of the province's vision that communities are going to become more water efficient and practice water conservation, promotion of rain water harvesting suddenly has become a very valuable tool for municipal governments. The greatest asset is that the water is free. It is of good quality (naturally soft and relatively clean) and located close to the consumer. Large scale participation in rain water harvesting has the potential to delay the construction and renovation of traditional water infrastructure. Harvesting rainwater will meet the definition of conservation, reduce impacts on the environment, and demonstrate local adaptation to climate change; sustainability strategies that municipalities must adopt especially when seeking future provincial funding.

WATER CONSUMPTION

The per capita daily water consumption, for users of the Chapman Creek water system, based on a three year average, is 593 litres.[9] This number includes all domestic, institutional, commercial and industrial users. It is considered a valid description as there is a relatively high proportion of residential connections within the system. The consumption is high when compared to other Canadian cities (Moose Jaw 389.66, Toronto 511, and Victoria 449) and high compared to the B.C. average of 490 L.[10]. In addition, there are seasonal variations. A three year average during the winter months (January and February) shows a per capita daily consumption of 475 litres whereas the three year average for the two summer months of July and August shows the per capita consumption escalating to 909 litres per day. Even with the removal of water use for outdoor purposes our water consumption is unacceptably high against world standards. Europeans, for example, use 150 L and in the UK 160 L.[11]

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[7] Ibid. page 75.

[8] Confirmed by D. Whyte, Sustainability Manager, SCRD, pers. comm., 2008-10-22.

[9] 2005-2007. Brooks, B., Environmental Technician, SCRD, 2008-10-21.

[10] www.livingwatersmart.ca, page 77.

[11] P. Dixon & G. Robe, *Recycling Water: A Conservation Strategy for the 21st Century, 2003*, A Water Advisory Committee Report prepared for the Capital Regional District, p. 12.

Figures released by the American Waterworks Association Research Foundation state that inside an average house, toilets account for the largest percentage of water use per capita per day at 26%. Clothes washers account for the second largest amount at 21%. Closer to the Sunshine Coast, The Rainwater Connection Ltd., suggests that as much as 40% of water consumption is used in flushing toilets, and that bathing (showers and baths) accounts for 32.5 % of the daily use. Laundry consumes 17.5% and cooking/dishwashing accounts for the balance at 10%[12]. Conventional toilets require 20 L per flush. Provincial changes to the Building Code that came into effect September 05, 2008 require a maximum of 6 L per flush in all new construction and renovations; this makes it probable that water consumption for the flushing of toilets could soon be significantly reduced. British Columbia's Water Plan suggests that by incorporating low flush toilets and other water efficient fixtures, such as low flow showerheads in the bathroom, a household could save as much as 2,000 L per week.

The largest single human use of Chapman Creek water appears to be during the summer months when 43% of the water used is diverted for outdoor use (lawns and gardens). Depending on the size of the hose, one hour of sprinkling can use 1,300 L of water. This is particularly significant when one considers that the recharge of Chapman Creek via precipitation is at its lowest during this part of the year.

CLIMATE

The most reliable climate data for the Sunshine Coast is obtained from the Gower Pt. station which is located at 34m elevation. The yearly average (1971- 2000) rainfall is 1323.5 mm and the precipitation average which includes snow water equivalent is slightly higher at 1369.1 mm.[13] The climate for this area up to 650m (which also hosts the largest amount of the Chapman Creek water users) is described as having warm, dry summers, cool winters with relatively small snowfalls. The long growing seasons show minor water deficits in the summers with the lowest precipitation in July and August, and the highest precipitation in November and December. Although the water intake on Chapman Creek is located at 175m the median elevation of the watershed is 920 m. At this elevation, precipitation is estimated to be 3,000 mm with 75% of it falling between the months of October to March. June, July and August have the least precipitation. In the winter, there is 200-400 cm of snow which contributes to the water level in Chapman

[12]Available on line at www.rainwaterconnection.com/rainwater_harvesting/how_much.htm accessed 2008-11-23.

[13]This station is identified as Gibsons Gower Point. Environment Canada, Climate Normals & Averages available at www.climate.weatheroffice.ec.gc.ca/climate_normals

Creek during the spring snowmelt period.[14] It is interesting to note that although June is one of the months with lowest precipitation, it is also a month that shows the highest water flows in the creek. The lowest flows are recorded in July, August and September.

Local government web sites also provide climate data, with the SCRD breaking it down to regional areas. Available are maximum 15 minute rainfall amounts, maximum one day precipitation amounts and also annual total rainfall and precipitation. Maximum one day rainfall amounts vary from 63 mm (Areas A, B, D) to 268 mm (Area F). Total annual precipitation amounts vary from 1,100 mm (Areas A, B, D) to 3, 300 mm (Area F). The annual total precipitation for Area E (Gower Pt. location) is recorded as 1,500 mm, this can be expected as the Gower Pt. location is close to sea level and more precipitation falls with increases in elevation. Sechelt records a somewhat lower amount at 1,200 mm and Gibsons is higher at 1,500 mm.

FUNCTIONS AND COMPONENTS OF RAIN WATER HARVESTING SYSTEMS

For a household, the collection and storage of rainwater can serve three broad functions and for the purpose of this paper are thought of as three systems. The home owner may wish to adopt any or all of the three depending not only on purpose but expense. The first system is for outdoor use, primarily irrigation of lawns and gardens, but it can also be used for water features, the washing of vehicles, pressure washing and fire suppression. This system utilizes non-potable rainwater and the least components. The second system also uses non-potable rainwater but inside the household for non-potable uses such as laundry and toilets. The building must be fitted with identified plumbing dedicated for non-potable water supply. The third system requires treatment of the rainwater to disinfect; usually filtration and ultraviolet radiation, for indoor potable water uses. A backflow prevention assembly is also required if the household is hooked up to municipal water. All three systems are useful for emergency preparedness.

The basic components of rainwater harvesting are relatively simple: a collection surface (i.e. the roof), a storage tank, a network of pipes to collect and distribute and, if required, treatment of the rainwater. The collection surface is the roof catchment area of either the house or other outbuilding. Most roofing materials are considered acceptable for non-potable systems excepting cedar and those using moss inhibitors (zinc and lead) on the roof. Asphalt is acceptable but difficult to keep clean. The smoothest and most inert roof surfaces are best for potable systems. These include metal, terracotta, slate tile and concrete, coated with nontoxic paint as needed.

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[14] Triton Environmental Consultants Ltd. July, 2006. *Chapman Creek Watershed Drinking Water Source Assessment Final Report*. http://www.scrd.ca/files/File/Water/Pages from Chapman-Creek-Final-Report-1-26.pdf , pages 11-13. Much of the information was obtained from Chapman, A. R. and D.E. Reksten, 1991. *Chapman Creek Hydrology Data Summary and Analysis.* Ministry of Environment, Water Management Division. Victoria, B.C. Accessed 2008-11-28.

Once the homeowner has calculated the size of the collection surface, its efficiency, the local precipitation and how much collected rainwater is needed, the most size-efficient storage tank can be determined. For a container garden, a small plastic rain barrel (~180 L) or two may be sufficient. For larger amounts and differing uses, depending on site conditions, and whether the tank is installed as the house is being built or afterwards, other options are: cast in place concrete tanks for new construction, pre-cast concrete, polyethylene, fibreglass and site-assembled polypropylene lined galvanized steel tanks.

Once the rainwater lands on the roof, it flows into gutters, downspouts and collection pipes to the storage tank. For the simplest outdoor irrigation system, pipes, or even the downspouts feed the water, preferably by gravity to a storage tank. On sites where gravity or other considerations, such as aesthetics, do not allow for this positioning of the storage tank a pump tank also known as a surge tank will be required. This small tank is paired with a pump that then moves the water "up" to the storage tank. This tank must be sized properly by determining how much water must be pumped per hour during a storm event. Also to be considered is the change in elevation and distance the rainwater is to be pumped. Fortunately, these pumps are readily available and similar to those used for well water. PVC pipes are also used for distributing the rainwater from the storage tank for larger applications both indoors and out.

For simple distribution from a rain barrel a garden hose may be all that is required. The most efficient method provides for drip irrigation to plants located down slope from the tank. An overflow connection allows extra water from the tank to drain into the existing perimeter drain. If the landscaping is not suited to gravity feed a submersible pump similar to those used for water features or well water can be installed. The system can be run manually with a fitted tap or an outdoor light timer could be installed and the irrigation automatically set.

For the larger indoor systems a pressure tank is usually required for the distribution system. For non-potable indoor use, as previously mentioned, pipes must be specially marked and dedicated for distribution; the standard in Canada is SCA B128. In addition, where a rainwater supply is connected to a distribution system that also has a municipal water connection, a backflow prevention assembly is required.

The largest difference between the non-potable and potable system is the requirement to treat the water. Even for the simple irrigation system, water should be conditioned, that is screened to remove the organic matter, such as leaves, needles, berries and pollens which land on the roof and are flushed into the collection pipes. This can be done with a variety of gutter guards, debris screens and pipe cleanouts. Asphalt roofs in close proximity to trees may have to be physically swept each season to remove any caught organic matter. For potable systems it is also recommended that a fine sediment trap be installed prior to the water entering storage to reduce the cleaning required of the storage tank. Potable systems usually incorporate a first flush flow diverter. The purpose of this device is to remove most of the dissolved contaminants (e.g. air borne pollution and animal droppings) from entering the water supply; in most cases it removes the first 0.5mm of rainfall (50L from 100m2 roof area). Once the potable water is distributed from the storage tank it is treated with filters and ultra-violet light to further remove any contaminants and destroy possible pathogens. Additional treatments such as reverse osmosis, biofiltration, and chlorination are also available.

Once installed and functioning, the three rainwater harvesting systems do require ongoing maintenance, with the potable system necessitating the most rigorous inspections.

HOW MUCH RAINWATER CAN BE COLLECTED AND IS WANTED

To determine how much rainwater a household has to collect, and therefore what it would cost to implement and maintain such a system, at least four criteria must be considered:

1. the amount of water to be used for a specific function over a given time period,
2. the size of the collection surface,
3. its efficiency, and
4. the average precipitation and patterns of precipitation over the same time period.

Consideration must also be given as to how dependent the consumer is on this collected water.

The collection surface is approximately the roof catchment area of either the house or outbuilding and is measured as the horizontal plane under the roof including the overhang. One mm of rain on one square metre of roof has the potential to collect one L of water (one inch of rain falling on one square foot has the potential to collect 0.52 Imperial gallons of water). Efficiency of the collection surface takes into account evaporation, the nature of the roofing material and the ability of pipes to collect water during storm events. Efficiencies are higher during cooler temperatures and periods of longer, more frequent rainfall events. Smooth collection surfaces such as steel are more efficient that asphalt or tile. Although not technically part of the collection roof, efficient gutters draining the surface are sized to prevent overflow and loss of rainwater during storm events. Potable systems need also to take into account the first flush diversion. Collection systems vary between 75-90% efficiency.

Choosing the most simple system, let us consider a household that has installed a system to water the outdoor garden during the summer months from June through September. Although accounting for a third of the year, normal precipitation at Gower Point for the months of June through September total 221.3 mm, substantially less than a third of the yearly total of 1369.1 mm.

There are different methods for calculating how much water needs to be stored. The Gower Point scenario is based on monthly water requirements. For example, the distance measured out on the ground, below the roof equals 200 square metres (2,153 square feet). This multiplied by the lowest monthly rainfall of 46.4 mm will capture (200*46.4) 9,280 litres of rainwater in July. Assuming that the capture rate is 85% efficient, (9,280*85%) 7,888 L of rainwater can be harvested. The tank does not necessarily need to be this large as water would also be constantly drawn from the tank to irrigate and rain events would also wet the gardens. The homeowner would compare the harvested rainwater to how many plants need to be watered and how often. For example, The Rainwater Connection Ltd. suggests that a 1 m shrub utilizes 32 L/ week; an 18" pot 8 L/week and 40 deck pots on drip irrigation utilize 227 L/ week. If drip irrigation, or soaker hoses were used, and xeriscaping practiced, including allowing the lawn to go dormant, it is easy to see how extensively the captured rainwater could be used.

For the second system which supplies nonpotable water indoors, potentially less rainwater needs to be harvested for toilets and laundry than for the outdoor system in spite of the fact that the use could be for year round. For homes built or renovated before September 2008, the usage is thought to be consistent throughout the year ranging from 47- 57% of total indoor use. A conventional toilet requires 20 L per flush and a conventional washing machine up to 193 L per load. With a population of 2.3 people per house and a daily per capita consumption rate of 475 L (winter rate which presumably excludes summer outdoor water use) there is a possibility of saving 513.4 L of municipal water per day (2.3 *475L*47%) per household if the household were to use harvested rainwater for these functions. Historical precipitation patterns indicate that there is significant rainfall usually at least every 10 days. A storage tank that would hold ten days worth of required nonpotable water should be at least 5.1 cubic metres in size (513.4*10/1000). With the installation of the now mandatory 6L or lower per flush toilets and the availability high efficiency washing machines, which utilize only 90 L per load, the rainwater storage required, and therefore tank size, for the household could be substantially reduced.

The third rainwater system involves the balance of indoor water consumption which is considered potable. This system usually combines with the non-potable indoor use and may or may not include outdoor usage. Here the annual water consumption per household must be calculated. The yearly precipitation patterns are particularly important in determining how much must be stored to meet needs year round. Although water may be conditioned (removal of foreign matter) for non-potable systems, it is not only conditioned but also disinfected for any potable uses. To aid with disinfection, the first 0.5 mm of rainfall landing on the collection surface is diverted. This diversion will affect the efficiency of the collection surface at different times of the year. Local methods in Greater Victoria and the Gulf Islands calculate requirements versus supply based on monthly amounts.

Using the average year round figure of 593 L per person per day, an average household of 2.3 people would require a total of 480 cubic meters (593*352*2.3). With the exclusion of outdoor water use, the average household would require 385 cubic meters per year. Within the Sunshine Coast Regional District, Area F has the highest annual precipitation at 3,300 mm; if all this were collected on a 200 square metre roof with an average 75% efficiency a possible 495 cubic metres of water could be harvested (200*3,300*75%). Given the historical precipitation patterns over the year, this would be ample water for all indoor usage and about equal to total usage. For the driest locations, Areas B and D the total annual precipitation is 1,100 mm. With the same collection system the largest amount captured would be 165 cubic metres (200*1,100*75%). Here there is a shortfall for both indoor and total usage if the homeowner were to rely completely on the harvested rainwater.

It is interesting to note that consumers who are involved in rainwater harvesting often become very conscientious of their water consumption and reduce their requirements accordingly. It is not inconceivable that the SCRD's daily indoor per capita consumption rate of 475 L could be lowered to at least the Canadian (annual) average of 350 L, if not lower. Rainwater harvesting systems have been established in the Strait of Georgia where daily consumption is between 227-273 L.[15] If a UK consumption rate of 160 L were used (160*2.3*352) the annual indoor requirement (130 m3) could readily be met by harvested rainwater.

COSTS OF MAJOR COMPONENTS

Tanks

For most systems the most expensive component (after the roof) is the tank. Considerations should therefore be given as to the optimal size based on monthly collection and utilization. For simple outdoor irrigation systems plastic 200 L (45 gal.) rain barrels are about $100 and are available locally at least at one garden nursery and at a couple of hardware stores.[16] Although there is a slight variation in size, colour and shape they all come with screens and spigots. There are provisions for overflow and connections to additional barrels. If other plastic barrels are sourced, there are good references on the internet on how to install openings and spigots.

Phone calls to several local suppliers indicate that, if components for larger rainwater harvesting system aren't available on the coast, the parts can be readily ordered. For tanks larger than rain barrels, the price goes down dramatically. The most common ones are made of polyethylene; there are at least two manufacturers on the Lower Mainland that

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[15]. www.rainwaterconnection.com/rainwater_harvesting/how_much.htm

[16] Sunshine Coast Nursery, Home Hardware, Canadian Tire, 2008-09-26

produce a variety of sizes and shapes which meet Canadian Drinking Water Standards. At 9m3 (approximately 2,000 gal.) the tank can be configured so that the homeowner still has the ability to move the tank on the back of a pickup truck. A few inquiries to the manufactures and to retailers on the coast indicate that prices range for that approximate volume from $0.53 - $0.70 per gallon not including taxes, delivery, and sometimes freight charges. The most common shape of the above tanks is cylindrical approximating 7' in diameter and 8'10" in height. Although it is still possible to put such a tank directly under the eaves a slightly smaller tank with a capacity of 6.8 m3 (1,500 gal.) could be configured such that it sat directly below the eaves. A level base to support the weight of a large tank would need to be prepared before placement and filling. Although unlikely to split during a freezing spell, a drawback for polyethylene is that sunlight will harden the plastic hence the rather limited warranty, in some cases eight years. If a tank is placed below ground, technically known as a cistern and specifically designed to withstand the pressure of burial, the warranty can be improved to 100 years.

There are precast concrete tanks of 4 - 5.5m3 (900-1200 gal.) in stock on the coast suitable for above or below ground installation. These run at about $1.65/gal plus taxes and delivery. Larger units can be ordered.

Other options for tanks are cast in place concrete. This is more cost effective when built during construction. The tank does not have to be located under the home but can be placed under decks or outbuildings. The majority of the professionals contacted stated that these tanks should be lined with a membrane, not only to ensure the potable quality of the water if necessary but also to maintain water tightness when the seemingly inevitable cracks in the concrete occurred. The author was able to locate a homeowner who had a 6,000 gallon (~27 m3) concrete cistern built and then sealed with acrylic 5-6 years ago and has not had encountered any problems. This particular system is used for the irrigation of lawns and gardens with a gravity feed into the cistern and a pump out to the irrigation system; it includes a float switch, a tank gauge, a filter and an overflow drain. The approximate cost was $5,000.

Also available are fibreglass tanks with linings that are approximately triple the price of the polyethylene ones. In Victoria and the Gulf Islands, larger tanks (>15 m3), made of galvanized steel, lined with polypropylene and site assembled are said to be durable and cost-effective.[17] The author has not been able to find anyone familiar with these tanks on the Sunshine Coast.

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[17] *Technology Brief - Rainwater Harvesting in Greater Victoria,* Capital Regional District Water Services, February 23, 2007, page 2, available on line at www.crd.bc.ca/water/conservation/outdoorwateruse/recycling/documents/TechnologyBrief-RainwaterHarvestingforGreaterVictoria.pdf

Collection & Distribution Pipes

Filling a watering can, attaching garden or soaker hose if the plants aren't too much higher in elevation are the simplest methods of distribution for a small outdoor system. For indoor uses PVC pipe of 3-4" diameter is usually used. The home owner should consider cleanouts and ball valves to isolate different components of a more complicated system.

Pressure Tank & Pump

For small outside systems submersible pumps from $20 -$160 will produce enough pressure to, for example, run a drip irrigation system. Larger pumps were quoted at $600-$1500. For an indoor system, the pressure tank and pump quotes began at $1000.

Treatment

The cheapest conditioner, or debris remover, is a piece of netting secured with an elastic band over the downspout pipe leading to a small rain barrel. This will need frequent manual cleaning depending on the cleanliness of the roof. For larger systems debris pigtails in the collection pipes allow coarse debris to fill up dead ends while the clean water overflows to the collection tank. Screw in caps allow for easy routine cleaning. Other options include high capacity traps located in the downspouts; these retail on line beginning at $275.[18]

The size of a first flush diverter is determined by the size of the collection area. Once sized, a simple diverter can be manufactured using a dead end length of PVC pipe that fills before overflowing with conditioned water to the collection tank. A small hole in the end allows for drainage between rainfall events. For larger roof areas a barrel to capture the first flush may have to be used.

Potable systems will require further filtration and disinfection. A cartridge filter and an ultraviolet lamp is seemingly the most common method because they can be added in line and don't require additional parts for the system. Prices on the internet begin at $275 for the UV lamp alone. Other options include ozone, chlorination, reverse osmosis, and bio-sand filtration[19]. For potable systems, homeowners must be vigilant themselves in the ongoing maintenance of the quality of the water. There are treatments that offer multiple barriers to pathogens, are self monitoring, can operate when the power is interrupted and that can function for longer periods of time before requiring manual maintenance. Prices

[18] Available, for example, from The Rainwater Connection Ltd. at www.rainwaterconnection.com/products/debris_traps/debris_traps.

[19] Available, for example, from Watertiger at www.watertiger.net/

for treatment can increase substantially depending on the option, sophistication, quality and volume of water that needs to be processed.

OTHER COSTS

A building permit is not required in the Sunshine Coast Regional District for installing a rainwater harvesting system that provides water for outdoor uses provided that a cast in place above ground concrete tank is not used. For the indoor systems, including retrofitting a single family dwelling, the applicable sections of the B.C. Building Code are to be followed; the appropriate plumbing permits must be obtained from the SCRD and code procedures followed. A typical house does not usually necessitate engineering approval. A Ministry of Health permit is not required for a single family dwelling.[20]

Using climate data and references in literature or on the internet to determine monthly precipitation and water consumption rates, a homeowner competent in math and plumbing could assemble and install an outdoor and a simple indoor system. For other homeowners or those needing more complicated systems professionals are available. Although rainwater harvesting is relatively unknown on the coast, there are examples of outdoor irrigation and combined non-potable and potable indoor systems for single family residential homes in the SCRD. Perhaps because of its infrequency, it was difficult to obtain quotes for engineering, design and installation based on generalized scenarios.

GENERALIZED SYSTEMS COSTS

A couple of hundred dollars can set up a small outdoor rain barrel system. Costs can be reduced by eliminating the tank altogether and directing downspout pipes into a simple network of pipes that direct water directly to the gardens. Created or natural ponds could store water over an extended time.

A rough budget of about $3000 was quoted locally for a small indoor non-potable system[21]. This matched the estimation of the February 23, 2007 report on rainwater harvesting in Greater Victoria produced by the Capital Regional District. The District's cost was based on a larger home with higher occupancy; 900 mm of annual precipitation (the average of 600-12,000 mm throughout the CRD) with 7-10 days between significant rainfall events, a roof area of 200 m2 achieving 85% efficiency and a cistern of 4-6m3. The operating costs were estimated at $25 per year.[22]

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[20] Allan Whittleton, Chief Building Inspector, SCRD. Personal communication, 2008-10-21

[21] Suncoast Waterworks Inc., Spring 2008

[22] *Technology Brief – Rainwater Harvesting in Greater Victoria*, page 5

The same report estimated that for a single family residence with an annual water demand of about 315m3 (including 70m3 of landscape irrigation), the capital cost of a system sized to "…augment all end uses of water as cost-effectively as possible."[23] would be $5,000. This home would have a storage tank of 8m3 which would supply about 45% of the annual demand. The annual operating costs would be $100.

The above conclusions were based on the 2007 CRD water rates which were in the range of $0.50-2.00 per cubic meter and included, if applicable, volumetric sewer charges. The authors determined that the most cost effective rain water harvesting system was the non-potable indoor system installed at the time of building construction. The estimated cost was $2.00-$2.50/m3.

DISCUSSION

Water rates for single family residences in the SCRD connected to the Chapman Creek system are at the low end of the CRD range. The vast majority, including the District of Sechelt and Sechelt Indian Government District, are currently paying a flat fee for water usage. Within the regional district itself, this is a combination of the Land Charge (up to one acre) of $198.87 plus User Fee per dwelling unit of $175.32. The sum of these charges divided by the average consumption per household (593*2.3*352) is equal to $0.78/m3. Although the average rainfall in the SCRD is higher than in the CRD the total yearly amount of water used by the average household in the SCRD is significantly higher at 480m3; at such low water rates the biggest drawback to rainwater harvesting is that it is not currently cost effective to the consumer.

Cost-effectiveness increases when rain water harvesting is incorporated during new construction, when the collection surface (roof) is large compared to demand and when the cost of supplying water and managing waste water increases. The former will occur in the near future with both the Town of Gibsons and the Sunshine Coast Regional District moving towards the metering of water. With respect to the latter, the SCRD does not manage storm water, but both the District of Sechelt and the Town of Gibsons have policies that require that new construction must maintain current storm water levels; that is, water runoff is not to increase between pre and post development. Rain water harvesting can help in capturing water during peak run off and slowly releasing it later either as irrigation or for indoor uses.

For the homeowner, whose concern is irrigation of the gardens, rainwater harvesting provides the freedom to irrigate whenever and however the homeowner desires. It can provide insurance against the time that the SCRD has to ban sprinkling because of low flow conditions in Chapman Creek caused either by increased demands or effects of

[23] Ibid, page 3

climate change. Living Water Smart: British Columbia's Water Plan urges both communities and individuals to adapt to such effects of climate change. Finally, many gardeners see the quality of rainwater as superior to treated tap water for their plants. The outdoor system can also be used without restriction for topping up pools, hot tubs, washing driveways and pressure washing.

For indoor use the greatest benefit is that the homeowner has other options in the treatment of their potable water. For those that do not wish to add chemicals to their water there is the option for example, to filter and then treat the water with ultra violet light to kill possible pathogens. Both outdoor and indoor systems can also be used for fire suppression or in the event of catastrophic damage caused by an earthquake.

Although the cost-effectiveness to the consumer will increase in the future as the price of water goes up, there are other benefits to rain water harvesting for both the consumer and local government that are applicable now. Of the greatest interest is the provincial government's intention to mandate purple pipes in new construction for water collection and reuse by 2010[24]. Not only is rainwater to be collected but also water from dishes, showers and washing which will be used for the flushing of toilets and the watering of gardens. The province's new vision for the management of water, which recognizes the limit of the environment to provide us with endless amounts of water, the unpredictable effect of climate change on the water cycle and the escalating cost of supplying water, makes rain water harvesting a very important tool for municipal governments to promote water conservation and reuse. The side effect of participating in rain water harvesting is that homeowners tend to reduce their overall water consumption.

In the October 2007 report Greening the B.C. Building Code: Background Research Water Efficiency, the authors identify three tools for increasing water use efficiency: regulatory, economic/ financial, and information-based tools.[25] Rainwater harvesting is an accepted method of increasing water use efficiency but it can also be used as one or all of those tools. The provincial government may provide the regulatory tool with the mandatory use of rainwater in two years' time. In addition, if the local governments were to continue and to increase their promotion of rainwater harvesting then the publicity itself becomes an information-based tool to promote the re-evaluation of water consumption by the consumer. Add an economic/financial incentive in the form, for example, of a subsidy on storage tanks for a given time period and rainwater harvesting has the very real potential to postpone local governments' much larger and costlier infrastructure development on the primary source of water.

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[24] www.livingwatersmart.ca , page 77.

[25] Prepared independently by Light House Sustainable Building Centre. Available on line at www.housing.gov.bc.ca/building/green/Lighthouse Research on Water Efficiency Measures Oct 22 07.pdf

RECOMMENDATIONS FOR LOCAL GOVERNMENTS

Long Term Recommendations

1. **Promote rain harvesting** as an alternate storage opportunity that targets water use during the lowest flow time of the year which coincides with the summer season's peak water demand period.

2. **Continue with public education programs** that focus on the value of water and the need for water conservation in relation to emerging environmental and economic circumstances.

3. **Clarify for the public** the fact that emerging water-use conflicts and potential shortages can not be responsibly ignored any longer.

4. **Set goals and objectives** for total rain harvesting storage capacity by 2019. For example, a reasonable goal might be 6,000 homes each with rain harvesting systems capable of storing a minimum of 9 m3 (2,000 gal.) for non-potable uses such as irrigation, toilets and laundry.

5. **Consider creating a subsidy** and other regulatory tools to motivate home owners and developers to install rain harvesting systems.

6. **Develop generic plans** describing construction, installation and permitting requirements of typical rain harvesting systems along with lists of suppliers and contractors that can meet the public's needs.

Short Term Recommendations

1. **Develop a plan** for complying with the Province's Living Smart Water goals and objectives. Many water conservation measurers will become mandatory by 2012; a proactive approach is prudent and will minimize expenses and other impacts for residents. See www.LivingSmartWater.gov.bc.ca

2. **Organize and promote a workshop** on the use and construction of rainwater harvesting systems: see http://www.rainwaterconnection.com/services/service.htm

3. **Continue supporting the use of rain barrel systems** on the Sunshine Coast: see http://www.crd.bc.ca/water/conservation/outdoorwateruse/recycling/documents/rainwatersuppliersupdatedAugust2008.pdf

4. **Publish a list of suppliers, designers, installers** of rain water systems and components. This list could be divided into three for outdoor irrigation (would

include landscapers and irrigations specialists), non-potable indoor and potable indoor (would include water treatment specialists) systems.

5. **Publish a brochure about permit obligations**. Confusion is evident about what kind of permits are and are not required for rain water harvesting within the different jurisdictions of the coast and for which rainwater harvesting systems. This publication should not only be posted on each government's web site but should also be made available to suppliers/designers/installers of the systems.

6. **Create a demonstration system** in a public location with self-directing signage. The Iris Griffith Centre already has an indoor potable system set up and they are pleased to explain to the public how it works. Ideas for the location of an irrigation system include Chaster House, the ferry terminals, the Sunshine Coast Salmon Enhancement Chapman Creek Hatchery. Any public building might be a suitable candidate.

7. **Significantly subsidize purchase of storage tanks** for the first few rain harvesting system builders in each regional area in exchange for publicity, images and data. Water storage tanks are the most expensive item in the system.

8. **Promote the building of "cast in place concrete cisterns"** for rain water storage under ancillary buildings when building permits are applied for. Cisterns allow much greater volumes to be captured; 45 m3 (10,000 gal.) could be stored under a garage.

Other Water Saving Suggestions

1. Offer a rebate on purchase of water efficient washing machines (in addition to B.C. Hydro subsidy).
2. Offer a rebate on irrigation controllers and rain sensors for efficient irrigation systems.
3. Offer workshops and workbooks on planning/installing an efficient irrigation system.

For all three suggestions see: http://www.crd.bc.ca/water/conservation/rebates/index.htm.

LOCAL RAIN BARREL, TANK & CISTERN SUPPLIERS: Updated to 01/28/09

Supplier	Product	Capacity	Child Resistant	Comments
Bonniebrook Industries 604 886-7064	Polyethylene tanks & cisterns	45-2,500 gal. (205 L-11.3 m3)	Yes	Supplier for Canwest Tanks & Ecological Systems Ltd.
Canadian Tire 604 885-6611	Plastic barrels	205-180 L (45-40 gal.)	Yes	Modified with spigot and hose
Casey's Country Garden Ltd. 604 885-3606	Recycled wooden wine barrels	120 L (26 gal.)	Yes	Must be modified
Gibsons Building Supplies 604 886-8141 604 885-7121	Re-used plastic barrels; polyethylene tanks & cisterns	45 gal. (205 L); 25-4,160 gal. (114 L-18.91 m3)	Yes	Recycled barrels can be modified; some are fitted with a spigot. Supplier for Canwest Plastics & Ecological Systems Ltd. and Premier Plastics Inc.
Home Hardware 604 886-2442 604 885-5818 604 885-9828	Plastic barrels	42-50 gal. (191-227 L)	Yes	With spigot, overflow, some flat-back, some with garden hose
Kleindale Nursery 604 883-9183	Plastic barrels	90 gal. (409 L)	Yes	Modified for irrigation with spigot and hose
MPH Supply Ltd. 604 740-9887	Polyethylene tanks & cisterns	25-4,160 gal. (114 L-19.91 m3)	Yes	Supplier for Premier Plastics Inc.
RONA Home Centre 604 883-9551	Polyethylene tanks and cisterns	25-4,160 gal. (114 L-18.91 m3)	Yes	Supplier for Canwest Plastics & Ecological Systems Ltd. and Premier Plastics Inc.
Swanson's Ready Mix 604 885-9666	Pre-cast concrete tanks	650 gal. (2.95 m3) in stock	Yes	Suitable for above or underground
Sunshine Coast Nursery 604 886-2796	Plastic barrels	45 gal. (205 L)	Yes	With spigot & overflow opening

Disclaimer: The SCCA was supplied with this information by local businesses and should not be held responsible for discrepancies between the information in the table and information received when you contact these businesses. Mention of company names or commercial products does not constitute endorsement or recommendation of the services or products.